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Measuring change in place values using public participation GIS (PPGIS)

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A B S T R A C T

Place values, like human values, are hypothesized to be relatively stable and slow to change over time. In 2004, we conducted a baseline study of place values, called landscape values, with residents of Kangaroo Island (KI), South Australia, using public participation GIS (PPGIS). In 2010, we implemented an internet-based PPGIS monitoring study with the same households to measure changes in the importance and spatial distribution of landscape values. The empirical results indicate general stability in values both in importance and spatial distribution. But the results also suggest that land-use changes such as those resulting from human development will significantly influence the distribution of landscape values. Additional research is needed to advance understanding of landscape values for identifying land-use compatibilities and conflict, and managing public lands in a manner consistent with public values.

Introduction

People are place-makers—we differentiate *place* from *space* by attaching meaning and values to space. The places we identify become "centers of felt values" (Tuan, 1977) that emerge through experience and are influenced by culture. The values that humans associate with place are central to individual and collective decisions about appropriate and desirable land use at multiple scales. Place values are not universal within a given population or region and may be contested, leading to conflict and change in land use over time. The empirical study of place has been examined using different approaches depending on discipline. For example, geographers have commonly taken a phenomenological approach to place, sociologists a social constructionist perspective, and psychologists a cognitive approach (Davenport & Anderson, 2005). Regardless of approach, place values have been treated as emergent qualities of place attachment or sense of place, but not directly measured and spatially quantified. This paper explores the stability and change over time of place values measured using public participation GIS (PPGIS), a method that spatially quantifies place values. With this method, predefined place values are identified by the general public or stakeholder groups using a values typology containing from 10 to 13 values.

Different terminology has been applied to the same predefined place values; they have been variously called forest values (Brown & Reed, 2000), ecosystem values (Reed & Brown, 2003), environmental values (Brown et al., 2002; Brown, Smith, Alessa, & Kliskey, 2004), landscape values (Alessa, Kliskey, & Brown, 2008; Beverly, Uto, Wilkes, & Bothwell, 2008; Raymond & Brown, 2011; Zhu, Pfueller, & Whitelaw, 2010), wilderness values (Brown & Alessa, 2005), and social values (Sherrouse, Clement, & Semmens, 2011). The shifting terminology appears to reflect, in part, the particular study context. For consistency, we refer to these predefined place values as landscape values to connote their applicability to a variety of place settings at a regional scale. The focus of this paper is on measuring change in landscape values and the implications for public participation GIS (PPGIS) used in support of land-use planning. We present and interpret the results of a longitudinal study of residents of Kangaroo Island (KI), Australia, an international tourism destination, that measured landscape values using PPGIS at two points in time, six years apart.

The human value formation and expression process is complex and involves both "held" and "assigned" values. Held values are ideas or principles that are important to people (Lockwood, 1999) and take the form of enduring beliefs about a specific mode of conduct or an end state of existence (Rokeach, 1973). Assigned values express the importance of an object relative to one or more other objects (Brown, 1984). Held values tend to be quite general while assigned values are more specific (McIntyre, Moore, & Yuan, 2008). For example, an individual may value natural areas over built human environments (held value), while the relative pristine coastal landscape of KI's Stokes Bay may be specifically valued by an individual for its scenic beauty (assigned value). Held values are believed to influence assigned values through the subjective evaluation of objects (Brown, 1984; Lockwood, 1999).

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Landscape values are an operationalized form of place value used for natural resource and environmental planning applications (Brown, 2005). A landscape value is best described as a type of "relationship" value that bridges held and assigned values. In the process of associating meanings with place, what is personally important to an individual becomes fused with conceptions of what appears important to the individual in the physical landscape. When mapping in PPGIS, individuals call upon their tacit, held values in the process of assigning values to a landscape such as KI. This landscape valuation process attempts to have the participant recall both experiences and symbolic meanings created through transactional human-landscape relationships (Zube, 1987) where humans are active participants in the landscape—thinking, feeling and acting—leading to the attribution of meaning and the valuing of specific landscapes and places. While it is tempting to view landscape values as purely "assigned" values because these values are linked to place, the influence of held values based on life experiences should not be discounted, especially with individuals that have an intimate relationship with the landscape, such as local residents.

How stable are landscape values? General human values have been described as relatively stable (Rokeach, 1973, p. 11) over time but is this also true of landscape values? The literature on value change offers somewhat conflicting results with some researchers reporting minimal change in values (e.g., Feather, 1975; Lubinski, Schmidt, & Benbow, 1996; Schwartz, 2005) while others report substantive change in values (Kohn & Schooler, 1982; Sheldon, 2005). Hitlin and Piliavin (2004) define value change as a change in the importance of a value as in the rating or ranking of a value on a questionnaire. In this research, we examined the relative stability or change in landscape values using PPGIS surveys in 2004 and 2010. We also assessed a second dimension of value change that is unique to landscape values: the potential change in the spatial location of values.

Brown and Reed (2000) developed the first typology of landscape values consisting of 13 values (aesthetic, recreation, biodiversity, life supporting, economic, learning, historic, cultural, future, intrinsic, spiritual, therapeutic, subsistence) as part of the Chugach National Forest (U.S.) planning process. This values typology was subsequently adapted and used by others for a variety of applications including forest planning (Beverly et al., 2008; Reed & Brown, 2003, 2009; Clement & Cheng, 2011), national park management (Brown & Weber, 2011), tourism development (Brown, 2006; Raymond & Brown, 2007), identification of conservation areas (Raymond & Brown, 2007; Zhu et al., 2010), wilderness suitability analysis (Brown & Alessa, 2005), rural development (Nielsen-Pincus, 2007), and the identification of ecosystem services (Brown, Montag, & Lyon, 2011; Sherrouse et al., 2011).

The term "public participation geographic information systems" was conceived in 1996 at the meeting of the National Center for Geographic Information and Analysis (NCGIA). PPGIS combines the practice of GIS and mapping at local levels to produce knowledge of place. The formal definition of PPGIS is nebulous (Tulloch, 2007) and "inconsistent across applications" (Schlossberg & Shuford, 2005) with use of the term "PPGIS" emerging from developed-country contexts while the term participatory GIS or "PGIS" is often used to describe participatory planning approaches in rural areas of developing countries, the result of a merger between Participatory Learning and Action (PLA) methods and geographic information technologies (Rambaldi, Kwaku Kyem, Mbile, McCall, & Weiner, 2006). Since the 1990s, the range of PPGIS applications has been extensive, ranging from community and neighborhood planning to mapping traditional ecological knowledge of indigenous people (see Brown, 2005; Dunn, 2007; Sawicki & Peterman, 2002; Sieber, 2006 for reviews of PPGIS applications).

In 2004, we completed a baseline PPGIS study on KI to identify landscape values and development preferences of residents (Brown, 2006). In 2010, we developed and implemented an internet-based PPGIS to monitor changes in landscape values. Our purpose here is to describe the methods used while seeking answers to the following research questions: (1) has the importance of aggregate and individual landscape values changed over time?; (2) has the spatial distribution of landscape values changed?; (3) how might change in land use affect the distribution of landscape values?; and (4) what are the implications of these empirical findings for land-use planning processes that seek to identify place values?

Methods

Study location

Kangaroo Island (KI) is situated off the coast of South Australia approximately 110 km southwest of Adelaide, the state's largest city (see Fig. 1). The predominantly rural island covers 4400 km^2 with a population of 4261 (Australia Bureau of Statistics, 2007). The economy is dominated by agriculture and tourism and receives about 185,000 annual visitors. The island is a popular tourism destination with national parks, conservation areas, and wilderness protection areas covering more than 30% of the island. KI offers a variety of landscapes including beaches, forests, desert dunes and farmland.

Data collection process

To conduct the 2010 longitudinal study, we mailed letters of invitation to the same KI households that were randomly selected in 2004 ($n = 967$). This list included both participants and non-participants from 2004. Given the time lapse of six years, we anticipated a higher percentage of returned or undeliverable letters even though the letter was addressed to the same person in 2004 "or current resident." The letter requested participation in the 2010 study, provided the study website URL, and included a unique seven digit access code that was keyed to the sampled household.

The study website consisted of an opening screen for the participant to enter their access code, followed by an informed consent screen, and then a Google Maps application that allowed the participant to drag and drop different digital markers representing landscape values onto a web map of KI. See Fig. 1 for a screen image of the PPGIS application interface. The instructions requested the participant to "use the map markers to identify the places you value…with your mouse, click on a marker and drag it onto the relevant map location." The different types of markers placed and their spatial locations were recorded for each participant. The first panel of markers in the web interface contained an identical replication of landscape values and their definitions from 2004 study with one exception—future value was dropped from the 2010 typology. Future value was not included in 2010 because the 2004 definition was ambiguous making interpretation of the mapped results difficult. Participants could place as few or as many markers as they deemed necessary to express their values. The landscape value typology and definitions appear in Table 1.

Following completion of the mapping activity (placing markers), participants were directed to a new screen and provided with a set of text-based survey questions to assess general, non-spatial development preferences and to measure respondent socio-demographic characteristics. Data collection concluded with participant completion of the survey questions. Study participants had the option to return to the website later and use their access code to add new markers or adjust previously-placed markers. The website was available to participants for approximately four months.

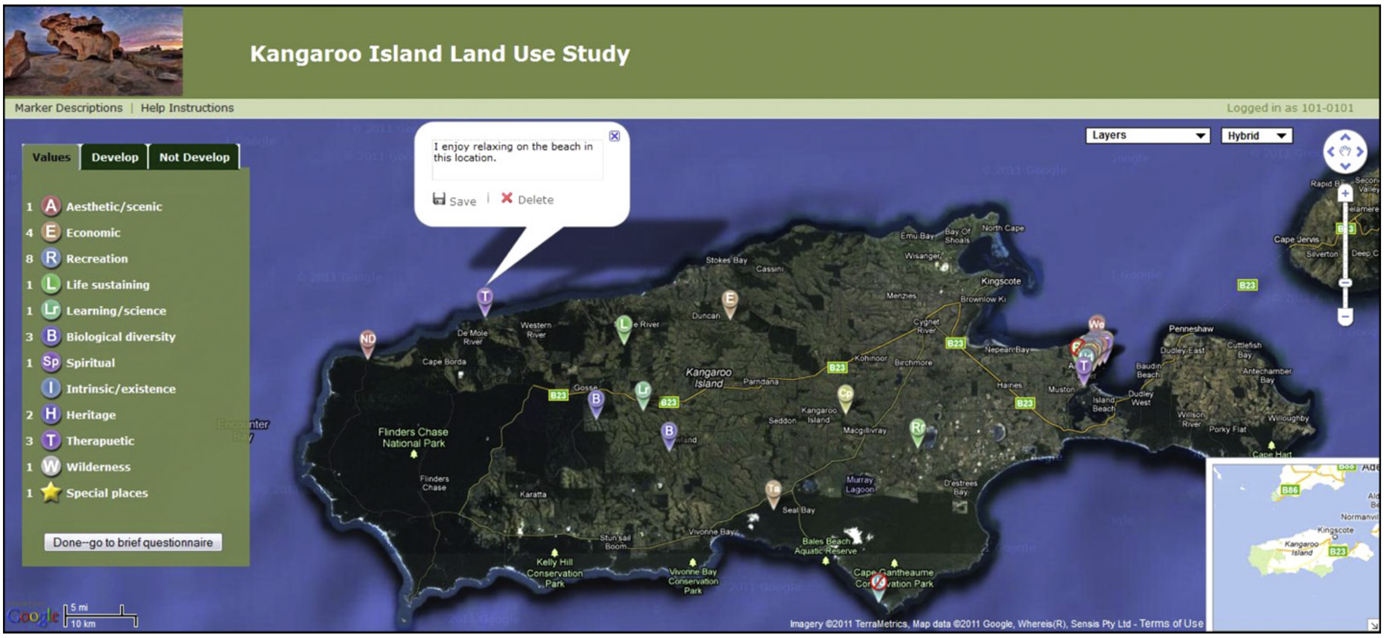

Fig. 1. Screen capture of PPGIS system for identifying landscape values. Participants drag and drop markers from the panel (left) onto the Google® map image. Each marker may be optionally annotated.

The 2010 internet mode of data collection differed from the baseline 2004 PPGIS study which was implemented using similar, but paper-based PPGIS methods. In 2004, residents received a large paper map of KI, sticker dots, and a survey questionnaire in the mail. The sticker dots were mnemonically coded and fixed to paper containing the landscape value definitions, similar to the digital panel of markers in the internet application. In both studies, participants were requested to place the value markers (sticker dot or digital dot) onto KI map locations representing those values. In 2004, the sticker dots were digitized into a GIS for analysis. In 2010, the digital markers were imported from the web server into a GIS for analysis. While the two PPGIS data collection methods involved

Table 1
The number, rank, spatial proximity, and spatial accordance of landscape values identified in 2004 and 2010 by Kangaroo Island residents using PPGIS.

Landscape value	2004			2010			Spatial accordance		
	Rank[a]	Number of points	R[b]	Rank	Number of points	R	phi[c]	χ^2	Sig.
Aesthetic—I value these places for the attractive scenery, sights, smells, or sounds	1	1784	.39	1	433	.53	.51	1372.21	$p < .001$
Recreation—I value these places because they provide outdoor recreation activities opportunities.	2	1505	.45	2	244	.56	.47	1154.64	$p < .001$
Economic—I value these places for economic benefits such as agriculture, tourism, or commercial activity.	3	1418	.45	5	148	.58	.29	455.95	$p < .001$
Wilderness—I value these places because they are wild.	4	1348	.57	4	180	.62	.46	1138.62	$p < .001$
Biological—I value these places because they provide for a variety of wildlife, marine life and plants.	5	1287	.58	3	209	.72	.35	652.17	$p < .001$
Heritage—I value these places because they have natural and human history.	6	1218	.46	6	141	.64	.52	1456.65	$p < .001$
Future[d]—I value these places because they allow future generations to know and experience them as they are now.	7	1172	.56	*	*	*	*	*	*
Learning (knowledge)—I value these places because we can use them to learn about the environment.	8	1147	.50	8	95	.73	*	*	*
Intrinsic—I value these places just because they exist, no matter what I or others think about them or how we use them.	9	1048	.59	10	48	1.05	*	*	*
Therapeutic—I value these places because they make people feel better, physically and/or mentally.	10	1010	.55	9	51	.78	*	*	*
Life sustaining—I value these places because they help produce, preserve, clean, and renew air, soil, and water.	11	998	.61	7	128	1.11	.16	134.08	$p < .001$
Spiritual—I value these places because they are spiritually special.	12	849	.62	11	33	.89	*	*	*

[a] Spearman's rank correlation between 2004 and 2010 value rankings = .90 ($t = 6.19$, df = 9, $p < .001$).
[b] R is a ratio of observed distances between points to the expected distances between points if the points were randomly distributed. R ranges from $R = 0$ (completely clustered) to $R = 1$ (random) to $R = 2.149$ (completely dispersed). From the R statistic, a standardized z score is computed to test the hypothesis that the point distribution deviates from randomness, either toward clustering or uniformity. The hypothesis of complete spatially random (CSR) distribution of points is rejected for all four PPGIS attributes.
[c] The phi-coefficient is a variation of the Pearson correlation coefficient that is used for binary data and measures the strength of a relationship on a scale from 0 to 1. Phi was calculated based on overlapping or non-overlapping "hotspot" grid cells generated from point distributions in 2004 and 2010. Grid cell densities were based on kernel estimation using 1K cell size and 3K search radius.
[d] Future value was not included in the 2010 landscape value typology.

different technologies, the Google Maps interface was designed to mimic the paper-based PPGIS process of placing sticker dots on a map. On the important variables of map scale and marker placement precision, the two methods were comparable.

Analyses

Respondent characteristics

To assess the similarity of 2010 respondents with the 2004 respondents, we examined socio-demographic variables common to both studies: age, gender, length of residence, and two items that asked about the respondent's level of familiarity with places on KI. Frequency distributions and descriptive statistics were generated for each variable depending on the variable's level of measurement.

Changes in the importance of landscape values over time

A total of 13,612 value points were identified in the 2004 baseline study while the 2010 monitoring study yielded 1710 value points for analysis. To assess potential changes in the importance of landscape values over time, we tallied the marker counts for each landscape value in 2004 and 2010. Previous research indicated the frequency of mapped landscape values was strongly correlated with separate measures of the ranked importance of the same landscape values (Beverly et al., 2008; Brown & Reed, 2009). Thus, the frequency of mapped landscape values is a valid proxy measure for the perceived importance of landscape values appearing in the typology. The 11 mapped landscape values common to both studies in 2004 and 2010 were rank-ordered from most to least frequent and Spearman's rank correlation was calculated to determine the similarity in the relative importance of landscape values over time.

Changes in landscape value spatial distribution over time

There are multiple approaches to assessing change in the spatial distribution of landscape values over time. A visual examination of two distributions placed side-by-side to determine spatial accordance (agreement) is an important, but subjective first step. To describe the general dispersion and clustering of value distributions on KI, we calculated the nearest-neighbor *R* index (Clark & Evans, 1954) which is a ratio of the observed distances between points to expected distances. *R* values less than 1 indicate clustering, values greater than 1 indicate dispersion, and values near 1 indicate random distribution. The *R* index is useful to describe the overall distribution of values but can miss locational changes in values.

To measure changes in landscape values by location between 2004 and 2010, we compared the spatial distributions of markers placed by respondents using standardized kernel density "hotspot" analysis and the phi-coefficient statistic which measures the strength of relationship between two binary distributions, thus quantifying the degree of spatial accordance.

The standardized kernel density maps were generated using 1000 m grid cell size and 3000 m search radius for the 2004 and 2010 aggregated landscape values and for each landscape value point distribution that contained at least 100 points in 2010 ($n = 7$ landscape values). Four landscape values (intrinsic, learning, therapeutic, and spiritual) had less than 100 observations in 2010 and thus were not individually analyzed for longitudinal change. The selected cell size and search radius were heuristics based on the size of the sticker dot relative to the map (the sticker dot occupied about 1000 m diameter on the 2004 study map) while the search radius was a judgment about the assumed level of precision in placing a marker and the distance at which landscape values might be presumed to cluster. Empirical research (Nielsen-Pincus, 2011) suggests that landscape values tend to cluster between 3 and 6 km. Kernel density estimation (Parzen, 1962; Rosenblatt, 1956) is a technique that fits a smoothly curved surface (grid) over each point producing a circular area (kernel) of a certain bandwidth (or search radius). The grid cells with the highest density values are commonly referred to as "hotspots". Because the number of points influences the kernel density calculations, we standardized kernel densities by subtracting the mean grid density and dividing by the grid standard deviation. By heuristic convention (see Alessa et al., 2008; Brown & Pullar, 2011), we classified standardized kernel densities in the upper third of the value range as hotspots.

To measure the degree of association between the spatial distributions in 2004 and 2010, we first clipped each density grid to the shape of KI buffered to 2 km. This eliminated the potential statistical influence of zero grid cell values associated with water surrounding the irregular shaped island. We then calculated the phi correlation coefficient (φ) for each pair of landscape value distributions using data from a 2×2 contingency table where cell values represent the presence or absence of a standardized grid hotspot in the same map location. The phi-coefficient is a variation of the Pearson correlation coefficient that is used for binary data and is related to the chi-square statistic (χ^2), where $\chi^2 = n\varphi^2$ (Chedzoy, 2006; Zhu et al., 2010). The phi-coefficient measures the strength of the relationship on a scale from 0 to 1 and the statistical significance of the relationship can be evaluated with the chi-square statistic. In total, we examined eight pairs of spatial distributions using this method: the aggregated landscape values in 2004 and 2010 and seven individual landscape values with sufficient observations for analysis (aesthetic, recreation, economic, biological, wilderness, heritage, and life sustaining).

To visualize potential locational changes in landscape values reflected in the phi-coefficient results, we spatially overlayed the standardized hotspot maps for the pairs of landscape value distributions.

Value change in land-use zoning classifications

Land-use zones are designations in the KI Development Plan that identify permitted and proscribed land uses within the zones. Zoning classifications are intended to identify the best use of land while separating potentially incompatible land uses. Zones can range from permissive (e.g., "Residential") to more restrictive (e.g., "Conservation" or "Watershed protection") of future development. In 2004, landscape values were found to be logically consistent with zoning classifications on KI (Brown, 2006). For example, in 2004, aesthetic value was the most common landscape value identified in the 'Coastal' zone, wilderness the most common value in the 'Conservation' zone, life sustaining in the 'Watershed Protection' zone, and economic in the 'Rural' and 'Residential' zones (p. 110). To examine whether landscape values changed within zoning classifications on KI, we generated frequency counts of landscape values within the zones. Spearman's rank correlation was calculated to determine the similarity of landscape values within the zoning classifications between 2004 and 2010.

Value change associated with land-use change

There were no large scale, anthropogenic land-use changes on KI between 2004 and 2010. However, in 2008, the controversial Southern Ocean Lodge, a luxury "eco-retreat" was built in the Hansen Bay (south coast) area which altered a relatively natural coastal area. This development project, which required state-level approval to remove native vegetation, was highly visible in the local media and KI residents would have been aware of the project. Although the number of landscape values identified in the vicinity of the development in 2010 is too small ($n = 34$) compared to 2004 ($n = 275$) to draw statistical inferences, the frequency distributions of values pre- and post-development were examined to identify value changes that may be related to the land-use change from natural area to tourism accommodation.

Results

Response rate and respondent characteristics

Of the 976 letters of invitation mailed in 2010, there were 115 full or partial responses yielding 1710 point locations of landscape values for analysis. A full response is an individual that maps one or more point locations and completes the survey questions at the end ($n = 87$); a partial response ($n = 28$) is an individual that maps one or more locations but does not answer the survey questions following the mapping activity. After accounting for non-deliverable letters, the 2010 internet-based PPGIS response rate was 16.2%. By way of comparison, the 2004 paper-based PPGIS response rate was 47%. The mapping response rate, defined as the proportion of those that do the mapping activity compared to the overall response rate, was 76% in 2010 compared to 91% in 2004. Based on matching survey ids and demographics, we confirmed that 48 individuals were the same individuals that participated in the 2004 study while seven individuals appear to be different from previous respondents at the same address. There was insufficient demographic information provided by the other respondents ($n = 60$) to definitively classify them as part of a longitudinal cohort.

Respondent characteristics in 2004 and 2010 are presented in Table 2 and indicate a high degree of similarity. Respondents were similar in average age, gender proportion, self-identified knowledge of places on KI, and knowledge of places on KI when self-compared to others. The 2010 respondents have lived on KI longer than the 2004 respondents, but this is to be expected given that it is likely that at least half of the 2010 respondents were the same individuals that participated in 2004.

Table 2
Respondent socio-demographic characteristics.

	2004		2010	
Age (years)		53.5		51.1
Gender	Male	53%	Male	52%
	Female	47%	Female	48%
Length of residence (years)		18.2		25.1
Knowledge of places on KI (self-identified)	Excellent	17%	Excellent	24%
	Good	60%	Good	52%
	Fair	23%	Average	23%
	Poor	1%	Below average	1%
Knowledge of places on KI compared to others (self-identified)	N/A		Much more	3%
	More	21%	More	33%
	Same	55%	Same	52%
	Less	21%	Less	12%
	No opinion	3%		

Changes in the importance of landscape values over time

The number of mapped landscape values and ranks based on frequency for the 11 landscape values common to both studies appear in Table 1. Aesthetic and recreation values were the most important values in both studies. The importance of biological and life sustaining values appear to have increased slightly from 2004 to 2010, while the importance of economic value decreased based on rank. However, the overall rank order of mapped landscape values changed relatively little between 2004 and 2010 with Spearman's rank correlation equal to .90 ($t = 6.19$, $p < .001$).

Changes in landscape value spatial distribution over time

All landscape values spatially clustered in 2004 with aesthetic, recreation, economic, and heritage values being the most clustered and life sustaining values the least clustered. The spatial clustering is evident from the lower R values in Table 1, none of which approach a value of 1 that would indicate random distribution. In 2010, all landscape values had consistently higher R values suggesting a possible shift toward greater dispersion of values. However, the higher R values in 2010 are likely the result of the much smaller sample size and fewer mapped markers rather than an actual change in values toward greater dispersion.

Changes in landscape value locations

Density maps for the spatial distribution of the 11 aggregated landscape values measured in 2004 and 2010 appear in Fig. 2. Visually, the two distributions appear quite similar with higher density hotspots visible in the same spatial locations over time. The coastal reaches of KI, in general, are highly valued with specific hotspots located in communities such as Kingscote and Penneshaw (northeast), natural feature destinations such as Admiral's Arch and Remarkable Rocks (southwest), or historical landmarks such as the Cape Borda lighthouse (northwest). To quantify these visual results, the locations for aggregate landscape values in 2004 and 2010 demonstrate strong spatial accordance with a significant overlap in density hotspots (phi = .53, $p < .001$). The somewhat more diffuse landscape values in 2010 (observable by larger areas of yellow) reflect the smaller number of point locations used to generate the point densities. Statistical measures for the spatial accordance of individual landscape values between 2004 and 2010 appear in Table 1 and range from relatively strong (heritage, phi = .52; aesthetic, phi = .51; recreation, phi = .47; and wilderness, phi = .46) to relatively weak (biological, phi = .35; economic, phi = .29; life sustaining, phi = .16). The lower spatial accordance measures likely reflect the smaller number of observations in 2010.

Comparative density maps for six of the seven landscape values analyzed in this study appear in Fig. 3. The highest density areas for 2004 appear in red color and the highest density areas for 2010 appear in blue. Visual comparison of the paired landscape value density maps supports the strength of the calculated phi-coefficients. The aesthetic, wilderness, heritage, and recreation maps appear most similar between 2004 and 2010 while the economic and biological maps appear least similar.

Value change in land-use zoning classifications

We compared the frequency of landscape values for five zoning classifications on KI in 2004 and 2010 and used Spearman's rank correlation to determine the degree of similarity. The top ranked values were the same in 2004 and 2010 for three zones: aesthetic values were most important in "Coastal" zones, economic values in "Residential" zones, and life sustaining values in "Watershed protection" zones. Aesthetic values were more important in "Rural" and "Conservation" zones in 2010 than in 2004, but the next most important values in these zones (economic and wilderness values respectively) were the most important values in 2004. See Table 3. Spearman's rank correlation indicates the least value change in "Residential" ($r = .88$, $p < .001$), "Watershed protection" ($r = .70$, $p < .01$), and "Conservation" zones ($r = .69$, $p < .01$), and the greatest change in the "Rural" ($r = .56$, $p < .05$) and "Coastal" zones ($r = .43$, $p > .05$).

Value change associated with land-use change

To assess the potential influence of changes in land use on landscape values, we examined the frequency distribution of landscape values in the Hansen Bay area where a controversial tourism resort was constructed between 2004 and 2010. The value

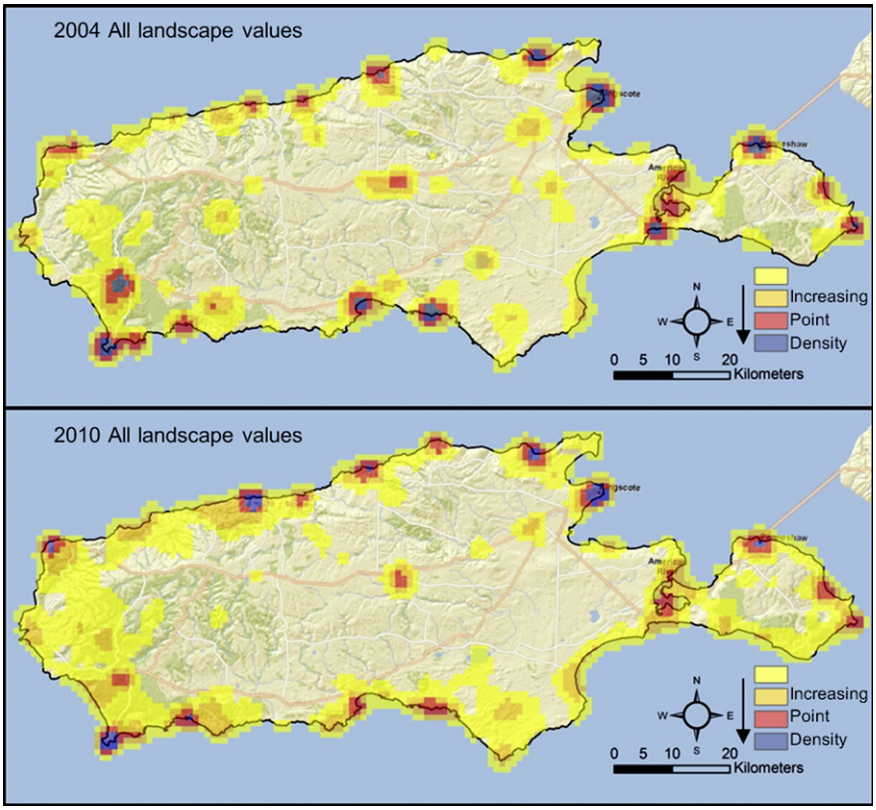

Fig. 2. Standardized density “hotspot” map of 11 combined landscape values in 2004 (top) and 2010 (bottom). Densities were created from point data using kernel estimation with 1K grid cell size and 3K search radius.

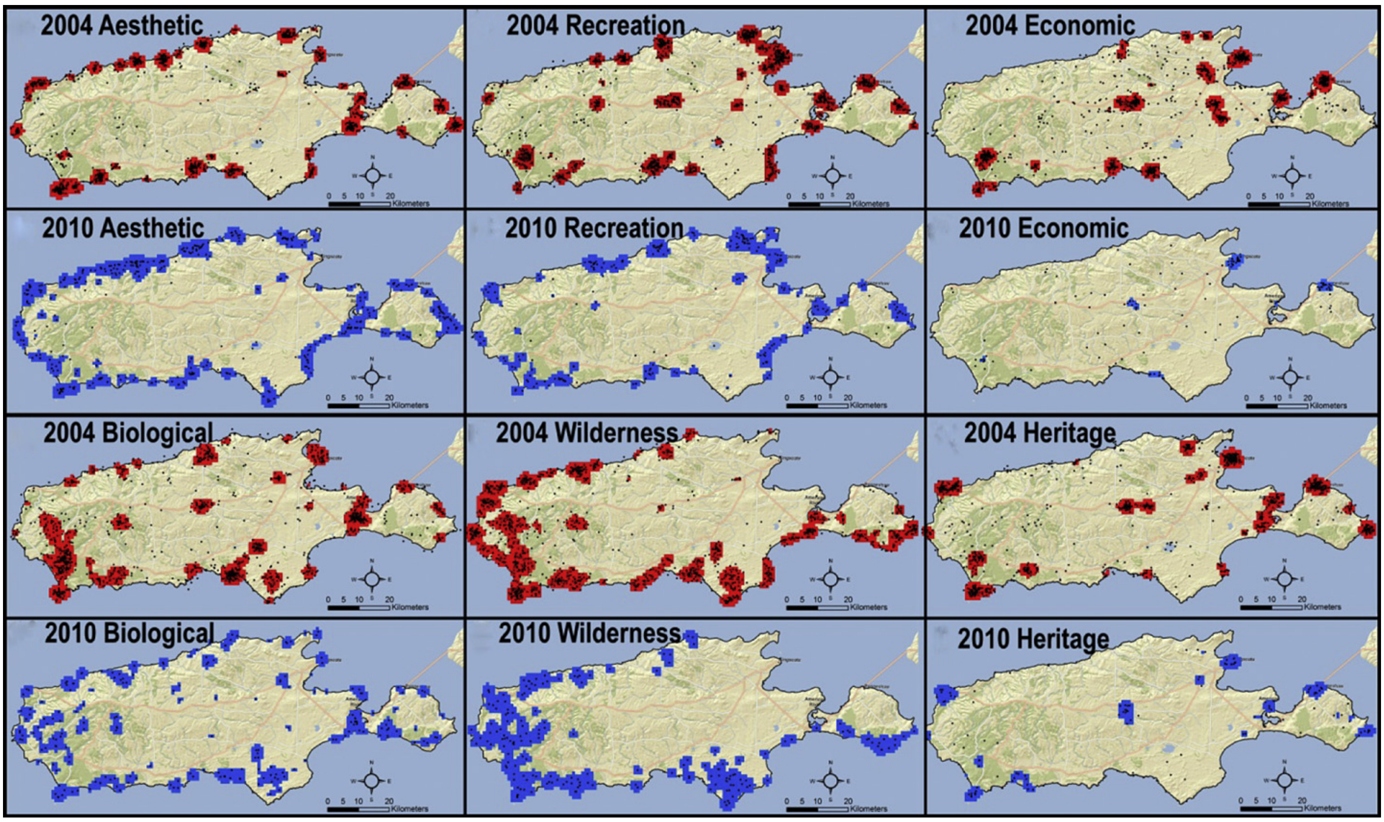

Fig. 3. Distribution of six landscape values in 2004 and 2010. Higher densities of values appear in red (2004) and blue (2010) based on standardized scores using kernel density estimation. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Table 3
Proportion (rank) of landscape values located within selected KI development plan zones in 2004 and 2010.

Landscape value	Coastal 2004	Coastal 2010	Conservation 2004	Conservation 2010	Rural 2004	Rural 2010	Residential 2004	Residential 2010[a]	Watershed protection 2004	Watershed protection 2010 [a]
Aesthetic	21.8% (1)	38.4% (1)	9.1%	22.5% (1)	7.4%	19.6% (1)	15.9% (2)	15.0% (2)	2.6%	4.5%
Economic	5.5%	5.2%	5.9%	4.5%	16.5% (1)	13.4% (2)	40.1% (1)	50.0% (1)	4.5%	13.6%
Recreation	13.9% (2)	20.2% (2)	5.3%	9.4%	10.6% (3)	12.7%	13.4%	15.0% (2)	12.3% (2)	18.2% (3)
Life sustaining	2.2%	2.3%	9.3%	6.6%	7.4%	13.0% (3)	0.4%	0.0%	33.1% (1)	31.8% (1)
Learning	4.8%	5.2%	10.2%	6.6%	11.4% (2)	4.7%	3.4%	0.0%	5.0%	0.0%
Biological	4.7%	9.8% (3)	11.8% (2)	15.9% (3)	9.2%	10.6%	1.7%	0.0%	10.5% (3)	27.3% (2)
Spiritual	7.1%	2.5%	3.7%	1.9%	5.1%	1.4%	3.4%	0.0%	2.1%	0.0%
Intrinsic	8.1%	3.2%	5.8%	2.3%	6.8%	2.8%	3.4%	5.0%	6.0%	0.0%
Heritage	9.4%	5.7%	6.4%	8.0%	9.3%	9.7%	15.5% (3)	15.0% (2)	3.7%	0.0%
Future	6.2%	N/A	11.4% (3)	N/A	6.2%	N/A	0.4%	N/A	7.1%	N/A
Therapeutic	9.6% (3)	3.2%	4.9%	2.4%	4.8%	4.2%	2.2%	0.0%	3.1%	0.0%
Wilderness	6.5%	4.3%	16.2% (1)	19.9% (2)	5.4%	7.8%	0%	0.0%	10.0%	4.5%
Spearman's rank correlation	$r = .43, p > .05$		$r = .69, p < .01$		$r = .56, p < .05$		$r = .88, p < .001$		$r = .70, p < .05$	

[a] Percentages based on fewer than 30 observations.

distributions pre- and post-development appear in Table 4. Although the small sample size in 2010 precludes statistical inference, the pre- and post distributions suggest that the significant change in land use influenced the mix of landscape values for the area. Following construction of the resort, the proportion of economic and recreation values increased while there were large, proportional declines in intrinsic, spiritual, and therapeutic landscape values.

Discussion

The empirical results of this study indicate general stability in the landscape values of KI residents for the period 2004–2010, both in the relative importance of landscape values and in their spatial distribution. This is not surprising given the largely rural character of Kangaroo Island (KI) and relatively slow pace of development on the island. There are multiple special places on KI whose values are known to residents and promoted to island visitors; the value of these special places are transmitted culturally providing for intra and inter-generational continuity of values.

And yet, landscape values, like human values, can change over time. Human development is a powerful force for shaping and changing the distribution of landscape values. The Hansen Bay area on KI offers an example of how new development and more convenient coastal access might shift the balance of landscape values from more indirect and non-use values such as spiritual, intrinsic, and wilderness values to more human use-based values such as economic and recreation values. This finding is consistent with previous landscape values research showing that the distribution of landscape values is influenced by roads and access in general. For example, Brown, Reed, and Harris (2002) found that recreation, aesthetic, and economic values were more proximate to roads than intrinsic, life sustaining, and future values in Alaska.

Table 4
Frequency distribution of landscape values in the Hansen Bay area pre- and post-development of the Southern Ocean Lodge in 2008.

Landscape value	2004 ($n = 275$)		2010 ($n = 34$)	
	Number of markers	% of Markers	Number of markers	% of Markers
Aesthetic	84	30.5	8	23.5
Biological	18	6.5	4	11.8
Economic	3	1.1	4	11.8
Heritage	2	.7	2	5.9
Intrinsic	23	8.4	0	0
Learning/knowledge	9	3.3	0	0
Life sustaining	7	2.5	0	0
Recreation	28	10.2	10	29.4
Spiritual	26	9.5	1	2.9
Therapeutic	38	13.8	1	2.9
Wilderness	37	13.5	4	11.8

Spearman's Rho = .36, $p > .05$.

The large scale and continuing human influence on earth systems and landscapes has resulted in a new term for our current geologic era—the anthropocene—a label that reflects the magnitude of human-influenced change (Crutzen, 2002). In the course of altering physical landscapes at both small and large scales, humans invariably change landscape values. The story of KI may be a parable for larger landscapes. In developing natural landscapes for agricultural, tourism resorts, and housing, direct use values (e.g., economic, recreation) are substituted for indirect and sometimes symbolic landscape values (e.g., spiritual, wilderness, and intrinsic). The conflict over land use is really a contest over which landscape values should be preserved in specific places, skirmishes in the meta-war over the ascendancy of particular human values.

Similar to the relationship between general human values and behavior, there is not a strong, predictable pathway between landscape values and human behavior. Most decisions about land-use change are passively accepted by the general population as either inevitable or for the betterment of humanity. And yet, under certain conditions, landscape values can motivate a strong behavioral response either to protect or exploit a landscape. NIMBYism is a pejorative term used to describe self-interest in preserving the status quo in land use but its basis lies in the desire to preserve the current hierarchy of landscape values. Interestingly, land developers often want to change the hierarchy of landscape values by elevating economic value but to avoid conflict they tend to position this argument in terms of community benefits, i.e., framing the change in values not as self-interest but as increasing the social good.

While human reflection on the value of landscapes is as ancient as the origin of our species, the modern approach to measuring landscape values through methods such as PPGIS has just begun. Where might a science of landscape values lead? There are three promising research pathways: (1) the identification of potential land-use conflict areas; (2) the assessment of compatibility of land uses with landscape values; and (3) the management of public lands for public values.

The identification of the distribution of landscape values in a specific area may predict the potential for conflict between present and prospective land use. This information would be useful to planners and politicians alike to allocate resources to manage the conflict. But the actual mix of landscape values may not, by itself, be highly predictive of actual conflict. We suspect that the intensity of landscape values, not just their spatial distribution, strongly influence the potential for land-use conflict. Previous efforts to measure landscape value intensity through the weighting of markers in PPGIS did not yield significant information beyond that provided by frequency counts (Nielsen-Pincus, 2011). However, a more rigorous psychometric approach to measuring the intensity of landscape values, not just their relative importance, would be valuable.

There has been some exploratory research on the compatibility of particular land uses with landscape values. For example, Brown and Reed (2011) explored the consistency of different landscape values with off-road vehicle use on a national forest in the U.S., finding that some landscape value and land-use relationships were relatively strong, but the majority of relationships were indirect or weak. Attitudes toward particular land uses are stronger predictors of policy preferences than values (Brown & Reed, 2000) but are less helpful to planners who require place-based information. Research to develop models that provide a valid and reliable causal chain from values to land-use preferences might enable evaluation of prospective land uses for compatibility with landscape values.

The measurement and analysis of landscape values appears ideally suited to assist planning and management of public lands because in theory, public lands should be managed for public values. And yet, there has been relatively little interest and support from public land management agencies. The list of agencies that have piloted PPGIS studies are relatively few—U.S. Forest Service, Natural Resources Canada, New Zealand Department of Conservation, and Parks Victoria (Australia). The use of PPGIS systems to measure landscape values for public land planning has been largely promoted by academics that see its potential for expanding public participation processes and developing decision support systems. The slow adoption of PPGIS methods by public agencies does not appear technological but may reflect a lack of government commitment to public participation and consultation in general (Brown, in press). Despite public consultation in public land management being legally required in many countries, the genuine desire for public input remains questionable. Until public agencies overcome their inherit conservatism toward public consultation, landscape values research will continue to remain an interesting, but ultimately academic approach to public land management.

Limitations

There are limitations to this study resulting from pragmatic research trade-offs that were necessary to implement this longitudinal PPGIS study. The first limitation is the difference in PPGIS implementation. Although the landscape values and their definitions were the same in 2004 and 2010, the modality of identifying the values changed from paper map to internet map. Web-based PPGIS offers significant advantages over paper-based PPGIS, the most important for this study being the cost of implementation. But the modality change resulted in fewer landscape values being identified per respondent. The internet modality also resulted in a lower response rate and ultimately less spatial data in 2004 than would have otherwise been expected using paper-map PPGIS. Web-based surveys have lower response rates than other modes of survey delivery (Cook, Heath, & Thompson, 2000; Couper, 2000) and this is also true of mail versus internet-based PPGIS (Pocewicz, Nielsen-Pincus, Brown, & Schnitzer, in press). In implementing the 2010 study, unlimited PPGIS markers were available to participants to map which paradoxically, had the opposite effect of reducing the number of markers placed by the same individual. We speculate that unlimited markers in 2010 resulted in less clear expectations about what constituted completion leading to respondent satisficing as was observed in other PPGIS studies (Brown et al., in press).

In the 2010 study, we could only definitively confirm about half of respondents as the same person from 2004, and of these individuals, only 22 identified 10 or more landscape values in both 2004 and 2010. We would have liked to analyze the longitudinal cohort data using repeated measures, allowing the same individual to act as a control, but there were too few respondents in 2010 for this analysis.

If there is a “paucity of research” (Hitlin & Piliavin, 2004, p. 378) on human value change, there is *no* research on how landscape values change. Because landscape values are relational values that bridge individual hierarchies of personal importance and perceived qualities of place, changes in either individual priorities or place attributes can conceivably change perceived landscape values. A social-psychological approach to investigating landscape value change will require significantly more research participants to explore the dual value dimensions of person and place. For now, we must be content with our ability to describe and quantify empirical change in landscape values without fully understanding the social-psychological reasons why.

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