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IDENTIFYING CITIZENS' PLACE VALUES FOR INTEGRATED PLANNING OF ROAD INFRASTRUCTURE PROJECTS

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ABSTRACT

Projects for road infrastructure and spatial development easily meet public resistance because of a lack of local knowledge of place values by (often non-local) planners. The aim of this study is to explore how insights in place values might improve the local knowledge base for planners of integrated road infrastructure projects and spatial development. We developed, tested and analysed the results from a novel online value-mapping tool called the 'Place Value Identifier'. The developed method allows us to (i) relate to 'soft' valuable places identified by Public Participation GIS as a complement to 'hard' land use data, (ii) define Valued yet Unprotected places based on combining 'hard' and 'soft' values and (iii) illustrate how these insights can be used for integrated planning of road infrastructure projects. The findings of this study show the increased potential of value mapping techniques and illustrate possible resistance areas around road infrastructure planning projects. This knowledge may assist planners in creating and selecting acceptable project alternatives that may invoke high public acceptance.

Key words: place values; the Netherlands; Public Participation GIS (PPGIS); valued yet unprotected places; land use values; road infrastructure projects

INTRODUCTION

Projects for road infrastructure and spatial development can affect landscape qualities that are valuable for people (Bengston *et al.* 2004). These projects have to meet multiple demands and expectations, which commonly cause delays in the design process. In addition, 'contextual aspects' nearby a road are playing an increasingly important role, 'including aspects related to the adjacent land uses, the socio-economic profile along the route and the environmental (ecological and cultural) landscape along the route' (Beukes *et al.* 2011). According to the US Federal Highway Administration (FHWA), context-sensitive design (CSD) is 'a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility' (FHWA 2007; see also Heeres *et al.* 2012).

Reaching all stakeholders is not an easy task. The opinions currently being heard are mainly the ones of the people attending consultation meetings, often with the intention to oppose plans (Tillema *et al.* 2012). 'If many people oppose a plan and are affected in their residential satisfaction, this is something for the policy makers and road planners to take seriously. Although an improvement of a major road may have regional or even national accessibility impacts, this does not mean that potential

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widely supported local discontent should not be dealt with in an appropriate manner' (Tillema *et al.* 2012, p. 749). In recent years, the use of Geographic Information System (GIS) as a platform has increased to explore new tools to identify *community values* and *land use preferences*. Karimi and Brown (2017) found that mapping of land use preferences, in contrast to values, is used to identify the spatial locations where various types of current or future land use appear acceptable (or not) to people. A lack of local knowledge of contextual aspects by (often non-local) planners could be a reason for resistance, because these aspects vary spatially and temporally (Keshkamat *et al.* 2009).

Using GIS in participatory mapping has proven to be a means to capture the *spatial dimension* of community values and land use preferences – giving rise to the term Public Participation GIS (PPGIS) (Brown & Reed 2011). 'PPGIS is a field of geographic information science that focuses on the use of geospatial technologies (such as mapping) by the public to participate in spatial planning processes' (Tulloch 2008). This foundation underneath mapping 'place values' raises questions about what we understand by 'the public'. As Schlossberg notes, 'the public in PPGIS depends on the definition and may include "decision makers", "affected individuals" or the "random public", among other groups' (Schlossberg 2005). The latter classification appears most consistent with common dictionary definitions of public that include 'all the people' or 'people in general'.

The PPGIS process can be a means to (geographically) represent existing social capital and enhanced community identity (Jorgensen 2010; Brown & Kyttä 2014). 'The countless layers of any place come together in specific times and spaces and have bearing on the cultural, economic, and political characteristics, interpretations, and meanings of place' (Graham 2010). PPGIS has developed as an approach to overcome the limitations of 'hard' GIS and introduce 'soft' GIS elements to complement the information support for spatial planning (Kyttä *et al.* 2013; Vich *et al.* 2018; Sijtsma *et al.* 2019). Hard GIS refers to data such as data on land use, job and population densities, and protection and conservation status. The term 'soft' refers to 'the subjective and qualitative nature of the mapped attributes as a contrast to the "hard" spatial data that is usually associated with GIS' (Brown & Kyttä 2014). Here, we understand 'soft' as a temporary state: soft value does not necessarily stay soft when subjective and qualitative data become more widely used and standardized, they may transform into 'hard' GIS data. For now, PPGIS methods can provide 'soft' spatial data layers that identify the spatial distribution of values or preferences (Davis *et al.* 2016; Bijker & Sijtsma 2017).

In this paper, we expand on previous (PPGIS) value mapping research in two ways. First, by relating 'soft' place value mapping to 'hard' spatial data layers to improve the knowledge base for planners of road infrastructure projects and spatial development. Road infrastructure, our focal point of study, is one of the aspects contributing to accessibility, being mainly related to reaching activities in a local context. Hamersma *et al.* (2014) state that accessibility factors and negative environmental aspects related to roads are traded off in people's overall residential context. According to Brown *et al.* (2020), for natural landscapes, expanded access (e.g. from roads) will bring more people in contact with the area with potentially different values and expectations. Second, we expand on previous research with regard to online mapped features by including polylines as a 'line-oriented' mapping option in our novel online value mapping tool, which is particularly interesting for (line-oriented) infrastructure. Until now, in online value mapping tools, only point and polygon features have been studied.

The aim of this study is to explore how insights in place values might improve the knowledge base for planners of integrated road infrastructure projects and spatial development. The developed method allows us to answer the following research questions:

1. How does PPGIS identifying 'soft' valuable places complement 'hard' land use data?
2. Can Valued yet Unprotected places be defined based on combining these 'hard' and 'soft' values?

3. How can these insights be used for integrated planning of road infrastructure projects?

In response to these questions, we designed a novel online value mapping tool called the Place Value Identifier (PVI) to identify valued and sometimes as yet unprotected places associated with different types of land use, ranging from parks and nature reserves, to multiple-use lands. In the next paragraph, we will provide a theoretical background and elaborate on the scope of these questions one by one.

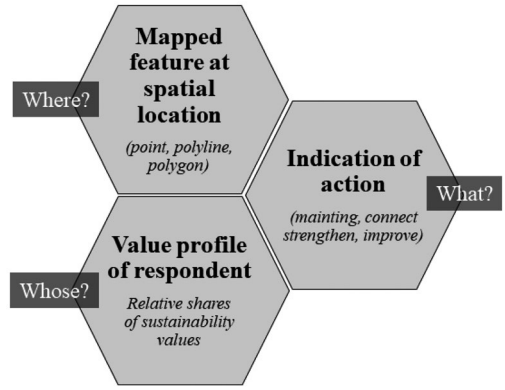

Figure 1. *Composition of a place value.*

THEORETICAL BACKGROUND

Relating PPGIS to 'soft' valuable places as a complement to 'hard' land use data – PPGIS methods are growing in popularity because of their ability 'to engage stakeholders and capture spatially explicit information on intangible landscape values that can be integrated with existing planning approaches' (Ives *et al.* 2017). Participatory approaches are particularly useful to explore and assess stakeholders' knowledge, preferences, practices, perceptions and values (Fagerholm *et al.* 2016). The rapid pace of software and technology innovation has greatly expanded the range of options available (Brown & Kyttä 2014). The variety of PPGIS methods and practices ensures that participatory mapping knowledge and experience (Jorgensen 2010) will accumulate slowly through a successive string of case studies. Brown and Kyttä (2014) identified key issues in PPGIS from more than 40 empirical studies of which the following three are of particular relevance to our study: (i) the spatial attributes measured in participatory mapping, (ii) the relationships between participatory mapped attributes and physical places and (iii) the integration of PPGIS data into planning decision support (Brown & Kyttä 2014). In this study, we define *place value* (Figure 1) as a composition of (i) a mapped feature that could be drawn as a point, shape or polyline at any spatial location; (ii) an indication of action whether the place should be maintained (keep in good condition), connected (make more accessible), improved (add something what is not there yet) or strengthened (add some of what is already there) and (iii) a participant value profile, which shows the relative shares of different sustainability values. The participant profile connected to marked places by one particular participant remains the same, whereas the marked places as mapped feature at a spatial location can differ. The composition of a place value is meant to indicate the characteristics of a 'place value', not as an indicator itself.

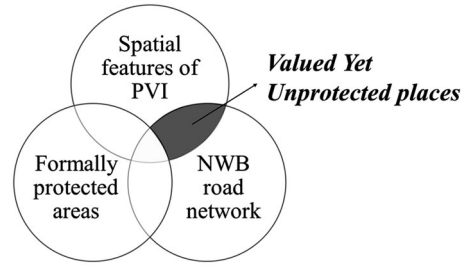

Figure 2. *Venn diagram of how we defined 'valued yet unprotected places'.*

Defining valued yet unprotected places based on combining 'hard' and 'soft' values – To improve spatial data quality, Levin *et al.* (2017) examined the potential of PPGIS for assessing protected area importance. Here we acknowledge the importance to know whether a place or an area is *protected* and *valued*. This can be either about Valued yet Unprotected or Valued and Protected places. Figure 2 shows how we defined the 'Valued yet Unprotected places' by combining 'hard' spatial data layers (formally protected

natural and monumental areas and the NWB road network) to mapped 'soft' place values (spatial features of PVI).

Usefulness for integrated planning of road infrastructure projects – Road infrastructure projects derive their identity not only from road networks but also from other networks, including social, ecological and economic networks with local, regional or national widths that overlap in a place (Castells 2010). Most value mapping techniques use points to let people mark places. However, put simply, spatial planning is mainly concerned with protecting or (re)developing areas, whereas road infrastructure planning is trying to optimize line objects in space. Point-based value mapping may then easily fail to recognize values in area shapes and line shapes. Brown and Pullar (2012) evaluated the spatial concurrence of point versus polygon-mapped features. The results then indicated 'the mapping of spatial attributes by participants with point rather than polygon features appears simpler and more effective, but requires significantly greater sampling effort' (Brown & Pullar 2012). Since 2012, however, software technique has progressed rapidly, making it simple and intuitive to most users to also draw areas or lines.

METHODS AND MATERIAL

Study design – To expand on previous (PPGIS) value mapping research, we designed a novel online value mapping tool called the PVI to identify valued places that can be associated with different types of land use, ranging from parks and nature reserves to multiple-use lands. For this spatially applicable 'hard' land use data, we used Dutch land use data (BBG2015) because of its suitable grain size to identify relevant land-cover features at local scales – as also argued by Garcia *et al.* (2017). The following BBG2015 land use main classes were used in our analysis: (i) built terrain, (ii) business terrain, (iii) forest, (iv) dry natural terrain, (v) greenhouse horticulture, (vi) road infrastructure, (vii) agricultural terrain, (viii) wet natural terrain, (ix) recreational terrain, (x) semi-built terrain, (xi) railway, (xii) airport and (xiii) water (BBG2015). An important feature of this PVI was that people were not asked to indicate which places possess a certain predefined value but were asked to indicate which places they find valuable, regardless of their reasons for doing so (De Vries *et al.* 2013). We used value mapping as a spatially explicit procedure in which participants mark places on a (digital) map; these designated point, polyline and polygon locations are then saved in X, Y coordinates (Brown & Reed 2012; Brown & Kyttä 2014). As found by Brown and Kyttä (2014), the type of place-based information that participants marked relate to a purpose that this information is thought to serve. Therefore, in this study, we specify this purpose to indicate valuable places in living environments with a standardized addition following the Dutch Ministry of Infrastructure and the Environment: *maintain, connect, improve or strengthen*, and why (Ministry of the Interior and Kingdom Relations of Netherlands 2020). The differences between these four indications of action is being visualized in Figure 3.

To explore the participant value profile with relative shares of different sustainability values, we developed a typology that focuses on sustainability values, starting from existing typologies in use for Dutch road infrastructure planning (Sustainability Check; 'Omgevingswijzer' in Dutch, see omgevingswijzer.org; Heeres *et al.* 2016, 2018). These sustainability values provide the potential for participants to inform decisions about place, broadly defined (Shamai & Ilatov 2005), we used the twelve sustainability values presented in Table 1. We formulated descriptions of these values in collaboration with Rijkswaterstaat (RWS, the Dutch executive agency of the Ministry of Infrastructure and water Management), based on their experiences with the use of the Sustainability Check (Heeres *et al.* 2016). In the Netherlands, Rijkswaterstaat is a major developer of road infrastructure project that has considerable spatial impact (Heeres *et al.* 2012; Arts *et al.* 2016; van Geet *et al.* 2019). This study was carried out in the Netherlands, as it is a densely populated country with many (sometimes combined) spatial and road

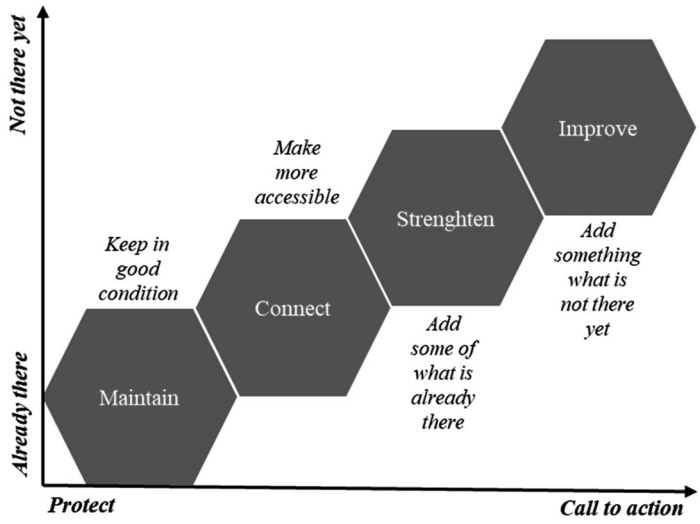

Figure 3. *Difference between the four indications of action.*

infrastructure development projects, which are often confronted with public resistance.

Data collection – This study was carried out with an online mapping tool called the 'PVI'. The online survey consists of an opening screen with a brief introduction of the study (Appendix A), followed by a screen with questions on sex, age, education and zip code and subsequently a Google map application that allowed the participant to drag and drop *three digital markers* representing *valuable places in their living environment* onto an online map. The participants saw a map at the zoom level of their neighbourhood surrounding their filled-out postal code. The instructions request the participant to 'mark three points, areas or lines you value in your living environment. Click on a marker and drag it onto the relevant map location'. We chose to limit the number of markers to three by balancing between the cognitive challenge of a mapping effort by participants and the different spatial features we wanted to test in our method. We know from previous research that there is a limit to how much you can ask from a participant (Pellenbarg *et al.* 2013; Davis *et al.* 2016; Scholte *et al.* 2018). Mapping effort appears to be a reasonable proxy of PPGIS spatial data quality for subjective spatial attributes (Brown 2017). However, the cognitive challenge of mapping different types of spatial features may vary by type of spatial attribute. For example, the mapping of place activities are hypothesized to be less cognitively challenging than the mapping of place values (Brown *et al.* 2012), which can influence the cognitive challenge. Brown (2017) stated that PPGIS applications where participants map place activities would take less effort and time than applications where participants map place values.

The spatial locations of the different types of markers (point, line or polygon) placed were recorded for each participant, along with other information including a timestamp of when the marker was placed and the Google map zoom level (scale) at which the marker was placed (Brown & Donovan 2014). After placing a marker, participants were asked to indicate whether they think the place should be maintained, strengthened, improved or linked and why.

Following completion of the mapping activity, participants were directed to a new screen and provided with the 12 values (see Table 1 and Figure 4 for screenshot of choice situation). Here, the participant distributed 100 points over the 12 sustainability values to indicate the degree of importance to each value. The data collected on the 12 sustainability values relates to the general importance a participant adheres to these values

Table 1. *Sustainability values and corresponding descriptions used in place value identifier.*

PPP	Sustainability value	Description
Planet	Water	Clean and safe water that is and remains suitable for nature, recreation, agriculture, fishing and industry
	Soil	Maintaining important ground qualities, such as sufficient support, archaeological value, underground infrastructure and a foundation for nature
	Energy and materials	Sustainable (re)use of materials and reduction of energy consumption, for example through the use of solar panels, solar boilers or heat pumps
	Ecology and biodiversity	Consistency in the living areas, breeding sites and protected areas of plants and animals to provide an optimal place for them to develop
People	Spatial use	Because space can be limited in the Netherlands, it is important that we set up available space as efficiently as possible
	Spatial quality	The value of an area and (cultural) buildings in the area for use and experience of space, both now and in the future
	Social relevance	Social connectedness and a vibrant community
	Well-being and health	An environment (air, noise and light) that protects health and promotes a healthy and safe lifestyle, both physically and socially
Profit	Accessibility	Efficient use of existing and new roads, as well as connections of different modes of transport (car, bicycle, bus, tram) to save space, fuel and time
	Development potential	The strength of the area to develop, recoup and link potential to the existing use of the area
	Business climate	The presence of and connection with other companies, the level of education and business opportunities
	Citizen settlement	Employment and local and regional amenities, such as shops, schools and recreation, for an attractive living environment

when considering spatial interventions, such as road and neighbourhood development. This has been asked once, after marking three valuable places.

Data collection concluded with participant completion of the survey questions. We carried out data collection for approximately 6 months (see also 'Data quality and sampling').

Data analysis – Participant characteristics and identified place values were analysed through descriptive statistics. The spatial distribution, patterns and intensities of mapped place values were described, first, by calculating the Euclidian distance between participants home and mapped locations, as it was expected that variation in distance might explain spatial patterns. Furthermore, we relate the identified place values to the participants' home address to check whether the marked places have indeed been done in their own living environment and to determine the distribution across the Netherlands. Because we are interested in public resistance related to road infrastructure projects, we developed a study design where proximity to the national and provincial road network and designated conservation or 'formally protected areas' play an important role. To achieve this, we related the NWB road network map (National Road Database; in Dutch Nationaal WegenBestand), the Natura 2000 map and national monuments map with our value mapping survey data. With these data, we are able to define 'Valued yet Unprotected places' a category of places that may not only easily be overlooked but can be a cause of resistance to projects. The stepwise procedure is described below (Figure 5).

In the first step (6A), we created a buffer of 200 meters from the national and provincial

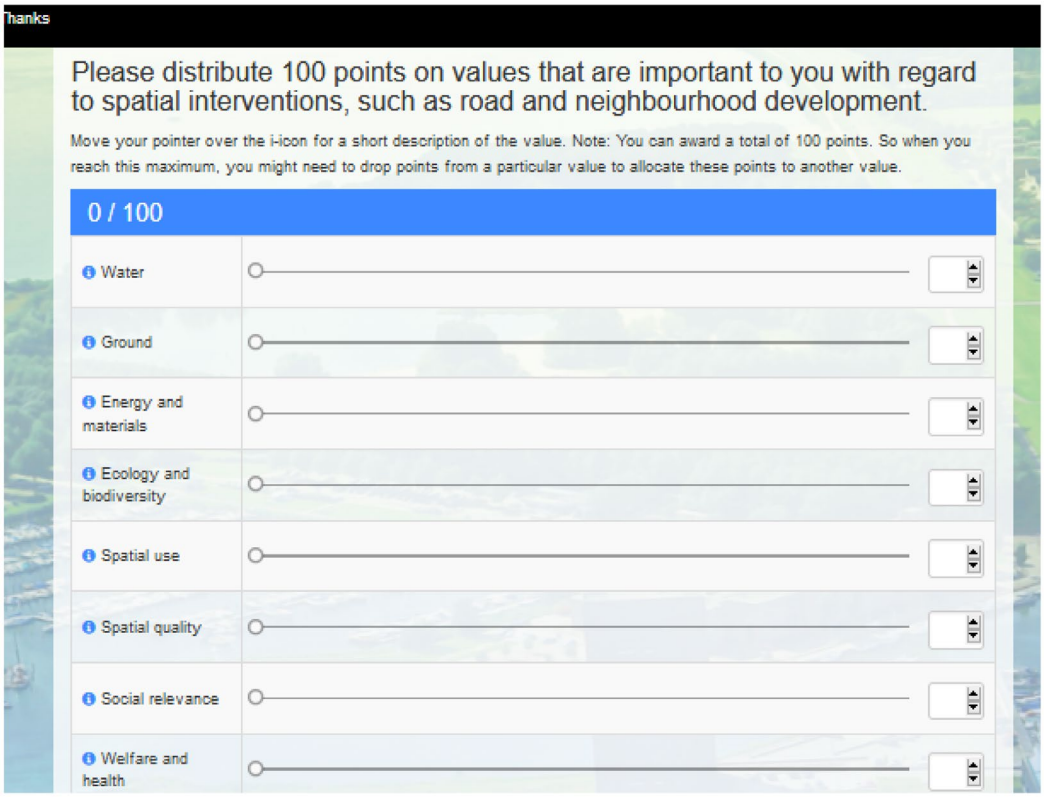

Figure 4. *Screenshot place value identifier – distributing 100 points over 12 values.*

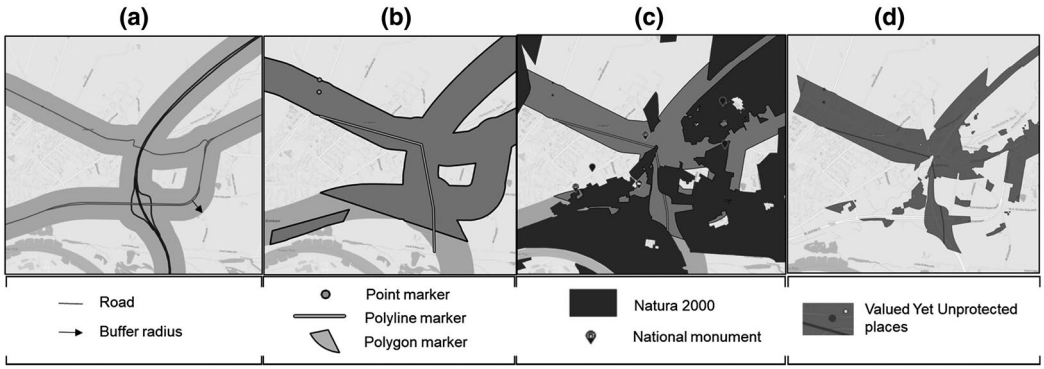

Figure 5. *Schematic visualization of how we defined Valued yet Unprotected places.*

roads of the NWB road network map. Within this buffer, in the second step we clipped the mapped features (point, polylines and polygons) of our value mapping survey data (6B). In the third step (6C), we erased the Natura 2000 polygons from our mapped features. In the fourth step (6D), we created a buffer of 1 meter from the national monuments and erased these polygons from our mapped features. The spatial features that are left is what

we call the 'Valued yet Unprotected places' with regard to road infrastructure projects. To assist planners in developing and selecting project alternatives, we present two maps in the result section to illustrate how our data shows potential resistance areas.

The motivations participants gave with regard to why they marked a particular place as valuable were analyzed using thematic coding with the software program ATLAS.ti., a text coding and analysis software (atlasti.com). The key Place Values were identified based on the literature review of Brown *et al.* (2020; see Table 2) as a starting point. While coding, we added codes for values, which were no part of this first code set. These added codes were on accessibility, nuisance, neglect and development potential (marked with a '*' in Table 2), since these themes were mentioned regularly by the participants. As such, the coding process was based on a combination of an inductive and deductive approach. Each motivation has been coded with at least one code. The coding scheme can be found in Appendix B. To understand the additional value of marking polylines in PPGIS and how they relate to road infrastructure and the motivations why participants marked a place, the polylines have been joined with the NWB road network map.

Data quality and sampling – According to Brown and Kyttä (2014), the quality of PPGIS data is inextricably linked with sampling design and

Table 2. *Place values and descriptions (based on Brown et al. 2020; codes with a * are added by the authors).*

Place values	Description
Aesthetic	—I value these places for the attractive scenery, sights, smells or sounds
Recreation	—I value these places because they provide outdoor recreation activities opportunities
Economic	—I value these places for economic benefits such as agriculture, tourism or commercial activity
Wilderness	—I value these places because they are wild
Biological	—I value these places because they provide for a variety of wildlife, marine life and plants
Heritage	—I value these places because they have natural and human history
Futured	—I value these places because they allow future generations to know and experience them as they are now
Learning (knowledge)	—I value these places because we can use them to learn about the environment
Intrinsic	—I value these places just because they exist, no matter what I or others think about them or how we use them
Therapeutic	—I value these places because they make people feel better, physically and/or mentally
Life sustaining	—I value these places because they help produce, preserve, clean, and renew air, soil and water
Spiritual	—I value these places because they are spiritually special
Social	—These places are valuable because they provide opportunities for social interaction
Accessible*	—I value these places because they provide a perception of accessibility
Nuisance*	—I perceive inconvenience or annoyance from something at this place
Neglected*	—I feel this place is not receiving proper attention
Development potential housing*	—I see potential for housing development at this place
Development potential accessibility*	—I see potential for accessibility improvement at this place
Development potential biological	—I see potential for biological development at this place
Development potential facilities*	—I see potential for development of facilities at this place

participation rates. In essence, 'data collected through PPGIS may be subjected to scientific standards of data quality, especially if it is to be used to support and justify decisions that are purported to have broad public support' (Brown & Kyttä 2014). In this study, sampling design and recruitment were intended to engage the greatest possible number of participants. Therefore, we used a Dutch participant panel called ThesisTools to recruit our participants. The online-based method allowed equal accessibility from all parts of the Netherlands. Dutch inhabitants were invited to participate through e-mail via ThesisTools. The invitation contained a short description of the study and a link to the tool. Nevertheless, this study also had difficulties with reaching a higher participation rate: the participation rate was 51 per cent. The participants (n = 7) who placed one or more markers clearly outside the living environment (the zoom level of their neighbourhood surrounding their filled out postal code) were removed from the database. The final database contained 1044 participants and 3132 valuable places (1734 points, 1120 polygons and 278 lines). Figure 6 shows a fairly even spread of the home locations of all 1044 participants across the Netherlands.

Both genders were almost equally represented, while 3.7 per cent were under 20 years; 53.1 per cent of participants were 21–60 years old; and 43 per cent above 60 years. A large majority (65.5%) of the participants were highly educated, 26.6 per cent had a secondary vocational education and 7.5 per cent secondary education (see Table 3).

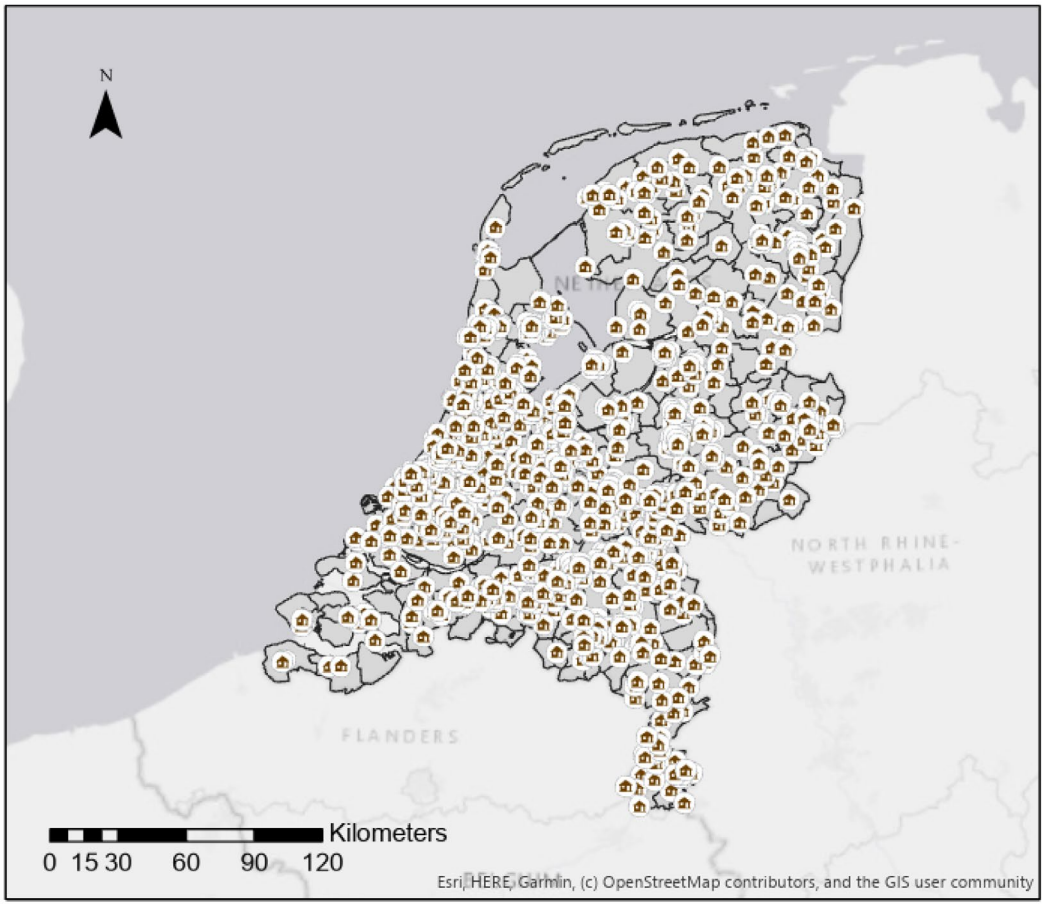

Figure 6. *Home locations of all 1044 participants in the survey (points may overlap).*

Table 3. *Participant characteristics.*

	Frequency	Per cent	Dutch population in per cent (CBS, 2018)
Gender			
Male	650	53	50.4
Female	577	47	49.6
Education			
Primary education	5	0.4	8.8
Secondary education (VMBO (LBO of MAVO))	93	7.5	19.6
Secondary vocational education (HAVO, VWO, HBS, MBO/ MEAO)	326	26.6	39.3
Higher vocational education (HBO/HEAO)	313	40.5	19.5
University education (WO)	307	25.0	11.4
Age			
11–20	45	3.7	22.3
21–30	102	8.3	30.9
31–40	102	8.3	
41–50	178	14.5	28.2
51–60	270	22.0	
61–70	185	30.0	14.0
71–99	162	13.2	4.5
Total	1044	100.0	100.0

With regard to the relative shares of different sustainability value profiles of participants (divided by education, gender and age), we see relative higher average scores on 'waterbodies', 'ecology and biodiversity' and 'well-being and health' by higher-educated participants. Lower-educated participants scored relatively high on 'waterbodies', 'accessibility' and 'business climate'. With regard to gender (male/female), we did not find exceptional differences, besides an overall relatively higher score on 'waterbodies', 'ecology and biodiversity' and 'well-being and health'. When looking at age, we see relative higher average scores on 'ecology and biodiversity', 'well-being and health' and 'accessibility' by participants under 30 years old.

RESULTS: IDENTIFYING PLACE VALUES

Marked valuable places – Participants ($n = 1044$) mapped 3132 valuable places (1734 points, 1120 polygons and 278 lines) located in the Netherlands. As an illustration of the resulting areas drawn by participants, Figure 7 shows the mapped features placed by the participants distributed in four different parts of the Netherlands.

The average length of mapped lines was 6.7 km and the average surface of drawn polygons was 5.5 km^2. As presented in Table 4, we found that the average distance (in km) from home differs for each feature type. On total average, polylines have been mapped a kilometre closer to home than points. Furthermore, we noted that for all feature types, the first mapped place was the closest to home. On average, the third mapped place was the furthest away from home. We can use this to delineate what, according to participants, is perceived as 'inside' their living environment, that is, within a radius of 2.4 km on average.

Table 5 shows participants' indications of action whether a mapped feature should be maintained, strengthened, connected or improved. According to participants, a large majority (55%–68%) of the mapped features needs to be maintained, followed

Figure 7. *Mapped features placed by the participants in different parts of the Netherlands. Upper left: Eastern part. Upper right: Norther part. Lower left: Western part. Lower right: Southern part.*

Table 4. *Distance from home (average) in km.*

Feature type	Total of three mapped places (km)	Place 1 (km)	Place 2 (km)	Place 3 (km)
Points	2.9	1.8	2.7	4.3
Polygons	2.3	1.5	2.3	3.0
Polylines	1.9	1.5	1.7	2.5
Total	2.4	1.6	2.2	3.3

by strengthened (17.4%–24.3%), improved (10.2%–19.1%) and connected (2.6%–5.4%). When looking at polylines, we see a higher percentage of connect (make more accessible) and improve (add something of what is not there) indications of action.

Valued yet unprotected places based on combining 'hard' and 'soft' values – To relate 'soft' valuable places as a complement to 'hard' land use data, all motivations why participants marked a place as valuable were analysed and coded. The following graphs

Table 5. *Indications of action per spatial feature.*

	Connect (%)	Improve (%)	Maintain (%)	Strengthen (%)
Polylines	5.4	19.1	55.0	20.5
Points	2.6	11.2	68.0	17.9
Polygons	2.6	10.2	62.6	24.3
Total	2.8	11.6	64.9	20.4

provide insights in the differences between PPGIS-based valuable areas with different land-use categories (Figure 8A) or their text-coded classifications for the reason of valuation (Figure 8B) while identifying the share of Valued yet Unprotected versus Valued and Protected places. The first thing that stands out is that the number of 'Valued yet Unprotected' is larger than the 'Valued and Protected' marked valuable places. Furthermore, we see quite some differences between the two types of values, for example, built terrain is the largest 'hard' value in number of places, whereas recreation is the largest 'soft' value. Meanwhile, only 222 VyU-places are categorized as the 'hard' land use value recreational terrain (BBG2015), whereas 1223 VyU-places have been 'soft' valued because they provide outdoor recreation activity opportunities. Nevertheless, these categories cannot always be compared one on one, for example, we found that outdoor recreation activities are mentioned regularly not only at the 'hard' land use value recreational terrain but also forest. Another example in this regard is that biological motivations have been mentioned regularly together with 'hard' land uses as water or forest, and can also be both wet- and dry natural terrain. Road infrastructure, as a hard value, has been marked in valuable places 1364 times, whereas accessibility motivations have been mentioned 282 times. These results show that these two types of values can complement each other in an insightful way: besides *what* is marked as valuable in terms of land use, we now also see *why* it has been marked as valuable.

To explore how this knowledge might improve road infrastructure projects and to assist planners in developing and selecting project alternatives, in Figure 9, we present two maps to illustrate how our method can show potential resistance areas of 'Valued yet Unprotected places' at the neighbourhood level of participants. Figure 9 shows two examples of perceived VyU-areas in the radius of 200 meters from national and provincial roads, including reasons (place values) why they feel the place should be maintained, connected, strengthened or improved. Furthermore, when indicated by participants as potential for development, this is also been illustrated on the maps. These two maps (10a/b) demonstrate a tension between, on the one hand VyU-areas that, according to participants, need to be protected, and on the other hand, VyU-areas that need some form of improvement. At the same time, the one does not exclude the other and can therefore become dynamic. For example: #1 'This is a dangerous place due to a narrow road with quite a lot of traffic and a bus four times an hour', #2 'Recreational opportunities are not yet fully exploited' and #3 'Ensuring that the city and the surrounding area work together well and that construction and population make optimal use of space, greenery and opportunities, whereby quality of life and sustainability are jointly implemented'. We feel that (more) systematic knowledge of these valuations is relevant to planning practice, because especially when indicated as 'to be maintained' by residents, this may cause resistance to projects. It should be borne in mind that the presented maps are a small subset and can be seen as an illustration for planners: for any specific project a broader database is needed, representative for the local population.

To understand the additional value of marking polylines in PPGIS, the motivations of participants to mark the polyline have been analysed with regard to the codes 'nuisance', 'accessibility' and other, which do relate the use of the (bicycle) path or road. We found that 107 of the 278 mapped polylines relate to road infrastructure or accessibility motivations. From these 107 polylines, 31 do not touch the

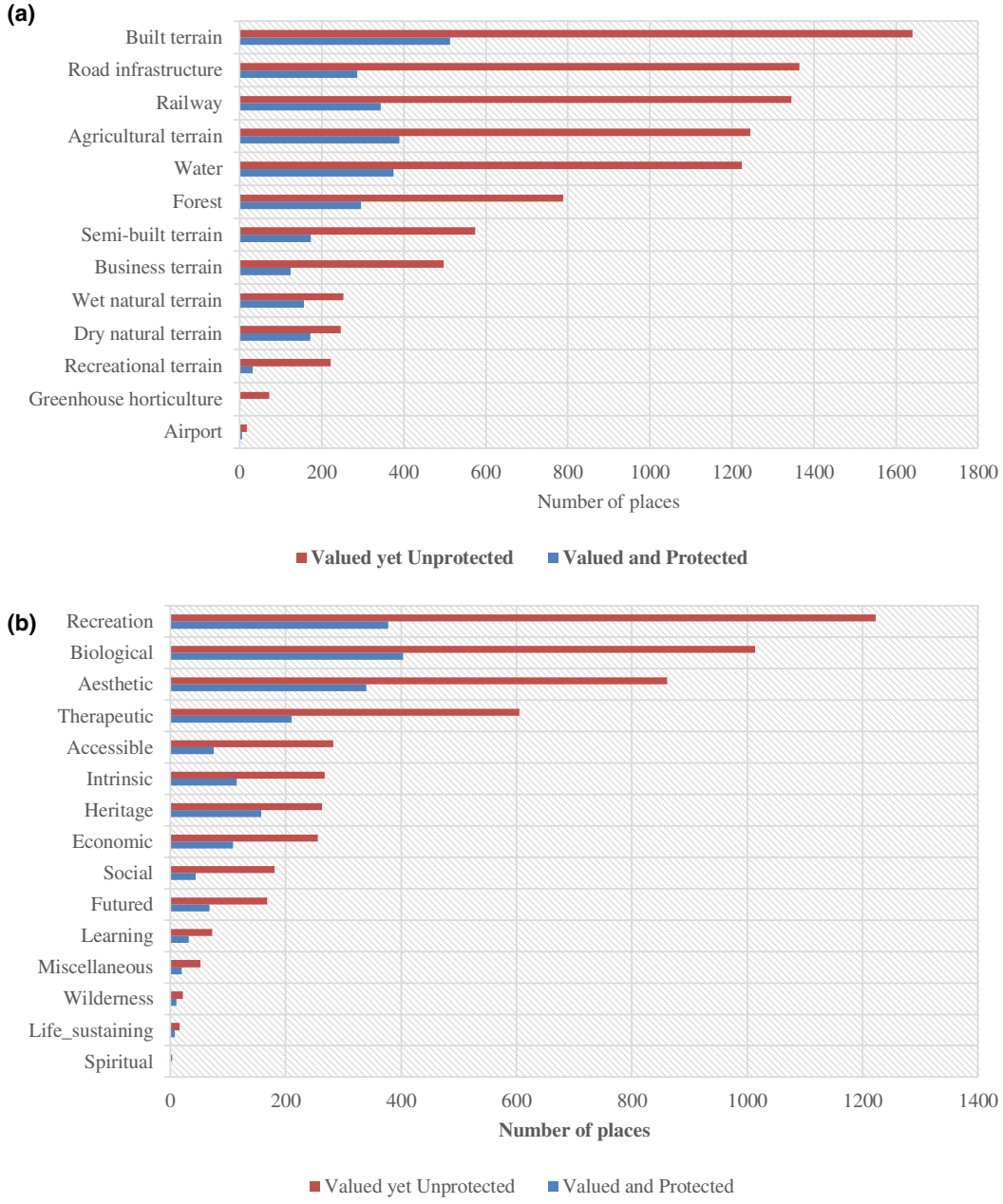

Figure 8. *(A) Combining PPGIS-based valuable areas with different land-use categories while identifying the share of valued yet unprotected versus valued and protected places. (B) Combining PPGIS-based valuable areas with their text-coded classifications for the reason of valuation while identifying the share of valued yet unprotected versus valued and protected places.*

NWB road network map. Table 6 shows a strong relationship between the wish for improvement and nuisance. Furthermore, with regard to the valuation of a (bicycle) path or road itself, more than half of the participants found that the place should be maintained. With regard to accessibility motivations, both improvement and maintenance are important for participants.

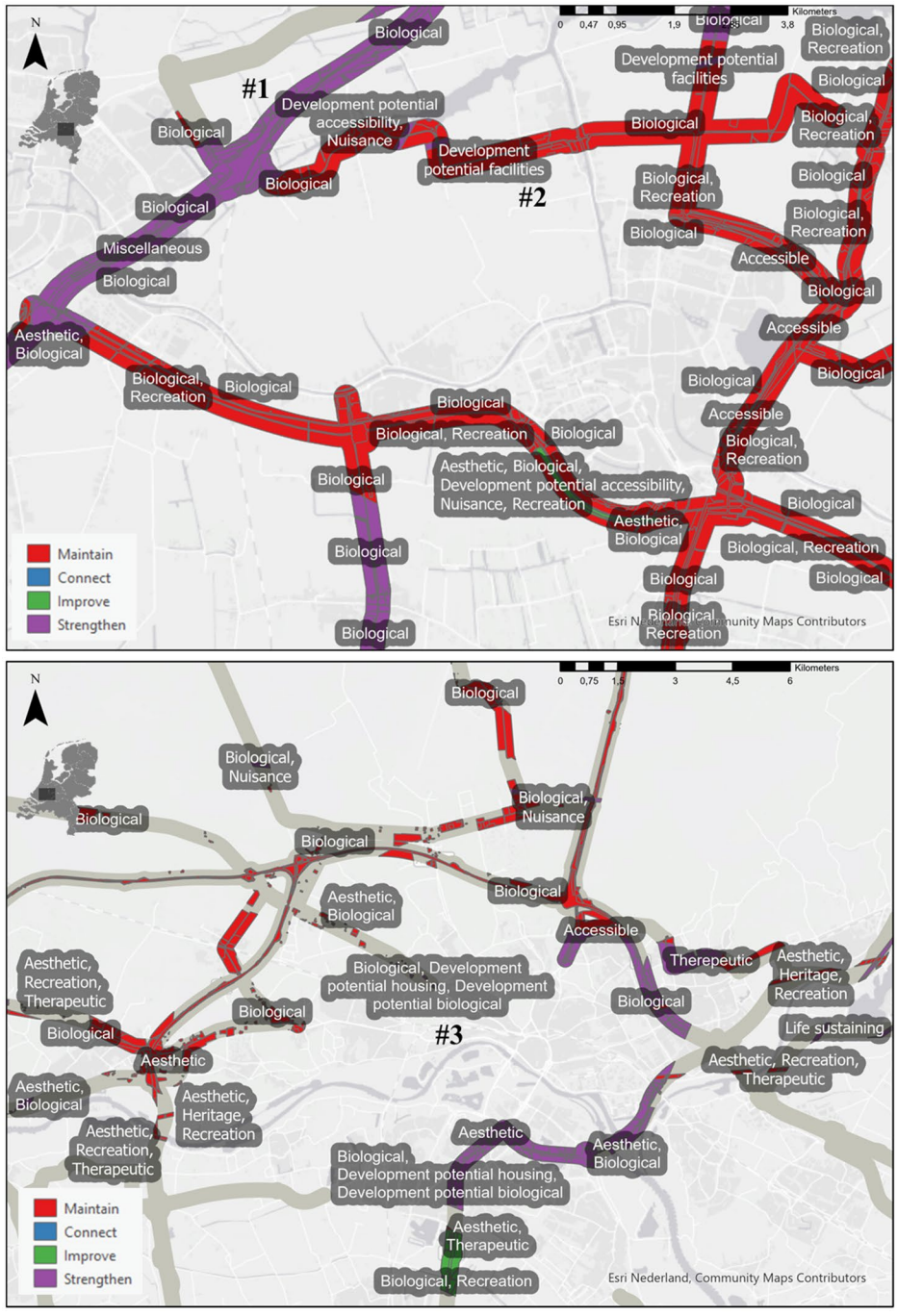

Figure 9. *Perceived VyU-areas in the radius of 200 meters from national and provincial roads, including reasons (place values) why they feel the place should be maintained, connected, strengthened or improved.*

Table 6. *Percentage of motivations for marking a polyline with regard to road infrastructure (n = 107).*

	Nuisance (%)	(Bicycle) path or road itself (%)	Accessible (%)
Connect	14	11	21
Improve	67	11	28
Maintain	5	53	31
Strengthen	14	26	21

Table 7. *Examples of participants' motivations.*

Call to action and coded motivation	Participants' motivation	Mapped feature
Improve and **aesthetic, biological, development potential accessibility, nuisance and recreational**	'It is a nice path for walking or cycling, but you walk very close to the N11. There is constant roar of traffic and there are few bushes or trees that protect you a bit from that. Perhaps a noise barrier could be a solution'. (#140)	
Maintain and **accessible, biological, recreation, therapeutic**	'Alphen a / d Rijn excels in detached asphalted cycle routes. Cycling, walking and running are wonderful here, with uneven ground junctions and lots of greenery. The Dijkslootpad is just one example, there are many more'. (#105)	
Maintain and **accessible, recreation, therapeutic**	'These are the starting points for a peaceful environment. From the points of the line you can cycle to Zandvoort on the one hand and the Haarlemmermeer on the other with the various options'. (#235)	

These motivations (Table 7) provide detailed descriptions and suggestions for the participants' value about the mapped place, and therefore why they think the mapped place needs to be maintained or improved. Furthermore, the combination of this motivation and mapped feature shows us how the participants drew the polyline and what the participant meant by drawing the polyline (e.g. as starting points (#235)).

DISCUSSION AND CONCLUSION: TOWARDS IMPROVING ROAD INFRASTRUCTURE PROJECTS AND SPATIAL DEVELOPMENT

In this section, we will discuss our findings, conclusions and limitations of this study. The aim of this study was to explore how insights in place values might improve the knowledge base for planners of integrated road infrastructure projects and spatial development. The developed method allows us to answer the research questions on (i) relating PPGIS to 'soft' valuable places as a complement to 'hard' land use data, (ii) define Valued yet Unprotected places based on combining 'hard' and 'soft' values and (iii) illustrate how these insights can be used for integrated planning of road infrastructure projects.

Relating PPGIS to 'soft' valuable places as a complement to 'hard' land use data – In evidence-based planning, the active use of a wide range of various types of knowledge, different ways to collect, analyse and deliver data are essential elements of planning (Faludi & Waterhout 2006). Brown and Kyttä (2014) argue that the PPGIS process can be a means to (geographically) represent existing social capital and enhanced community identity to improve the quality of land use decisions. This study expanded on this previous research by identifying 'soft' place values and enabling a shared understanding of these key place values to facilitate the selection of an acceptable – instead of optimal – plan alternative (Hilbers *et al.* 2019). Our findings show Valued yet Unprotected places, which can both be seen as potential resistance areas and can assist planners in developing and selecting an acceptable project alternative. The identified VyU-areas could be a important for project leaders in communicating the protected area importance (Levin *et al.* 2017). Furthermore, the type of location-based experiential information presented in this paper can be a welcome addition to other 'hard' spatial data layers and formally protected areas in evidence-based planning (Faludi & Waterhout 2006). PPGIS would benefit from future research that elaborated further on PPGIS integration with and without specific road infrastructure projects or other spatial developments (Laatikainen *et al.* 2017), accompanied by a critical analysis of possible enabling or constraining factors.

Defining valued yet unprotected places based on combining 'hard' and 'soft' values – Our results show that PPGIS delivers important relevant information that is not easily found in only hard GIS data. Both 'hard' and 'soft' values can complement each other in an insightful way: besides *what* is marked as valuable in terms of land use, we now also see *why* it has been marked as valuable. Since *Valued yet Unprotected places* have not been captured by (only) hard spatial data with a formally protected status until now, but are perceived as valuable, it is an important category of places that can easily be overlooked. Furthermore, in these defined areas, a *call to action* could be expedient: a large majority of participants indicated their valuable places with maintain, followed by strengthened, improved and connected. We saw quite some differences between the PPGIS-based valuable areas with different land-use categories or their text-coded classifications for the reason of valuation while identifying the share of Valued yet Unprotected versus Valued and Protected places. For example, our results showed that the built terrain was the largest 'hard' value in number of places, whereas recreation is the largest 'soft' value. We feel that knowing this can be very relevant to planning practice and future research on potential resistance areas, especially when indicated as 'to be maintained' or 'development potential housing/accessibility/biological/facilities' by residents.

Usefulness for integrated planning of road infrastructure projects – Most PPGIS studies in recent years use points to mark places or participants mark predefined areas (Brown & Kyttä 2014). The rapid pace of software and technology innovation, together with the accommodating improvement of peoples' intuitive skills to work with online maps, enabled us to expand the range of PPGIS options available. Considering the linear nature of road infrastructure development,

we found additional value – even though it was only 9 per cent of the mapped features – of marking polylines regarding road infrastructure maps with indications of action to connect (make more accessible) and improve (add something of what is not there). When zooming into the motivations of the mapped polylines, there seems to be a relationship between the wish for improvement and congestion and nuisance. Furthermore, with regard to the valuation of a (bicycle) path or road itself a connection was suggested between the marking and the wish to maintain. With regard to accessibility, both the option to improve and maintain are important for participants. These results indicate the need for further research on the meaning of the differences in spatial dimensions and the valuation of place (as also suggested by Brown & Kyttä 2014).

Overall, this paper has discussed how the knowledge base for planners of road infrastructure projects and spatial development can be improved by identifying citizens' place values a complement to traditional 'hard' spatial data layers on (formal) values and impacts. The findings of this study increase our value mapping techniques and may assist planners in developing and selecting acceptable project alternatives that invoke less public resistance, since the knowledge of place values can be incorporated in the (context-sensitive) design of road infrastructure project. To further improve planning and decision-making on road infrastructure project and spatial development, and to address citizens' and other stakeholders' preferences for future land use and management, further research is needed into the use of such knowledge in the design of road infrastructure project and spatial development: what explains the differences in valuation of place?

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APPENDIX A

INTRODUCTION OF THE ONLINE SURVEY (PLACE VALUE IDENTIFIER)

In a densely populated country like the Netherlands, space can be limited. Many social activities such as living, working, recreation, traffic and transport need to be located somewhere in the available space. This scarcity can lead to conflicts, as many interests are competing over the setting up and using of space. Major spatial projects (such as roads or neighbourhoods) often lead to sharp discussions.

We would like to know how you value different themes and places that governments consider when developing roads and neighbourhoods. This helps governments to improve integrated planning in an area. Completing this survey will take about 15 minutes, and your response is anonymous.

APPENDIX B

CODING SCHEME MOTIVATIONS

Place values (Brown *et al.* 2020)	Description	English translation of Dutch key phrases
Aesthetic	—I value these places for the attractive scenery, sights, smells or sounds	Beautiful View Sound Smell Attractive Gorgeous Color Superb Visually defining Special
Recreation	—I value these places because they provide outdoor recreation activities opportunities	Sport Walking Cycling Surf Swim Tennis Recreate/recreation Activity Play Organize Park Theater Beach Dog walking area Rider
Economic	—I value these places for economic benefits such as agriculture, tourism or commercial activity	Agriculture/agricultural Tourism/tourism/tourist Employment opportunities Store Groceries Catering industry/hospitality Market Economy/economic Facility/facilities Production
Wilderness	—I value these places because they are wild	Rough Wild

Place values (Brown *et al.* 2020)	Description	English translation of Dutch key phrases
Biological	—I value these places because they provide for a variety of wildlife, marine life and plants	Green Nature Plants Biodiversity Forest Trees Dunes Bird
Heritage	—I value these places because they have natural and human history	History/historical Monument Estate Castle Heritage Archeology/archaeological
Futured	—I value these places because they allow future generations to know and experience them as they are now	Future Generation Preserve Protect To keep
Learning (knowledge)	—I value these places because we can use them to learn about the environment	To learn Knowledge Culture School Education
Intrinsic	—I value these places just because they exist, no matter what I or others think about them or how we use them	Character Picturesque Unique Icon Typically Home Grown up
Therapeutic	—I value these places because they make people feel better, physically and/or mentally	Relax Peace To move Enjoy Delicious Feeling Nice Experience Yummy Nice
Life sustaining	—I value these places because they help produce, preserve, clean, and renew air, soil and water	Clean Environment
Spiritual	—I value these places because they are spiritually special	(life of) Faith Spirit

Place values (Brown *et al.* 2020)	Description	English translation of Dutch key phrases
Social	—These areas are valuable because they provide opportunities for social interaction	Meeting Social Friends Together People Cozy Association Community/community centre Volunteer
Accessible	—I value these places because they provide a perception of accessibility	Connection (road) Accessible Public transport (OV) Close to Nearby Path Train Access Near Walking distance
Nuisance	—I perceive inconvenience or annoyance from something at this place	Disturbance Dirty Disruptive Nuisance
Neglected	—I feel this place is not receiving proper attention	Neglected