



The missing intangibles: nature's contributions to human wellbeing through place attachment and social capital

Yuki Yoshida¹  · Hirotaka Matsuda² · Kensuke Fukushi^{3,4} · Kazuhiko Takeuchi^{3,5} · Ryugo Watanabe⁶

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Abstract

Communities in socio-ecological production landscapes and seascapes are aging and depopulating. While longstanding interdependence of humans and nature in such areas holds crucial hints for sustainable development, they continue to be undervalued by existing economic frameworks. We suspect omission of non-material nature's contributions to people (NCPs) as a possible reason for this undervaluation and focus on the intangible aspects of human–nature relationships: people's direct and emotional attachment to their land and interrelationships between close-knit human communities and a thriving natural environment. Field observations on Sado Island, Japan, and literature reviews informed our hypothesis that perceived nature, conceptual human–nature relationships, place attachment, and social relationships contribute to subjective wellbeing. Structural equation modeling of island-wide questionnaire responses confirmed our hypothesis. Nature contributes to wellbeing by enhancing place attachment and social relationships; ecocentrism contributes to greater values of perceived nature. Free-response comments elucidated how local foods and close interpersonal relationships enhance residents' happiness and good quality of life, as well as how aging and depopulation impact their sense of loneliness. These results lend empirical support to the understanding of human–nature interdependency in socio-ecological production landscapes and seascapes. In assessing their value to local residents and society at large, greater consideration should be given to intangible aspects of human–nature relationships and quality of life.

Keywords Human–nature relationships · Quality of life · Socio-ecological production landscapes and seascapes · Cultural ecosystem services · Non-material nature's contributions to people · Relational values

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✉ Yuki Yoshida
yoshida.yuki@nies.go.jp

- ¹ Center for Climate Change Adaptation, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba, Ibaraki 305-8506, Japan
- ² Department of Agricultural Innovation for Sustainable Society, Faculty of Agriculture, Tokyo University of Agriculture, 1737 Funako, Atsugi-shi, Kanagawa 243-0034, Japan
- ³ Institute for Future Initiatives, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
- ⁴ Institute for the Advanced Study of Sustainability, United Nations University, 5-53-70 Jingumae, Shibuya-ku, Tokyo 150-8925, Japan
- ⁵ Institute for Global Environmental Strategies, 2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115, Japan
- ⁶ Sado City, 232 Chigusa, Sado City, Niigata 952-1209, Japan

Introduction

Human wellbeing has long been the objective of sustainable development and understood to depend on nature and nature's contributions to people (NCPs) (Kates et al. 2005; Díaz et al. 2015). However, imbalance of human and ecological systems continues to jeopardize nature and thereby the wellbeing of current and future generations (Steffen et al. 2015; IPBES 2019). Within this context, this study aims to tackle the undervaluation of NCPs in rural communities. Socio-ecological production landscapes and seascapes, or Satoyama-Satoumi land- and seascapes, are considered model societies of human–nature harmony (Takeuchi et al. 2016). Their multifunctional landscapes not only enhance human wellbeing and community resilience (Schippers et al. 2014; Ebi et al. 2020), but provide habitat for diverse flora and fauna (Takeuchi 2010). Moreover, longstanding interdependence of humans and nature holds crucial hints for our

future (Takeuchi et al. 2016). But while intangible aspects of this relationship such as people’s direct and emotional attachment to their land, or the interrelationships between close-knit human communities and a thriving natural environment remain scarcely understood (Biedenweg et al. 2017), many of these societies are challenged by the global phenomenon of rural depopulation and aging (UN DESA Population Division 2019). We suspect our societal focus on monetary values and the most materialistic NCPs (Yoshida et al. 2018) to be an underlying cause for their systemic decline.

Why non-material NCPs?

Discourse in the policy-making arena has focused on material aspects of the human–nature relationship (Muhar et al. 2017). Frameworks such as of ecosystem services are used in ways considered more objective, more conducive to monetization, and at the macro-level to rationalize the legitimacy of considering human–nature relationships in policy (Muradian 2013; Allasiw et al. 2016). Failing to address non-material human–nature relationships, however, can be counterproductive (Comberti et al. 2015) and detriment less tangible aspects of the human–nature relationship that are nonetheless critical to wellbeing (Rode et al. 2015). Moreover, these “less tangible” aspects of a place can be more important to inhabitants (Martín-López et al. 2012) and determine their environmental behavior (Gobster et al. 2007; Orenstein 2013).

In this paper, we use the term “intangible” to encompass the primarily non-material aspects of the human–nature relationship. The term originates from UNESCO’s concept of intangible cultural heritages (Kurin 2007). No matter how crucial, intangible heritages are loaded with cultural meanings and significances (Lenzerini 2011) and may not be equally understood or appreciated by an outside group. Intangible human–nature relationships, too, are inarguably real, but may be best assessed through individuals’ perceptions.

Conceptual framework

We hypothesize that non-material NCPs enhance peoples’ subjective wellbeing. More specifically, we hypothesize that these NCPs take the form of place attachment and social relationships, and that peoples’ conceptualizations of their relationship with nature predict the richness of these NCPs (Fig. 1). The rest of this introduction summarizes the literature (reviewed in greater detail elsewhere (Yoshida 2018)), which, in combination with field observations, informed our theoretical and empirical understandings of human–nature relationships. Subsequent sections will report on our postal questionnaire, which gathered quantitative and qualitative

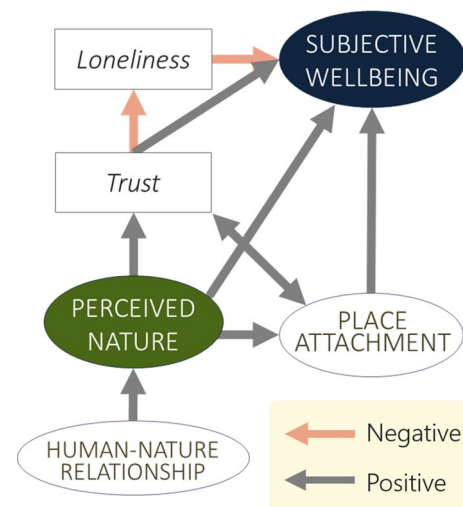


Fig. 1 Hypothesized model of how nature contributes to human wellbeing in the intangible human–nature relationship

data to examine one Satoyama-Satoumi community’s experiences of the NCPs.

Wellbeing and its determinants

Wellbeing Wellbeing is a vast and dynamic concept, as is the literature on nature’s benefits on human wellbeing. Studies have assessed direct influences of contact with nature on positive emotions (Tarrant 1996; Hartig et al. 2003; White et al. 2010) and life satisfaction (Kaplan and Stephen 1995; Vemuri and Costanza 2006). Similarly, connectedness with nature (Perrin and Benassi 2009; Cervinka et al. 2011) and works on nature-embedded constructs of wellbeing, such as the Ecuadorian *Buen Vivir* (Guardiola and García-Quero 2014) and Edward Wilson’s *Biophilia Hypothesis* (Wilson 1984; Gullone 2000), suggest that human wellbeing benefits from inherent, or intrinsic, values of nature. The concept of relational values of nature, too, reframes the importance of the human–nature relationship to our wellbeing (Díaz et al. 2015; Chan et al. 2016).

Self-reported measures of wellbeing are influenced by some noise but considered reliable enough for empiric studies (Di Tella and MacCulloch 2006). Consistency of responses to various measures of subjective wellbeing has been verified across situations and time (Sandvik et al. 1993). Their convergent and discriminant validities have been demonstrated with behavioral and physiological correlates (Sandvik et al. 1993; Shedler et al. 1993; Di Tella et al. 2003; van Reekum et al. 2007), and an experimental study using various self-reported measures of wellbeing reported limited bias due to social desirability (Konow and Earley 2008). “Subjective wellbeing” is used here to refer to perceived wellbeing based on self-reports of respondents.

The term is regularly used interchangeably with “happiness” and “life satisfaction” (Matsushima and Matsunaga 2015), and we adopt it here as an umbrella term for closely related constructs.

Notably, many moderators of seemingly direct NCPs, such as natural beauty (Zhang et al. 2014), health (Howell et al. 2011; Seymour 2016), and other psychological constructs, e.g., meaning in life (Howell et al. 2013), complicate the isolation of direct benefits from perceived nature to subjective wellbeing. We thus include a direct path from nature to subjective wellbeing in our analysis but focus on the moderation of these benefits through social relationships and place attachment (Fig. 1).

Social capital and loneliness Social capital is variously defined, but generally refers to the “norms and networks facilitating collective action for mutual benefit” (Michael Woolcock and Apr 1998, p. 155) and is often understood as social norms, trust, reciprocity, and civic engagement (Kawachi et al. 1997; Healy et al. 2001). Many studies link social capital to subjective wellbeing (Kuroki 2011; Bartolini and Sarracino 2014; Helliwell et al. 2016b) as well as to indirect determinants of wellbeing such as health (Kawachi et al. 1999; Rose 2000; Ziersch et al. 2005), economic productivity, democracy, and child welfare (Putnam 2000; Healy et al. 2001). Some specify that its impact on happiness may be stronger than that of education or income (Healy et al. 2001).

Following common practice, this study uses generalized trust (of unknown others) to operationalize social capital (Delhey et al. 2011). Social trust is one of the oldest and most available indicators for social capital (Helliwell et al. 2016a), correlates closely with other measures on civic engagement and social connectedness (Putnam 2000; Healy et al. 2001), and is known to yield policy-relevant results (Harper 2001; Bjørnskov 2006).

One impact of Sado’s population decline on resident experiences may be increased isolation, resulting in loneliness, or feeling that one has “too few” social relationships (Russell et al. 1980, p. 472). At the same time, rural communities in areas such as Sado are known to be tight-knit and closed. As the intimacy of connections matter for loneliness more than sheer social contact (Baumeister and Leary 1995), social needs of well-immersed community members may be fulfilled despite a low population density. We consider loneliness in addition to generalized trust in light of its known, adverse impacts on wellbeing (Baumeister and Leary 1995) and pertinence to Sado’s declining demography.

Place attachment Literature on place and place attachment is riddled by ambiguity and multiplicity of definition across academic disciplines. For compatibility with the breadth of topics we aimed to cover, we focused on the quantita-

tive strength or importance of a person’s bond with a place (rather than on the qualitative meanings of places) (Lewicka 2011). Further, place attachment is seen to have both functional and emotional attributes: place dependence and place identity, respectively (Williams et al. 1992). We draw upon Williams and Vaske’s (2003) questionnaire, originally designed to assess place attachment within the context of recreational destinations, and since adapted for use in other contexts (Jorgensen and Stedman 2001; Brown and Raymond 2007).

Place attachment is known to improve subjective wellbeing. For example, Scannell and Gifford (2017) report on the various psychological benefits of place attachment. Residents of Swedish mountain communities who were more strongly attached to certain places reported a greater sense of wellbeing when visiting those places than residents who were less attached (Knez and Eliasson 2017). The emotional attachment, place identity, best predicted wellbeing in this study. Separation from place, such as through relocation, is reported to have adverse emotional and cognitive impacts on wellbeing (Scannell and Gifford 2017).

Perceived nature Perceived nature here refers to respondents’ subjective evaluation of their natural surroundings. A forerunner in this regard was found in forestry, where early discussion questioning a commodified view of forests led to the suggestion that multiple values be considered in forestry management (Rolston and Coufal 1991). The list of values has been modified (Brown and Reed 2000; Brown 2005), adapted as landscape values, and empirically validated in multiple contexts beyond forestry (Brown 2003; Alessa et al. 2008; Cerveny et al. 2017). Mapping studies report partial to moderate overlap of landscape values with biophysical and ecological measures of the context (Brown 2005; De Vreese et al. 2016).

Conceptual human-nature relationships In the literature, “human–nature relationship” is used to refer to a spectrum of material and non-material relationships. Non-material aspects, the focus here, are variously referred to with terms such as values, value orientations, worldviews, connectedness with, visions of, and social representations pertaining to nature (Flint et al. 2013; Yoshida 2013; Muhar et al. 2017). We borrow van den Born’s (2008) definition, “views that people hold about their appropriate relation with nature” (p. 87), which overlaps with many of these terms. Conceptual relationships with nature have been empirically linked with nature-relevant behaviors (Braito et al. 2016, 2020; Yoshida et al. 2017), and understanding of these cognitive, affective, and cultural relationships with nature is considered essential for promoting any change in the material relationship (Guerry et al. 2015).

Interrelationships among perceived nature and the NCPs

Social capital and place attachment Past studies attest to a positive linkage between place attachment and social capital. For one, social relationships are encompassed within the concept of “place” in place attachment literature (Mesch and Manor 1998; Scannell and Gifford 2017). Other studies have examined the two as separate concepts and confirmed causality in both directions (Mesch and Manor 1998; Lewicka 2005; Stefaniak et al. 2017). Additional evidence suggests that positive influence of place attachment on social capital may be mediated by belongingness (Scannell and Gifford 2017). Place attachment may increase one’s sense of belongingness by reinforcing feelings of embeddedness in the community and through symbolic connections with ones’ ancestors or culture. This sense of belongingness is suggested to enhance the community’s social capital through increased effectiveness of civic activities.

Perceived nature and social capital There is an extensive body of environmental psychology literature on the benefits of urban green spaces, one strand of which attests to its positive impact on social capital (Kweon et al. 1998; Sullivan et al. 2004; Wood and Giles-Corti 2008; Seeland et al. 2009; Holtan et al. 2014; Hadavi 2017). These studies broadly agree that green spaces enhance neighborhood social capital by facilitating social interactions. Green spaces are further reported to foster inclusive interactions (Seeland et al. 2009) and to flatten social inequities (Mitchell and Popham 2008). Both objective and subjective measures of nature have been used, and findings in rural settings have also come to consistent conclusions (Weinstein et al. 2015).

Social capital has also been discussed as an ecosystem service, i.e., NCP. The Millennium Ecosystem Assessment (2005) situates aspects of social interactions frequently used to measure social capital, such as social relations, cohesion, and interactions, as components of human well-being. Subsequent discussions of cultural ecosystem services led to the explicit inclusion of social capital and cohesion as one of the cultural services provided by ecosystems (Chan et al. 2012).

Social capital is further known as beneficial to nature. Barnes-Mauthe et al. (2014) find that cohesive communities are better positioned for collective action to effectively manage ecosystems. They conceptualize the relationship as bi-directional, whereby natural capital fosters social capital by facilitating interactions. We too acknowledge this bi-directionality of the relationship between social capital and nature but are constrained in analytical power to assess this explicitly. Given the greater volume of literature on the benefits *from* nature, we have chosen to focus on this causal direction.

Perceived nature and place attachment Existing literature purports that nature fosters place attachment. As converse examples, environmental degradation led to loss of place attachment in many parts of the world (Burley et al. 2007), and lack of natural capital in urban or built environments has seen similar impacts on human connectedness with nature (Schultz 2002; Louv 2008). Further, as expected from reports that intangible aspects of human–nature relationships are influenced by their context (Flint et al. 2013; Eastwood et al. 2016), different physical environments are likely to have differing outcomes for place attachment. Perceptions and responses of a given context will also differ for each person. Indeed, the effect of place attachment altered according to what “place,” or object of attachment, respondents considered (Scannell and Gifford 2017). People who reported being attached to outdoor areas, the place type most closely associated with nature, were more likely to report psychological benefits of relaxation and activity in the area, but less likely to report practical benefits such as of provisioning ecosystem services. Similarly, studies using participatory mapping of landscape values report that different values of the landscape coincide with, and likely contribute to, greater place attachment (Brown and Raymond 2007).

Study context

For our empirical study, we chose the island city of Sado, Japan, as an illustrative case of the undervaluation of NCPs in rural communities. The community is recognized as an exemplary Satoyama-Satoumi and Globally Important Agricultural Heritage Site (GIAHS of FAO), yet struggles with a precipitous population decline from its peak of over 125,000 residents in 1950, to less than 55,000 in 2020 (Sado City Education Committee 2011; Sado City 2020). We previously demonstrated the undervaluation of Sado’s natural capital using an economic metric (Inclusive Wealth Index); Sado’s per capita natural capital was nonetheless roughly triple that of national averages (Yoshida et al. 2018). Here, we aim to address subjective realities of how islanders experience and value nature and NCPs that are pertinent to their wellbeing, but have yet to be included in economic evaluations of societal welfare.

Materials and methods

The questionnaire was titled “Sado’s wealth and happiness” and distributed as an 8-page booklet. A description of the study was printed on the outer envelope and as an enclosed information sheet. The description also clarified that the questionnaire was voluntary and anonymous, organized by The University of Tokyo and supported by Sado City.

Both the lead author and City office's contact details were provided.

Table 1 compiles the constructs assessed in this study, explained briefly below. All items have been translated from Japanese.

- **Subjective wellbeing.** Three items from differing conceptual backgrounds: single-item measures of happiness and life satisfaction commonly used to assess subjective wellbeing (Mellor et al. 2008; Veenhoven 2017), and a third item that assesses mental wellbeing in a longstanding domestic survey (Takahashi and Aramaki 2014). To minimize the influence of other questions on responses to this dependent variable, these questions were placed at the beginning of the questionnaire. A common prompt asked respondents to answer the questions about their life in general.
- **Social capital.** A widely used, single-item measure of generalized trust (Reeskens and Hooghe 2008).
- **Loneliness.** We adopted a single-item measure, considered better suited for an elderly population (Holmén et al. 1992) than the popular UCLA Loneliness Scale (Russell 1996).
- **Place attachment.** Five items assessing emotional aspects of place attachment were based on Williams and Vaske's (2003) questionnaire. Respondents were asked to answer the questions about their local community (*chiiki*), specified as "hamlet (*shūroku*)/group of hamlets (*shūrakugun*)."
- **Perceived nature.** Landscape values were operationalized to assess the quantity of nature. These questions specified the context as regarding the natural environment of the respondent's local community (*chiiki*). Responses to this measure have been verified against land cover data (Yoshida et al., Manuscript in preparation).

Table 1 Questionnaire items and descriptive results

Concept	Item	<i>n</i>	<i>M</i>	<i>SD</i>
Subjective wellbeing				
Happiness	All in all, I am happy right now	529	3.64	1.07
Life satisfaction	All in all, I am satisfied with my life	530	3.44	1.12
Sense of purpose and peace	I live with a sense of purpose, and peace and vigor of heart	530	3.32	1.14
Place attachment^a				
Part of me	I feel 'X' is a part of me	523	3.22	1.09
Special to me	'X' is very special to me	522	3.27	1.07
Identify with	I identify strongly with 'X'	527	3.30	1.09
Attached to	I am very attached to 'X'	524	3.42	1.12
Incomparable	No other place can compare to 'X'	524	3.12	1.05
Perceived nature				
Therapeutic	There is a lot of natural environment that links to mental and physical comfort	526	3.69	1.01
Aesthetic	There is a lot of beautiful nature and sceneries	527	3.92	0.96
Spiritual	There is a lot of natural environment with spiritual or religious value	523	3.23	1.02
Social capital				
Trust	In general, do you think that people can be trusted? ^b	521	3.22	0.93
Loneliness				
	Do you experience loneliness? ^c	527	2.50	1.06
Human–nature relationships				
Partner	Nature and I help each other. Nature is a partner/buddy	501	3.57	1.10
Steward	I have the obligation to maintain and manage nature and to leave it for future generations	502	3.73	1.09
Participant	I am part of nature, and strongly bonded both mentally and bodily	500	3.40	1.08
User	My happiness depends on the blessings of nature	504	3.56	1.08

5-pt Likert scale unless otherwise specified (1: "Do not think so at all," 3: "Neither," 5: "Think so very much")

^a'X' refers to place of relevance

^b1: "Cannot be trusted at all," 3: "Neither," 5: "Can be very trusted."

^c1: "Never," 2: "Occasionally," 3: "Sometimes," 4: "Often," 5: "Always."

- **Ecocentrism** (conceptual human–nature relationships). Four items from a previous study of US farmers (Yoshida et al. 2017) addressed ecocentric types of human–nature relationships: the most ecocentric Participant, Partner, Steward, and relatively anthropocentric User. Respondents were asked to indicate their agreement with each statement regarding their land or surrounding natural environment.
- **Open-ended questions.** Three open-ended questions were included toward the end of the questionnaire. The questions were, “What is Sado’s wealth, to you?” “How does that wealth relate to your happiness?” and, “Free response: please write if you have any additional comments on Sado’s wealth or happiness of living in Sado.”
- **Demographics.** Questions on demography were included at the end of the questionnaire. Respondents were asked to select the most fitting response for multiple choice questions on sex, education, occupation, and household income.

Sampling was stratified by age and district with the aim of representing all Sado residents of Sado. First, we determined the sample size based on a target confidence interval of 95% and known response rates (30–45%) to a shorter survey with a comparable target group (Table 2). Second, questionnaires were allotted proportionately by population to the city’s ten districts. Third, target numbers were apportioned to age groups based on population size and representation in a previous survey, i.e., expected response rates. Finally, recipients were randomly selected by age group and district from the city’s Basic Resident Register (*jyūmin kihon daichō*), omitting those registered with a medical or care facility or residents younger than 15-year-old.

A list of the age and district groups with associated identifier numbers and sealed, numbered envelopes containing a numbered questionnaire, information sheet, and prepaid

return envelope were prepared by the researchers. The list and questionnaires were sent to the Sado City Hall, where officials selected recipients, addressed the envelopes, and posted the questionnaires. Responses were received at the City Hall and forwarded to the researcher. The sub-district (*aza*) of residence and age of questionnaire recipients were provided by the city to enable subsequent matching with identifier numbers while protecting the residents' identity.

Structural equation modeling tests latent constructs by considering each questionnaire item rather than an aggregated variable assumed to represent that construct (Jöreskog 1970; Ullman and Bentler 2004). In a similar manner, it removes measurement error and assesses causal relationships where dependent variables may simultaneously predict another. As such, its analytical strength with complex, multi-dimensional phenomena drives its increasing use across both social (Goldberger 1972; Maccallum and Austin 2000; Tarka 2018) and ecological sciences (Grace 2006; Schweiger et al. 2016); we applied this technique using STATA.

Responses to open-ended questions were coded for emergent themes. Each comment was reviewed in two separate sittings to ensure that all comments were coded with the completed list of codes and for verification.

Results

Respondents

Of 1464 questionnaires sent, 7 were undeliverable and 536 were answered, resulting in a 36.8% response rate. Data were entered in Microsoft Excel by the lead author and assistants. All entries were reviewed in a different sitting than the inputting.

Table 3 summarizes demographic characteristics of the respondents alongside population statistics. Most

Table 2 Age distribution of Sado’s population (2015), respondents of a prior questionnaire (2016), and recipients, respondents and response rate (rr) of the present study

Population (18–79 years old)		2016 respondents		Population (15+ years old)		Present study				
Age range	%	<i>n</i>	%	Age range	%	Recipients ^a		Respondents		
						<i>n</i>	%	<i>n</i>	%	<i>rr</i> (%)
18–19	2	16	1	15–19	4	145	10	30	6	21
20–29	8	89	6	20–29	6	133	9	27	5	20
30–39	13	116	8	30–39	10	228	16	56	11	25
40–49	15	188	13	40–49	11	174	12	59	11	34
50–59	18	284	19	50–59	14	213	15	73	14	34
60–69	24	419	28	60–69	19	175	12	119	22	68
70–79	21	383	26	70–79	17	215	15	102	19	47
				80+	18	181	12	68	13	38

Population data: Statistics Bureau of Japan (2017)

^aRecipients were selected in five age groups. Eight age groups are shown here for comparison with the 2016 questionnaire

Table 3 Demographic characteristics of questionnaire respondents

	<i>N</i>	Full sample 536	23–65 years old 284	Population 57,255
Age	Range	15 to 94	23 to 65	0 to 100+
	<i>M</i>	57.6	48.2	54
	Median	61.0	49.0	58.6
	SD	19.7	12.4	
	Skewness	– 0.5	– 0.4	
	<i>n</i>	534	284	57,255
Sex	Females	54%	50%	52%
Household income	< 3 million JPY	55%	47%	49%
	3 to < 5 million JPY	24%	27%	26%
	5 + million JPY	21%	27%	24%
	<i>n</i> ^a	423	236	22,070
Education	High school or less	68%	55%	79%
	2-year college or above	32%	45%	21%
	<i>n</i> ^b	487	272	51,510
Occupation	Employed by other	36%	51%	63%
	Self-employed	17%	12%	
	Full-time housework	10%	9%	20%
	Part-time	11%	16%	16%
	Unemployed	26%	13%	3%
	<i>n</i> ^c	475	269	36,865

Population data: Statistics Bureau of Japan (2012, 2017, 2019)

^aOmitting “don’t know” responses

^bOmitting those younger than 23 or in school

^cOmitting “other” and students

respondents were middle-aged or older ($M = 57.6$ years old, Median = 61.0 years old), and roughly half (55%) of the respondents were female. Household incomes of most respondents were under 3 million JPY, as is the case for 49% of Sado residents (Statistics Bureau of Japan 2019).

Preliminary analysis

Responses to questionnaire items are summarized in Table 1. Reliability tests and factor analyses are summarized in Table 4. For all four constructs assessed, only one factor had an eigenvalue above 1, and alpha coefficients of Cronbach’s test of reliability indicated satisfactory to high levels of internal validity. For perceived nature, a factor score was generated to aggregate the three observed measures according to their factor loadings.

Structural equation modeling results

Figure 2 reports results on the hypothesized model ($n = 471$). The model hypothesized that perceived nature positively influences subjective wellbeing through individuals’ social relationships and place attachment. It further posited that the

amount of one’s perceived nature is positively influenced by their ecocentric human–nature relationships.

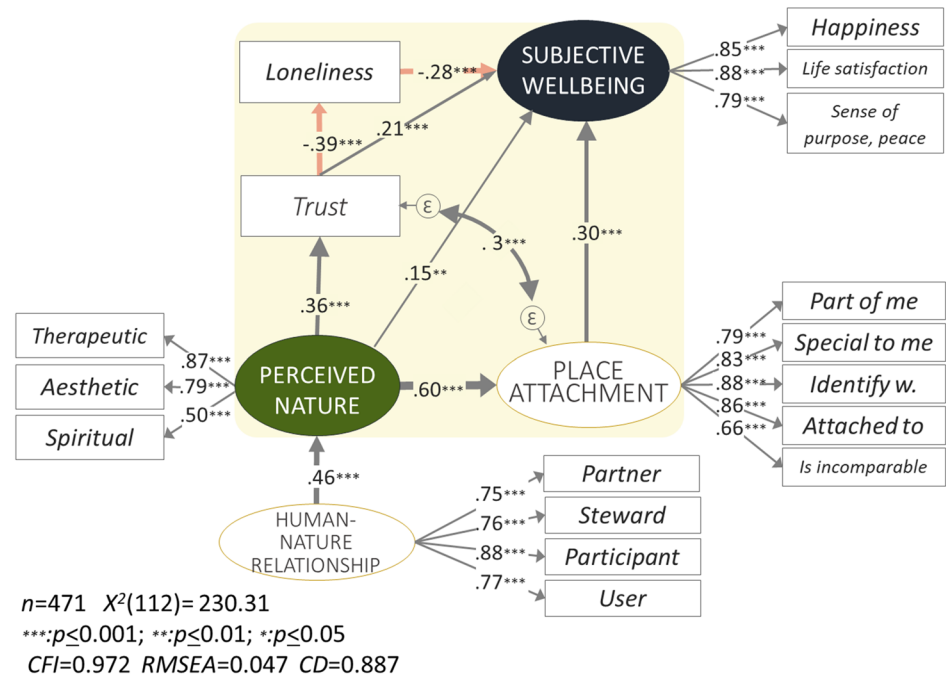
The model fits the data well, supporting all hypothesized paths of human–nature relationships. As would be expected with a sample size greater than 400, the Chi-square test of the model’s fit is significant ($\chi^2(112) = 230.31$, $p \leq 0.001$). The root mean squared error of approximation (RMSEA), which penalizes for unnecessary complexity, also reports a good fit of under 0.05 (RMSEA = 0.047; 90% CI = 0.039–0.056) (Acock 2013). The model explains 88.7% of the variability, and the coefficient of determination (CD), or R^2 , for subjective wellbeing is 45.1%.

The strongest determinant of subjective wellbeing was place attachment ($B = 0.3$, $p \leq 0.001$), followed by loneliness ($B = -0.27$, $p \leq 0.001$), trust ($B = 0.21$, $p \leq 0.001$), and perceived nature ($B = 0.15$, $p \leq 0.001$). Trust had a significant effect on loneliness ($B = -0.39$, $p \leq 0.001$), and was in turn influenced by perceived nature ($B = 0.36$, $p \leq 0.001$). Perceived nature strongly influenced place attachment ($B = 0.6$, $p \leq 0.001$), and was in turn influenced by ecocentric human–nature relationships ($B = 0.46$, $p \leq 0.001$).

As a final step, we added basic demographic characteristics as additional predictors of subjective wellbeing (Fig. 3).

Table 4 Internal validity of construct measures

Construct	Alpha coefficient	Variance explained	Factor loadings	Uniqueness	<i>n</i>
Subjective wellbeing	0.88	80.4%	0.88–0.91		527
Place attachment	0.90	71.4%	0.74–0.89		515
Ecocentrism	0.87	72.2%	0.83–0.89		496
Perceived nature	0.74	66.7%	0.50–0.77		520
Therapeutic			0.76	0.42	
Aesthetic			0.77	0.41	
Spiritual			0.50	0.75	

Fig. 2 Results of the structural equation model

This slightly improved the fit of the model ($\chi^2(176)=315.18$, $p \leq 0.001$, $RMSEA = 0.046$; 90% CI = 0.038–0.054; $CFI=0.961$, $n = 377$; $CD=90.2\%$), even despite the lowered sample size after omission of incomplete or “don’t know” responses on income. Place attachment’s strong influence on subjective wellbeing remains unchanged ($B=0.35$, $p \leq 0.001$). Log of income ($B=0.10$, $p = 0.025$) is a weaker predictor of subjective wellbeing than sex ($B=0.14$, $p = 0.002$) or any of the perceived constructs already included in the model. Neither age ($p = 0.296$) nor education ($p = 0.431$) helps to better explain subjective wellbeing. The CD for subjective wellbeing has improved slightly, to 46.1%. This finding contradicts prior reports that relied on categorical income data and found stronger regressions coefficients for income (0.3–0.5) than for social trust (0.25–0.45) (Helliwell et al. 2016b). Considering the volume of preexisting studies on the importance of loneliness or social capital for wellbeing, the stability of place

attachment’s statistical significance in predicting subjective wellbeing, with and without other constructs, is a noteworthy finding of our study.

Respondent commentary

Of 536 respondents, 357 responded to one or more open-ended prompt on Sado’s wealth and their personal happiness. An overwhelming 90% of the 357 described nature and NCPs (Table 5). “Clear sky and ocean, delicious air,” “experiencing the seasons in the ocean and mountains,” exemplify the emphasis on intrinsic and relational values in 77% of responses. Abundance of good, fresh food was mentioned by 43%. “Good rice and fish. There are many fields, so I can make anything myself. I also receive many blessings of the mountain and am truly happy. It is the source of my wellbeing,” summarized one respondent. Similarly, while

Fig. 3 Structural equation model results with demographic predictors of subjective wellbeing

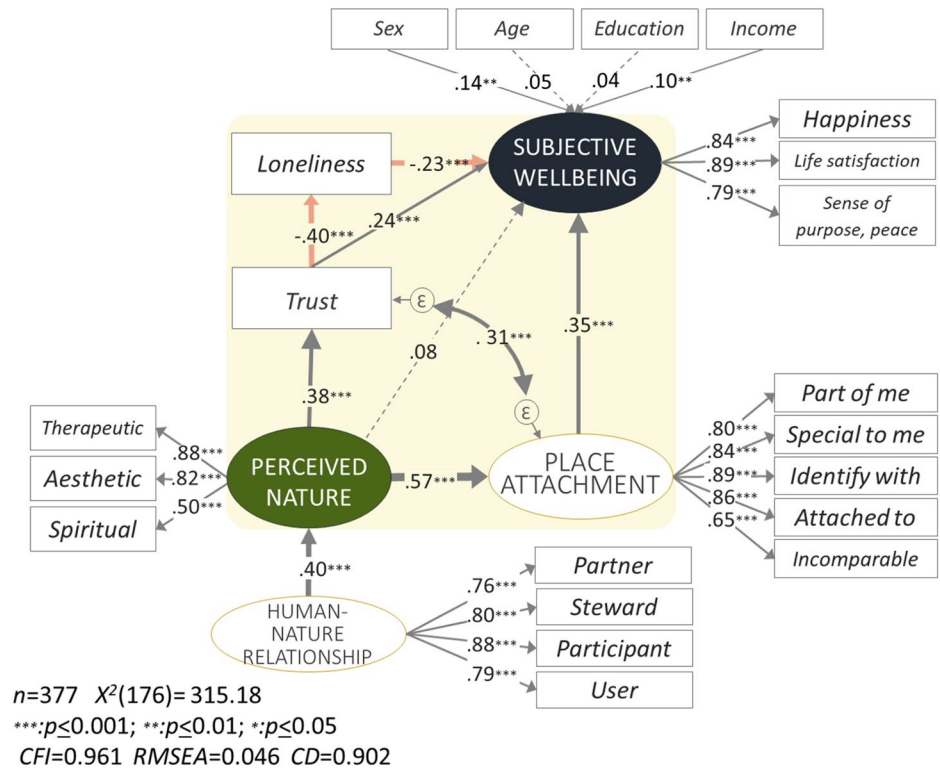


Table 5 Recurring codes and frequencies of free response comments

Codes	n	%*
Nature's contributions to people	320	90
Intrinsic, relational	275	77
Food	155	43
Topography, season	80	22
Absence of natural disasters	19	5
Peace of mind	115	32
Social capital, human character	97	27
History, culture	52	15
Comfort, safety, childrearing	14	4
Unhappy	18	5
Total number of commenters	357	

*All percentages are of the 357 responses to free response questions

7 respondents (2%) noted low incomes or lack of employment as a concern, others elucidated along the lines of above comments, “we do not worry about basic needs even with low income ... we would never be wealthy in the stressful cities that are all about money.” Indeed, 32% of respondents described a deep peace of mind, and all but a few of these comments indicated nature as its source.

Social relationships and community, such as “warm interpersonal relationships,” “helping each other,” and

“human character” were mentioned by 27%. Though stark when mentioned, loneliness was not often mentioned in the questionnaire and generally linked with remoteness and aging. “Aging and depopulation is visibly making the community a lonely place,” and “I will probably die [alone] without even entering senior housing,” were some of the evocative descriptions of unhappiness by 5% of respondents.

Discussion

This study examined intangible aspects of Sado residents’ relationships with nature. Our model based on field observations and literature review hypothesized social capital and place attachment as mediators of the effect of nature on subjective wellbeing. Previous studies also substantiated the role of conceptual human–nature relationships (e.g. ecocentrism) in determining people’s perceptions of and behaviors regarding their environment. However, no prior study encompassed all the pieces of our analysis, and an island-wide postal questionnaire was conducted to assess these relationships. Our analysis confirmed place attachment to be a strong determinant of subjective wellbeing. The role of social capital was secondary despite the large volume of prior works on its importance to wellbeing. Our study thus breaks new ground, not only by illuminating the

non-material ways in which nature contributes to human wellbeing, but also by highlighting the relative importance of place attachment in this context.

In addition to affirming the importance of intangible aspects of human–nature relationships to human wellbeing, the findings can be interpreted for people’s role in enhancing nature. More ecocentric views of the human–nature relationship were associated with higher levels of perceived nature; other studies attest to the objective accuracy of perceptions of nature (Yoshida et al. ; Brown 2005; De Vreese et al. 2016). One explanation for this finding is that individuals’ internal orientations induce differing perceptions of a given physical landscape (Van Riper and Kyle 2014). Another, drawing from past findings on the linkages between ecocentrism and pro-environmental behavior (Braitto et al. 2016; Yoshida et al. 2017), would suggest that ecocentric individuals cause physical changes in the environment by contributing to the maintenance of natural landscapes. These findings elucidate how conceptual human–nature relationships contribute to both tangible and intangible ways in which we relate to nature; in other words, that ecocentrism (broadly speaking) may underlie the harmonious coexistence of humans and nature.

Limitations

We believe that our hypothesized model was theoretically and empirically justified. However, no prior work fully encompassed our model, and we necessarily relied on subjective interpretations of field visit observations and available literature. Additionally, this research focused predominantly on NCPs, i.e. flows from nature to people. While SEM is designed to assess complex, causal models, causal directionality cannot be verified by cross-sectional data (Bollen and Pearl 2013). For example, whether one’s general subjective wellbeing (global life satisfaction) is the cause, or effect, of satisfaction in specific areas of life, such as work, interpersonal relationships or health, has been a topic of continued contest (Headey et al. 1991; Scherpenzeel and Saris 1996; Chmiel et al. 2012). Our focus on subjective wellbeing as the outcome variable is consistent with the more accepted interpretation in preexisting literature (Lucas 2004) but an assumption nevertheless that cannot be verified with the present data.

Findings are also subject to measurement error and self-selection of participants. Recipients of the questionnaire, particularly of a postal questionnaire such as this one, may interpret the questions in unintended ways (De Silva et al. 2006). For example, there is ambiguity regarding the radius of trust (how generalized is “general”?) (Delhey et al. 2011), and responses of Sado residents may not be comparable with responses to the question in another context. Underlining this difficulty, measurement issues with survey assessment

of generalized trust have previously been suggested as an explanation of its weak explanatory power (Delhey et al. 2011). While other questionnaire items have not undergone such prior scrutiny, our measurement of perceived nature diverged from previously validated scales and may also have weakened the fit of models. Additionally, the questionnaire’s title, “Sado’s wealth and happiness,” is likely to have guided participant self-selection and induced more optimistic responses. Critical responses made in spite of this positive framing must be taken with great weight.

Implications and future directions

The combination of place attachment, social capital and ecocentrism in investigating the linkages between nature and human wellbeing was a novel, and thus preliminary attempt. Theoretical lineages of each concept were generally independent of one another, and our findings must be further examined to assess and address their overlaps and discordances. Both theoretical and contextualized research for validation would help to further comprehend and better manage these non-material aspects of human–nature relationships.

Already, the finding that intrinsic orientations toward nature play a significant role in shaping our human–nature relationships, and that this in turn influences people’s subjective wellbeing, sheds critical insight for decision makers. For one, it affirms reports on the detrimental impacts of motivation crowding (Rode et al. 2015), cautioning against nearsighted, if well-intentioned, interferences in people’s human–nature relationships. More fundamentally, the fact that non-material human–nature relationships outweighed the impact of income on subjective wellbeing compels us to reconsider our societal focus on tangible realities and to further invest in addressing these intangible aspects of human–nature relationships.

Academic work has illuminated possible paths forward as we speak. Teaching local history can strengthen place attachment and related benefits including social trust and civic engagement (Stefaniak et al. 2017). Social capital is considered society’s wealth, and most effectively enhanced by increasing social trust among the most disadvantaged (Helliwell et al. 2016a). Childhood exposure to nature and environmental education can enhance feelings of ecocentrism and connectedness with nature (Liefländer et al. 2013; Rosa et al. 2018).

Intangible phenomena often result from cultural and experiential factors that can be difficult to control (Fukuyama 2001). Great caution must thus be exercised to protect and nurture the intangible aspects of human–nature relationships and wellbeing. As convenient and familiar as so-called objective measures of the material world may be, we urge for greater emphasis on to the subjective realities that open new possibilities for nature-conducive development.

Conclusion

This study affirmed hypothesized linkages between nature and good quality of life: non-material NCPs play a significant role in determining subjective wellbeing, and ecocentric human–nature relationships contribute to the upkeep of nature’s values. These results lend empirical support to the understanding of human–nature interdependency in socio-ecological production landscapes and seascapes. In assessing the value of such regions to local residents and society at large, greater consideration should be given to non-material aspects of human–nature relationships and quality of life.

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