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Abstract: The publication of the EU Biodiversity Strategy to 2020 requires a substantial effort in terms of operationalizing the ecosystem service concept. Target 2 of the Strategy in fact advocates that ecosystems and their services have to be "maintained and enhanced" in the current decade. This necessitates the development of methods to map and assess ecosystem services at regional and Country level, which is recognized under Action 5 of the strategy.
Research on ecosystem services mapping and valuing has boosted in recent years, nevertheless compared to other groups (provisioning, regulating) cultural ecosystem services are not yet fully integrated into operational frameworks. One reason is the transdisciplinarity which is required to address the issue: by their own definition cultural services (which encompass physical, intellectual, spiritual interactions with biota) need to be analysed from multiple perspectives (i.e. ecological, social, behavioural). A second reason is most likely the lack of data for large-scale assessments, being direct surveys a main source of information. Among cultural ecosystem services, assessment of outdoor recreation can be based on a large pool of literature developed mostly in social and medical science, and landscape and ecology studies. This paper presents a methodology to include recreation in the conceptual framework for EU wide ecosystem assessments (Maes et al., 2013), which couples existing approaches for recreation management at Country level with behavioural data derived from surveys and literature, and population distribution analysis. The result is a frame that can be applied to quantify the capacity of outdoor recreation as ecosystem service to citizens in the EU, and describe through Country profiles differences in provision, as input to land planning processes.

Dear Editor,

we are pleased to submit a contribution to Ecological Indicators. The manuscript is entitled Mapping cultural ecosystem services: the case of outdoor recreation. This is an original contribution to the scientific literature and its submission is supported by all the authors. The paper contains new material which is not considered elsewhere for review or publication.

Our paper proposes a methodology to include outdoor recreation in the Mapping and Assessment of Ecosystem Services (MAES) framework (http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf), in support of the EU Biodiversity Strategy to 2020. More in general, we believe the paper indicates a viable path to include a cultural ecosystem service in EU wide and national assessments, which provides information to land planning and is also applicable in scenario modeling. The methodology we propose is in fact based on an existing operational approach to recreation management (the Recreation Opportunity Spectrum), to which we add a synthesis of behavioural information derived from surveys and literature review. The analysis of results coupled to population distribution provides an overview of the geographical distribution of the outdoor recreation potential to EU citizens. We believe that our paper is among the first to address this topic at this scale and resolution; given the relevance of natural value in the proposed methodology, and its links to restorative effects of outdoor activity, we hope the paper can provide inputs to the evaluation of progress toward the 2020 biodiversity targets, and more in general to making a better environment accessible to EU citizens.

Best regards,

Maria Luisa Paracchini

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Mapping cultural ecosystem services: the case of outdoor recreation

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Mapping cultural ecosystem services: the case of outdoor recreation

Abstract

The publication of the EU Biodiversity Strategy to 2020 requires a substantial effort in terms of operationalizing the ecosystem service concept. Target 2 of the Strategy in fact advocates that ecosystems and their services have to be “maintained and enhanced” in the current decade. This necessitates the development of methods to map and assess ecosystem services at regional and Country level, which is recognized under Action 5 of the strategy.

Research on ecosystem services mapping and valuing has boosted in recent years, nevertheless compared to other groups (provisioning, regulating) cultural ecosystem services are not yet fully integrated into operational frameworks. One reason is the transdisciplinarity which is required to address the issue: by their own definition cultural services (which encompass physical, intellectual, spiritual interactions with biota) need to be analysed from multiple perspectives (i.e. ecological, social, behavioural). A second reason is most likely the lack of data for large-scale assessments, being direct surveys a main source of information. Among cultural ecosystem services, assessment of outdoor recreation can be based on a large pool of literature developed mostly in social and medical science, and landscape and ecology studies. This paper presents a methodology to include recreation in the conceptual framework for EU wide ecosystem assessments (Maes et al., 2013), which couples existing approaches for recreation management at Country level with behavioural data derived from surveys and literature, and population distribution analysis. The result is a frame that can be applied to quantify the capacity of outdoor recreation as ecosystem service to citizens in the EU, and describe through Country profiles differences in provision, as input to land planning processes.

Keywords

Outdoor recreation, ecosystem service, Recreation Opportunity Spectrum, accessibility

1.1 Introduction

Originating from the Millennium Ecosystem Assessment (MA, 2005) and The Economics of Ecosystems and Biodiversity initiative (TEEB, 2010), the ecosystem service concept has been embedded in multiple policies and initiatives at global and European level, such as the Aichi Targets of the Convention on Biological Diversity, the EU Biodiversity Strategy to 2020, the EU Blueprint to safeguard Europe’s Waters, the current proposal for the Common Agricultural Policy. This has created the need to operationalise the concept, both in terms of geographical mapping and economic valuation, so that ecosystem services can be effectively incorporated into policy-making. Many initiatives are supporting the difficult path to an effective and harmonised use of the ecosystem service concept to support sustainable use of natural capital, as the common goal of the above mentioned policy actions under the EU resource efficiency flagship (EC, 2011). The work presented in this paper aims at providing a framework for addressing outdoor recreation as an example of cultural ecosystem services. It is part of a larger effort to set up tools and methods for the spatially explicit evaluation of ecosystem services in support of the Biodiversity Strategy 2020 (Maes et al., 2011).

Among the main ecosystem services groups identified by MA, 2005 -provisioning, regulating, supporting, cultural- and CiCES (Maes at al., 2013, Haynes-Young and Potschin, 2013) -provisioning, regulation and maintenance, cultural- the latter is the one that due to its intangible nature and dependence from social constructs is particularly challenging to map and assess (Daniel et al., 2012).

Cultural ecosystem services are defined as "non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience"(MA, 2005). Examples of cultural ecosystem services are: appreciation of natural scenery; opportunities for tourism and recreational activities; inspiration for culture, art and design; sense of place and belonging; spiritual and religious inspiration; education and science (De Groot et al., 2010).

This paper develops a model to assess the flow of recreational services to citizens, at the continental scale. Recreation was selected due to its importance for millions of people and because it is a service for which the geographical distribution of ecosystems are particularly important. More specifically, the type of recreation addressed in the paper includes outdoor recreational activities generating benefits in daily life (day leisure visits), spanning from having a walk in the closest green urban area, to a bike ride in nature after work, picnicking, observing flora and fauna, to a daily trip to enjoy the beauty of nature. Tourism and long distance (>100 km) traveling is not included in the exercise, and it would require a different approach (Curry and Ravenscroft, 2001).

The proposed methodology is based on two components. The modelling of the ecosystem function, through a recreation potential index; and modelling of the ecosystem service through the Recreation Opportunity Spectrum, to evaluate to what extent European citizens can benefit from ecosystems.

2.1 Material and methods

2.1.1 Characterising recreation as ecosystem service

Recreation is addressed in this paper from the perspective of ecosystem services, therefore the focus is on the natural environment, on the service supplied by natural and semi-natural habitats, but as well by more intensively managed ecosystems such as agricultural lands. Therefore, all ecosystems are considered to be potential providers of the service, irrespective from their conservation status, though the range of provision changes according to ecosystem characteristics.

The conceptual framework linking ecosystems to the socio-economic system is presented in Figure 1 (Maes et al., 2013), and describes from where and with which intensity the flow of the services originates, and how benefits reach people generating wellbeing. Recreation potential is classified by Costanza 2008 as "User movement related", since the delivery of the service strictly depends on the presence of people in the ecosystems. Accessibility is, therefore, a main component of the modelling exercise. It is, in fact, necessary that people reach sites in order to benefit from the service.

Figure 1

Therefore, in the case of outdoor recreation, three main components characterise the flow of the benefit:

- the ecosystem function, which is provided in principle by all ecosystems, with a provisioning intensity that ranges from "low" to "high" in relation to identified ecosystem characteristics.
- accessibility: people must be able to reach recreation sites in order to the ecosystem service flow to happen, and infrastructures are needed to make the sites accessible. A range in the degree of accessibility is considered, infrastructures include facilities for recreating in nature (hiking trails, snow tracks, bird-watching towers, harbours etc.), the road network, the presence of urban centres.
- the flow of the benefit, which is a combination of potential provision and fruition.

In order to map outdoor recreation as ecosystem service it is necessary to know the main features that characterise the behaviour of people when they recreate. This concerns i.e. the type of preferred habitats, the travelled distance, and the presence of attractive features (i.e. trails, bird-watching towers). An overview on some common features of recreational preferences in Europe was drawn by analysing three visitor surveys, namely the Finnish National outdoor recreation demand inventory (LVVI2)(Sievänen and Neuvonen, 2011), the Danish national household survey and national on-site recreation survey (Jensen and Koch, 1997; Jensen, 2003), and the English Monitor of Engagement with the Natural Environment Survey (MENE)(Natural England, 2011; Sen et al., 2011). In addition, a number of other studies cited in literature was explored (Bartczak et al., 2008; Bujosa Bestard and Riera Font 2009; Kienast et al., 2012; Goossen and Langers 2000; Ode et al., 2009; Brown et al., 2010). The variables representing ecosystem functions and effect of human infrastructure and accessibility on the recreation ecosystem service (Fig.1) used in the model were selected based on the above-mentioned studies (for description of survey results see Appendix A).

Though habits of people related to local recreation are linked to culture, latitude, type of environment, age, social status, etc. the following evidence was present in surveys and literature:

- distance travelled is relatively short: close-to-home visits take place within ca. 8 km from the starting point, which is in the most cases the respondents' home;

- water exerts a specific attraction;
- people are keen in travelling longer distances to reach more natural habitats;
- arable land is not recorded as being particularly attractive for recreation in nature, while grassland, especially if extensive, is listed among recreation sites;
- forests are generally considered as attractive sites;
- overall, more natural sites appear to be more attractive than areas of higher anthropic influence.

In the analysed studies there is no particular information on the role that protected areas specifically play in attracting people (no specific questions in the surveys). However, their role can be derived from the Finnish survey (Sievänen and Neuvonen, 2011), according to which regions of outstanding natural value like Northern parts of Lapland are the destination of a higher share of trips to state-owned land (comprising protected sites, wilderness areas, and large hiking areas) than all other more populated regions together (Maes et al., 2012a) .

2.1.2 An approach to model outdoor recreation in Europe

The method identified to address recreation mapping and the provision of the ecosystem service benefit at EU scale is based on the Recreation Opportunity Spectrum (ROS) model (Clark and Stankey 1979; Joyce and Sutton 2009). The ROS model was developed in the US to provide a framework for:

- Establishing outdoor recreation management goals and objectives for specific management areas.
- Trade-off analyses of available recreation opportunities as characteristic settings would be changed by other proposed resource management actions.
- Monitoring outputs in terms of established standards for experience and opportunities settings.
- Providing specific management objectives and standards for project plans.

Examples exist in literature of the ROS models application at very large scale making it suitable for continental studies (Joyce and Sutton, 2009; Ministry of Forests, Forest Practices Branch for the Resources Inventory Committee, 1998; Stankey and Wood, 1982; Parkin et al., 2000; Yamaki et al., 2003). In the present case the ROS approach is not used in the planning process for providing a range of visitor experiences, but rather as an assessment tool of the current situation of (potential) recreation provision in Europe. The analysis focuses on the whole range of possibilities for recreation provided by ecosystems, more or less managed. The original methodology has been adapted in order to match peculiarities of the European continent and data availability. The ROS inventory focuses on the identification of three main delineation factors of the ROS zones: remoteness, naturalness, and expected social experience. When adapted to the ecosystem services context, these can be associated on one side to the potential provision of the service, on the other to the possibility of reaching recreation sites and the degree of remoteness that characterise the sites.

The applied methodology is organised in the following steps:

- The ecosystem function (recreation potential) is mapped through a composite indicator on the basis of findings from surveys and literature;
- remoteness/accessibility is mapped through a zoning of Europe based on degrees of proximity vs remoteness;
- the ROS is calculated by cross-tabulating the former two results.

2.1.3 Recreation potential indicator (RPI)

According to the findings from surveys and from literature, recreation potential is mapped through components that have a specific link with people's behaviour. These have been divided in three components: the first relates to the degree of naturalness identified as a proxy for people's preference for more natural areas; the second concerns protected areas as public recreation areas. Though in reported literature there is no specific reference to people's preference specifically for such areas, they are considered here as indicators of a high natural value (Maes et al., 2012b) and as providers of recreation services and facilities. The third component concerns water attractiveness.

Such components can be mapped on the basis of the following data and indicators or proxies:

1. The natural value is modelled through the hemeroby index (or degree of naturalness), which is an index that measures the human influence on landscapes and flora (Sukopp 1976; Wrbka et al., 2004; Fu et al., 2006). The European hemeroby map (Paracchini and Capitani, 2011) was obtained by attributing to each CORINE land cover (CLC) class (Bossard, Feranec and Otahel, 2000) its average degree of naturalness on the basis of literature, and by reclassifying agricultural and forested areas on the basis of data concerning management, such as data on nitrogen input and livestock density provided by the CAPRI model and the tree species database of the JRC (AFOLU). CAPRI is an agro-economical model allowing regionalised impact analyses of the CAP. In Capri-Dynaspat dataset, production data of 30 crops in the European administrative regions for EU27 have been broken down to, so-called, Homogeneous Spatial Mapping Units (HSMUs), identified by soil conditions, land cover, slope, and regional administrative boundaries (Kempen et al., 2006). On the basis of disaggregated crop share, the model allows calculating indicators of intensity of management (as nitrogen input and livestock density) at HSMU scale. Input data for the reference year are provided by the Farm Structure Survey (FSS). The AFOLU tree species datataset (Köble, R. and Seufert, G., 2001) includes the distribution of more than 100 species in 1 km^2-cell grid layers. The

distribution data of the 26 most abundant species in Europe and of 9 introduced species were used to attribute different degrees of naturalness to forest areas. The hemeroby scale ranges from 1 (natural) to 7 (artificial).

2. Public recreation areas were mapped using the Natura 2000 database and the Common Database on Designated Areas (CDDA). The Natura 2000 database contains sites designated under the Birds Directive (Special Protection Areas, SPAs) and the Habitats Directive (Sites of Community Importance, SCIs, and Special Areas of Conservation, SACs). The CDDA holds information about protected sites and the national legislative instruments, which directly or indirectly create protected areas (European Environment Agency, http://www.eea.europa.eu/data-and-maps/data/nationally-designated-areas-national-cdda-6). Though very high in natural value, sites classified as “Strict Nature Reserve: not accessible for recreation purposes” have been excluded from the processing.

3. The current exercise focuses on terrestrial ecosystems, recreation linked to water is modeled as attractiveness exercised by water bodies on the surrounding areas. There are many factors driving water attractiveness (i.e. coastal morphology, water quality, protected areas, presence of infrastructures such as harbours, piers and equipped beaches), three of which are considered in the presented approach: 1) data on bathing water quality are annually collected by the European Environment Agency, as measured under the EU Bathing Water Directive (76/160/EEC). The information is used to assign a value to the coast stretch (1 km) in the vicinity of the sampling point, in function of water quality for bathing purposes, assuming that it affects destination choices (Vesterinen et al., 2010). In the current application points are selected where good or sufficient water quality status is achieved. Values are not interpolated, this option is open in further implementations of the model. 2) Data on outdoor recreation facilities are not available EU-wide, therefore it is assumed that water attractiveness decreases as the distance from the coast increases, being high in the vicinity of water, in a buffer within which recreation facilities (including summer houses) can be found. Such distance in the presented work is set at 2000 m. Coastlines of sea and lakes have been extracted from CLC2000 dataset, and a S-shaped impedance function has been used to calculate attractiveness (Kwan, 1998; Geurs and Ritsema, 2001). The following inverse logistic function (1) has been applied to all coastlines:

$$f(d) = \frac{1+K}{K+e^{\alpha \cdot d}} \qquad (1)$$

where:

d is the distance from coast, α and K are the size and shape parameters of the function respectively set at 3.50E-03 and 150 in a way that attractiveness is halved at mid-distance. Ad hoc surveys are needed for specific fine-tuning of the function.

3) Coastline included in protected areas has been identified as adding value to recreation provision, in this case the impedance factor is not applied and the weight of the 2 km buffer equals 1.

The three components have been aggregated following the procedure for building composite indicators (OECD/JRC, 2008). Once made dimensionless by (linearly) rescaling the values in the 0-1 range on the basis of their minimum and maximum value, the components have been aggregated as illustrated in Figure 2. All components (and in the case of water the internal factors) are considered equally important, covering complementary aspects of recreational supply, therefore they are given equal weights, within and among them. This maintains the method neutral to local preferences (Paracchini et al., 2012), but at the same time offers the possibility of adaptation if the model is run on a region for which preferences are known. The final result is the Recreation Potential Indicator.

Figure 2

2.1.4 Remoteness and accessibility

Remoteness and accessibility have been addressed in the second step of the analysis, in order to assess how the benefit (recreation) can be delivered to people. The proxy that has been identified couples information on both variables and has been mapped by classifying the EU into zones of proximity versus remoteness. From the ROS perspective this part takes into account remoteness and to some extent expected social experience. Distance from roads and residential areas have been used as input. The information on the road network is provided by the TeleAtlas database (TeleAtlas, 2009), and covers all paved roads in Europe. Gravel roads have been discarded to ease the processing, though would be equally important for recreation. Residential areas are extracted from CORINE land cover classes “continuous urban fabric” and “discontinuous urban fabric”, therefore, all urban patches larger than 25 ha are considered in the mapping. In the current exercise there was the necessity to adapt overseas experiences to the peculiarities of the European continent, especially considering that the EU does not contain large wilderness areas like other continents. Therefore, the concepts of remoteness and proximity have to be tuned to the experience of EU citizens. In order to do so, a panel of ten European experts of different nationalities was asked to fill out a table in which they had to define thresholds for distances from roads and urban, and assign each combination a label among the following five: neighborhood, proximity, far, remote, very remote. Table 1 shows the average results, which were used to produce the zoning of the EU27 in terms of remoteness and accessibility.

Table 1

2.1.5 The Recreation Opportunity Spectrum for the EU

The final ROS has been obtained by merging the RPI and the zoning for the EU in terms of remoteness and accessibility. The potential for recreation has been classified in three classes of high-medium-low provision by defining thresholds derived from the analysis of data distribution of the RPI, and aggregating the information on remoteness and accessibility in three classes (
Table) for further ease of representation. The RPI classes identify areas with low-medium-high recreation provision: low provision is characteristic of intensively managed areas (i.e. a great part of the EU arable land), medium provision is characteristic of permanent vegetation (i.e. pastures, permanent crops, managed forests), high provision is mostly typical of protected areas (with no habitat distinction) and forests characterised by a high degree of naturalness.

Table 2

2.1.6 Recreation as an ecosystem service to European citizens

An analysis of population data allows estimating the quality of recreation provision to the European citizens. The potential flow of the service to visitors can be estimated by modelling the share of population that can theoretically access the different ROS zones. As mentioned above, the present study addresses daily recreation, therefore according to the analysed surveys two reference distances have been identified for close-to-home and daily maximum travelled distance: 8 and 80 km. The map of EU population density at 100 m resolution (Gallego, 2010) has been used as a source of information on population distribution in Europe. The smoothing function (1) has been applied to describe how far population travels to reach destinations for recreation. Surveys indicate that travelled distance can be modelled using (1), in fact the highest percentage of trips is done in the vicinity of travel origin (Millward et al., 2013; Kienast et al., 2012, Yang and Diez-Roux, 2012). The function assumes that the average citizen has higher probabilities to travel to sites that are closer compared to those that are farther away. The value of each cell of the resulting layer corresponds to the number of inhabitants who can reach the cell from the surrounding 8 or 80 km, given the impedance described in function (1). Such value is the result of the weighted sum (2):

$$P_{cell} = \sum_{x=1,D}^{-D} \sum_{y=1,D}^{-D} f(d_{x,y}) * P_{x,y} \quad (2)$$

where:
D is the maximum travelled distance
x, y are the coordinates of each cell with respect to the processed cell
d is the distance of each cell from the processed cell
P is the population living in the x, y cell
f is function (1)

The values of α and K in the two cases are reported in Table 1. The function shape shows that the probability of traveling beyond 4 km (close to home trips) and 30 km (daily trips) decreases below 0.5.

Table 1

3.1 Results

The resulting indicator for the RPI is shown in Figure 3, the detail shows the model behaviour in the proximity of water bodies.

Figure 3

Figure 4 shows the remoteness and accessibility map for Europe, and Figure 5 the final ROS map. Table 3 illustrates the statistical distribution of ROS classes as percentages of the total analysed territory.

Figure 4

Results show that “easily accessible” classes cover the majority of the EU surface (87%). This is an expected result, due Europe’s high degree of anthropization, and the fact that residential areas are spread throughout the whole continent, leaving the possibility of finding remote ROS zones only in marginal areas (Atlantic North, Boreal). This does not mean that areas with a high potential for recreation are scarce, in fact they account for 44.25% of the total analysed area (41.7% if Sweden and Finland, which are mostly characterised by high recreational supply values, are excluded) and include mostly forests and other natural vegetation, and protected areas.

Figure 5

Table 4

The maps of potential population distribution on close-to-home and daily trips are shown in 6. In practical terms the map is a density distribution of potential visitors, assuming that every cell can be reached by all residents in their respective surroundings according to (1).

Figure 6

Results allow calculating what type of recreation provision EU citizens potentially have access to, and this corresponds to the ecosystem service flow, or the benefit that population can - in average - draw from recreation in the different ROS zones.
The maps in Figure 6 can also be interpreted as the density of potential trips of EU residents in their respective surroundings (whether 8 or 80 km) counted on a 100 m grid. Therefore, the percentage of potential trips per ROS zone can be calculated by dividing the sum of potential trips per ROS zone by the total of all possible trips. Results are reported in Table 5.

Table 5

Since the ROS classes are defined also through distance from roads and residential areas it is expected that the majority of trips takes place to “easily accessible” sites. This explains also the reason why the share of close-to-home trips (8 km) is higher in the low and medium provision sites (“easily accessible”) compared to 80 km trips, and is lower in the high provision sites though “easily accessible”, which usually are not located in the immediate surroundings of residential areas and therefore can be reached after longer trips.
This approach can be applied at any convenient scale. For example, statistics at country level provide information on how the benefit flow changes according to environmental conditions and population density. Table and Table show the results for Sweden and Italy. Clearly in a country like Sweden where forests are dominating, the share of trips to sites with a high provision of recreation potential is higher than in a country like Italy where a large part of the population lives in intensively cultivated flatlands, while areas

with a high recreational value are mostly concentrated in the Alps and Apennine mountain ranges.

Table 6

Table 7

Results at country scale (based on regional data) can be summarized as shown in Figure 7, which provides "Country profiles" for recreation reflecting the actual ecosystem service provision. Calculations are made per region (NUTS2) in four countries as an example, and the axes are reporting the number of inhabitants versus the percentage of potential trips to "high provision – easily accessible" areas for close-to-home trips.

Figure 7

4.1 Discussion and conclusions

In this paper we propose a method for mapping and assessment of outdoor recreation as an ecosystem service. The described methodology allows an estimation of the potential flow of the benefit, in terms of daily recreation activities, to all citizens, and considers all ecosystems as potential providers of the service. In our view this is an important aspect because visitor surveys clearly show that people typically do not travel long distances for this type of activities, therefore they can most often choose their destinations among a limited set of options, which includes the type of ecosystems available in the surroundings of their homes. Choices on where to actually go are driven by many factors (available time, age, accessibility, weather, personal taste, etc.) but are nevertheless constrained by characteristics and state of ecosystems in the neighbourhood. These findings are in line with what was reported by Anderson et al. (2009) in their analysis of England's visitor survey. The authors found, in fact, peak activity in regions with high human population densities around London and the arc of conurbation that encompasses the cities of Manchester, Birmingham, Sheffield, and Leeds, and advocate for "*bespoke policy approaches designed for the landscapes where people live, work and play at highest densities*". Also, choice modelling analysis of the demand for recreation in Denmark shows that spatial location of recreation sites and substitution patterns between these sites are important for individuals undertaking recreational activities as "*the overall recreational value is expected to depend on the proximity to population clusters and on the way in which recreationists respond to potential recreation substitutes*" (Termansen et al. 2008).

The present analysis shows that 61 to 64% of trips for outdoor recreation (depending on the maximum traveled distance) can be made to sites providing low to medium recreation provision, and the remaining to sites characterised by a high provision. The potential availability of the recreation service to people in a region mostly depends on spatial distribution of population, accessibility and distribution of ecosystem types. In the presented approach the distribution of nature protection areas plays an important role, and makes a difference in the benefit flow in a continent like Europe, where the anthropic footprint is high. This is shown in Figures 6, 8 and 10: like in other countries, in Germany most people live in the agricultural flatlands, but the network of nature protection areas is such that the share of potential trips to ROS class "high provision – easily accessible" for close-to-home trips (8 km) is generally higher than e.g. in Italy. In this latter Country people on the average have to travel farther in order to find areas characterised by a high recreation potential, as these are mostly located in the mountain ranges. As mentioned above the situation in Finland is different: in regions where most of population lives the density of nature protection areas is lower than in Lapland, but the boreal environment is characterised per se by a high provision of recreation potential and people widely benefit from it as demonstrated by the visitor surveys (see Appendix A).
The presented work is the first attempt to model recreation as ecosystem service at continental scale. It is worth pointing out limitations that should be addressed in further improvements of the methodology: Southern EU countries are under-represented in terms of surveys and therefore in the description of people's attitude to recreation; access denied to visitors in private property (i.e. agricultural parcels) and inaccessible areas (i.e. cliffs, steep slopes) are not taken into account; potential visitors density should take accessibility directly into account; scenic beauty and cultural landscapes are not explicitly included in the exercise.
Figure 10 provides information for a possible use of results in policy making (land use planning in particular). The presented results provide information for planning future improvements in the rate of delivery of the service at different spatial scales. This is particularly important due to restorative health effects of outdoor activity, and the link between health and quality of nature in the surroundings of living places (Hanski et al., 2012; Bowler et al., 2010; Tzoulas et al., 2007; Cole and Hall, 2010; Natural England, 2011).

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Table(s)

Table 1: Classes of the accessibility/remoteness index (legend on the right)

Distance from urban areas (km)	Distance from road (km) < 1	1-5	5-10	> 10
< 5	1	2	2	4
5-10	2	2	2	4
10-25	3	3	3	4
25-50	3	4	4	4
> 50	4	4	4	5

1	Neighborhood
2	Proximity
3	Far
4	Remote
5	Very Remote

Table 2: The Recreation Opportunity Spectrum classes (legend on the right)

			Recreation Potential		
			1	2	3
			< 0.19	0.19-0.25	> 0.25
Remoteness/ Accessibility	1	Neighborhood	1	4	7
	2	Proximity	1	4	7
	3	Far	2	5	8
	4	Remote	3	6	9
	5	Very Remote	3	6	9

1	Low provision - easily accessible
2	Low provision - accessible
3	Low provision - not easily accessible
4	Medium provision - easily accessible
5	Medium provision - accessible
6	Medium provision - not easily accessible
7	High provision - easily accessible
8	High provision - accessible
9	High provision - not easily accessible

Table 1: Parameters of the cumulated population model

MOBILITY MODEL	PARAMETERS	
Long distance function 80 km	α	1.12E-04
	K	27.95793

Short distance function 8 km	α	1.13E-03
	K	450

Table 4: Statistical distribution of ROS classes

ROS Categories	EUROPE	%
1	low provision - easily accessible	24.00
2	low provision - accessible	0.52
3	low provision - not easily accessible	0.04
4	medium provision - easily accessible	25.25
5	medium provision - accessible	2.18
6	medium provision - not easily accessible	0.48
7	high provision - easily accessible	37.81
8	high provision - accessible	6.44
9	high provision - not easily accessible	3.30

Table 5: potential trips per ROS zone

	ROS classes	% trips 8 km	% trips 80 km
Europe	1 - Low provision- easily accessible	36,70	35,54
	2 - Low provision- accessible	0,06	0,14
	3 - Low provision- not easily accessible	0,04	0,01
	4 - Medium provision- easily accessible	27,35	25,34
	5 - Medium provision- accessible	0,11	0,35
	6 - Medium provision- not easily accessible	0,01	0,02
	7 - High provision- easily accessible	35,43	37,61
	8 - High provision- accessible	0,21	0,88
	9 - High provision- not accessible	0,09	0,11

Table 6: ROS results for Sweden

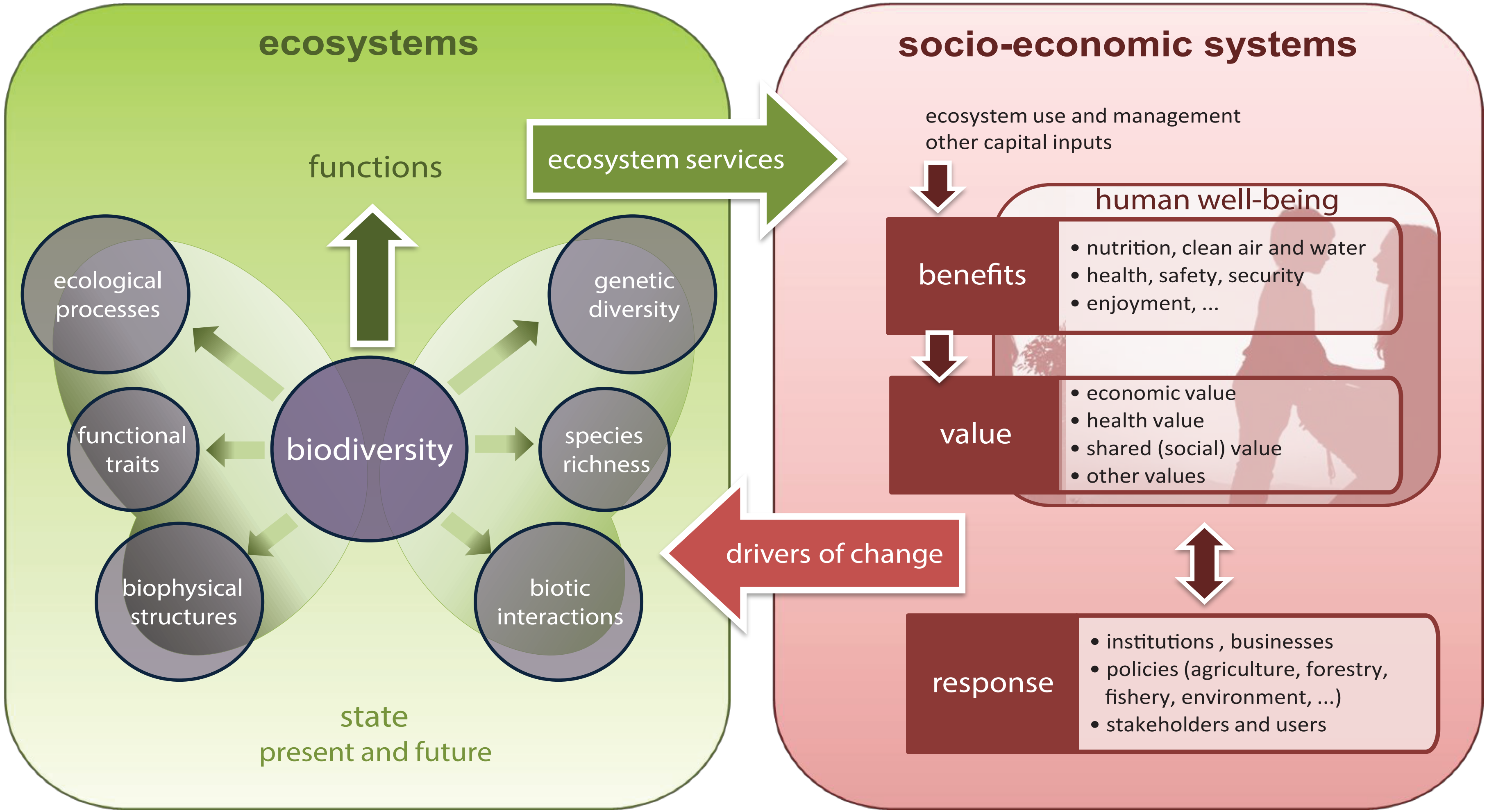
Countries	ROS classes	% trips 8 km	% trips 80 km

Sweden	1 - Low provision- easily accessible	22,70	18,83
	2 - Low provision- accessible	0,04	0,11
	3 - Low provision- not easily accessible	0,01	0,03
	4 - Medium provision- easily accessible	21,85	21,93
	5 - Medium provision- accessible	0,38	1,84
	6 - Medium provision- not easily accessible	0,06	0,29
	7 - High provision- easily accessible	54,01	51,84
	8 - High provision- accessible	0,76	3,99
	9 - High provision- not accessible	0,19	1,14

Table 7: ROS results for Italy

Countries	ROS classes	% trips 8 km	% trips 80 km
Italy	1 - Low provision- easily accessible	41,38	39,11
	2 - Low provision- accessible	0,01	0,02
	3 - Low provision- not easily accessible	0,00	0,00
	4 - Medium provision- easily accessible	32,41	29,10
	5 - Medium provision- accessible	0,02	0,12
	6 - Medium provision- not easily accessible	0,00	0,00
	7 - High provision- easily accessible	26,15	31,23
	8 - High provision- accessible	0,04	0,40
	9 - High provision- not accessible	0,00	0,02

Figure 1



ecosystems
functions
ecological processes
genetic diversity
functional traits
biodiversity
species richness
biophysical structures
biotic interactions
state
present and future
ecosystem services
drivers of change
socio-economic systems
ecosystem use and management
other capital inputs
human well-being
benefits
• nutrition, clean air and water
• health, safety, security
• enjoyment, ...
value
• economic value
• health value
• shared (social) value
• other values
response
• institutions , businesses
• policies (agriculture, forestry, fishery, environment, ...)
• stakeholders and users

Figure 2

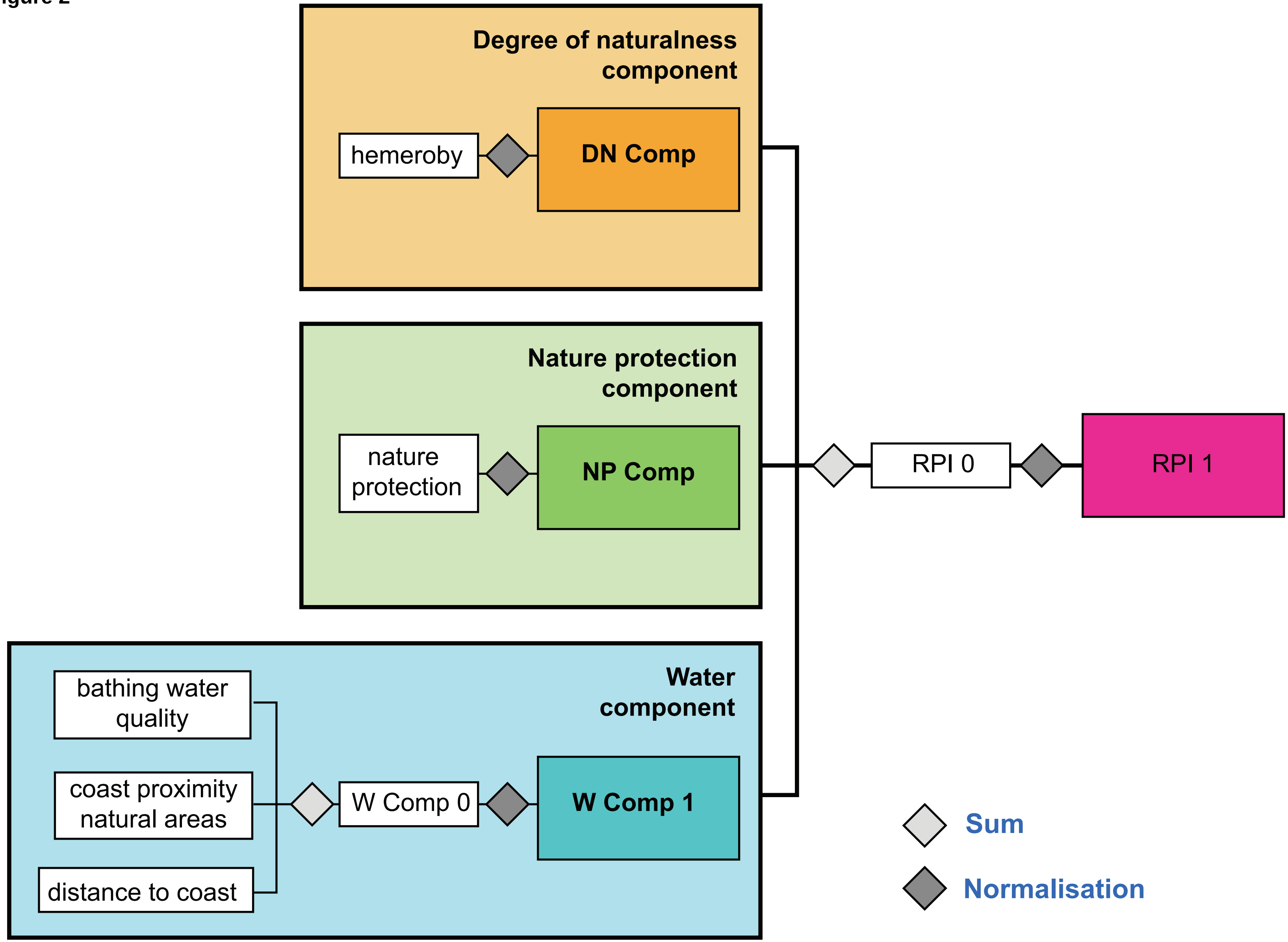
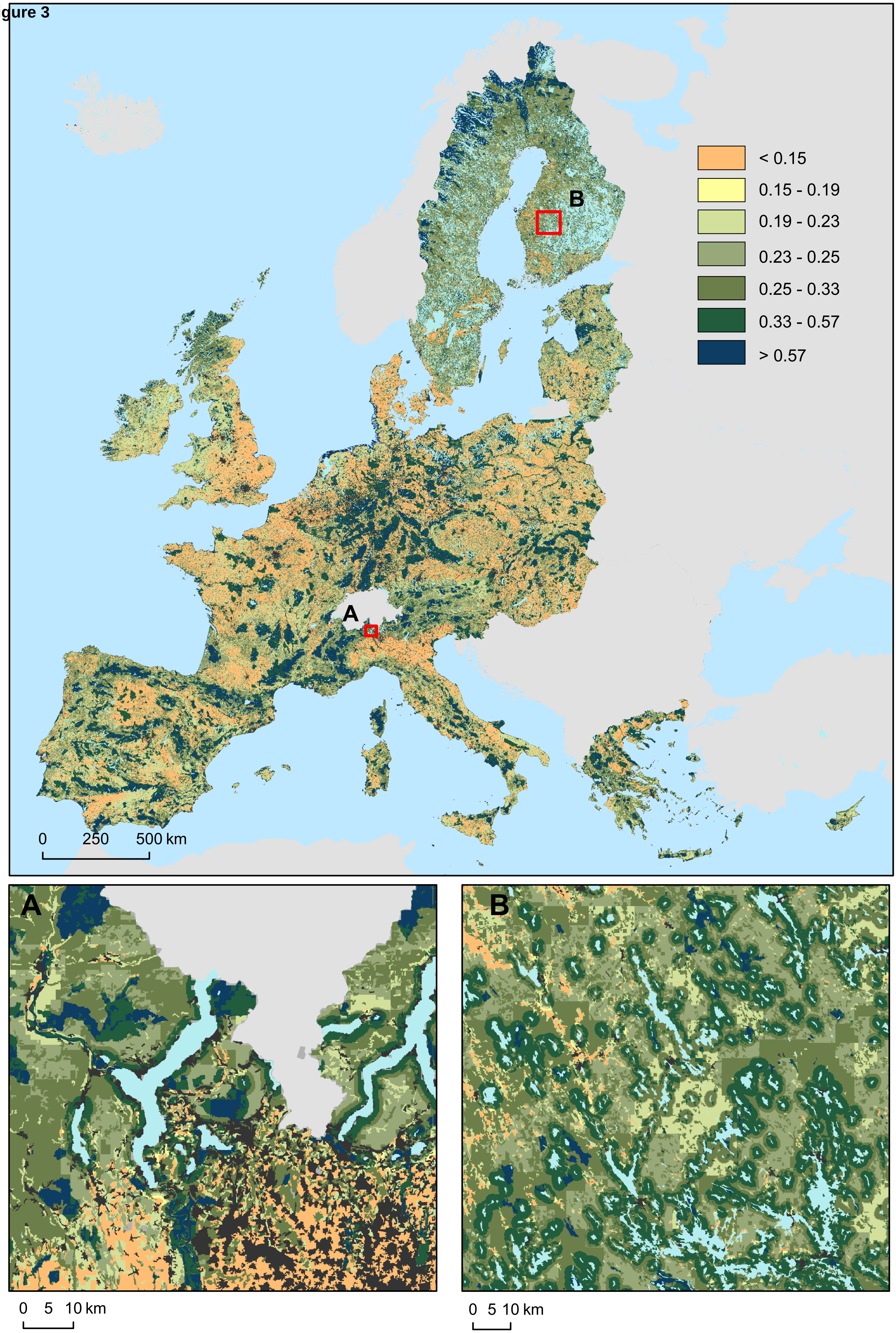

Degree of naturalness component
hemeroby
DN Comp
Nature protection component
nature protection
NP Comp
RPI 0
RPI 1
Water component
bathing water quality
coast proximity natural areas
distance to coast
W Comp 0
W Comp 1
Sum
Normalisation

Figure 3



< 0.15
0.15 - 0.19
0.19 - 0.23
0.23 - 0.25
0.25 - 0.33
0.33 - 0.57
> 0.57
A
B
0 250 500 km
A
B
0 5 10 km
0 5 10 km

Figure 4

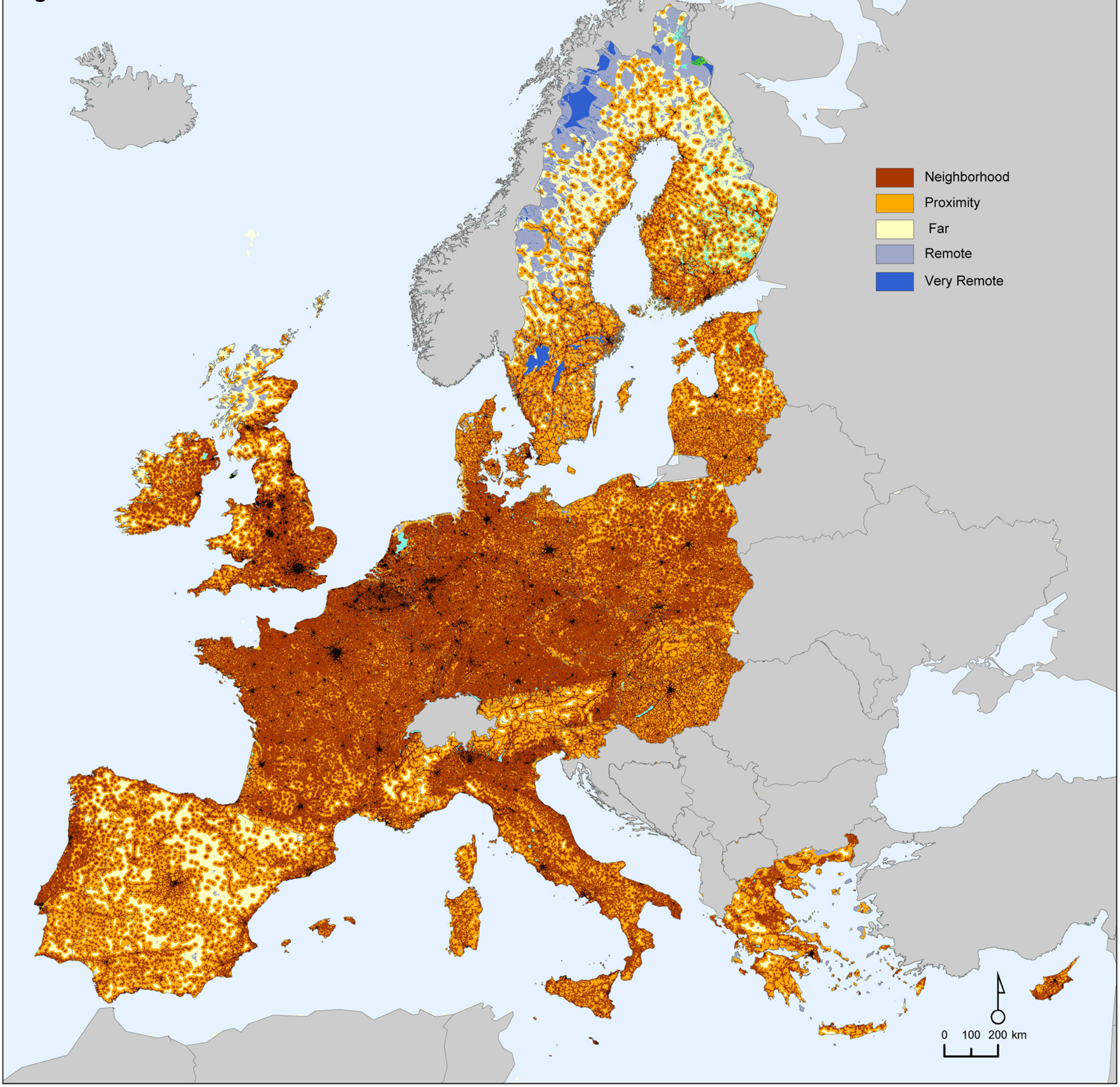


Figure 5

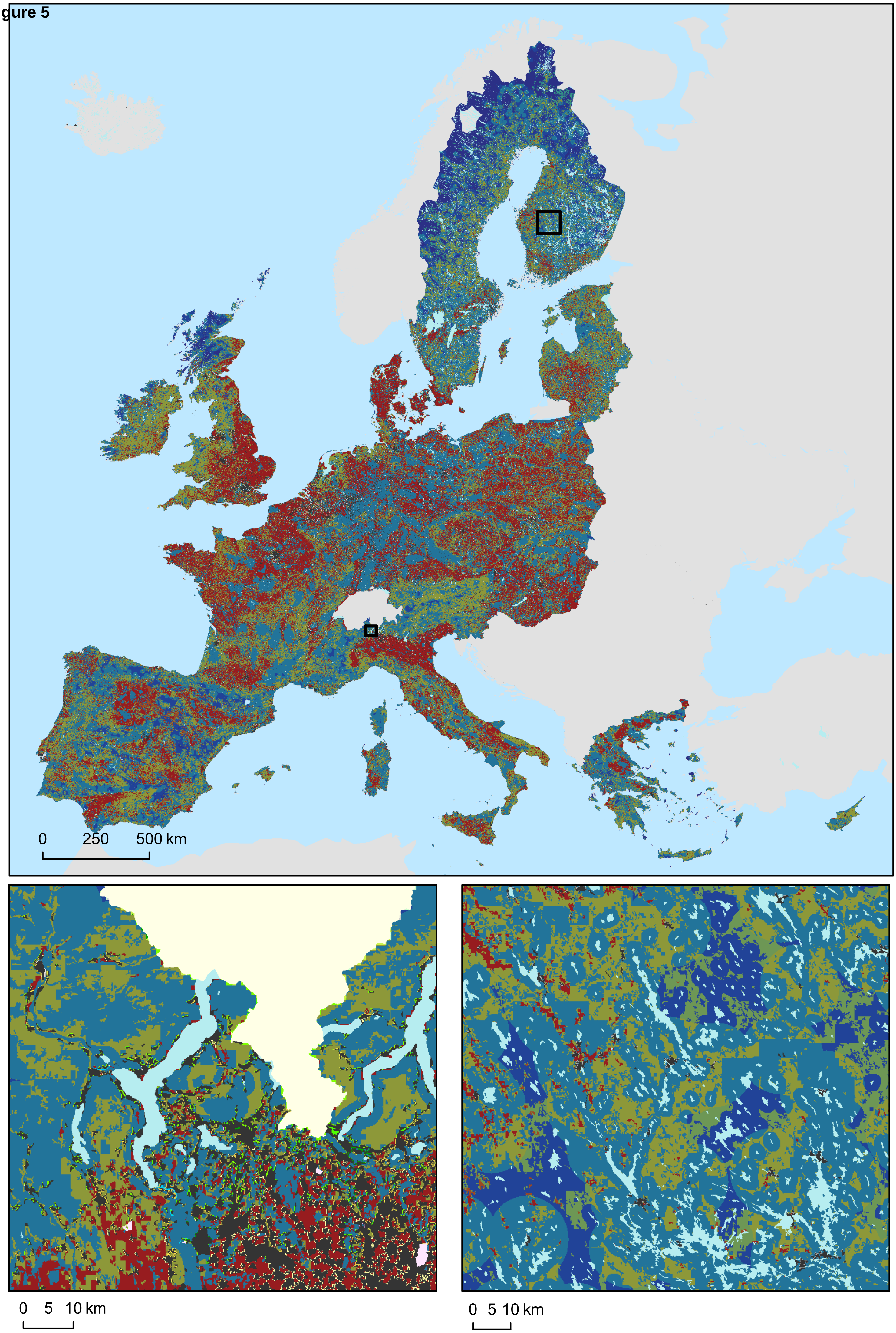


Figure 6

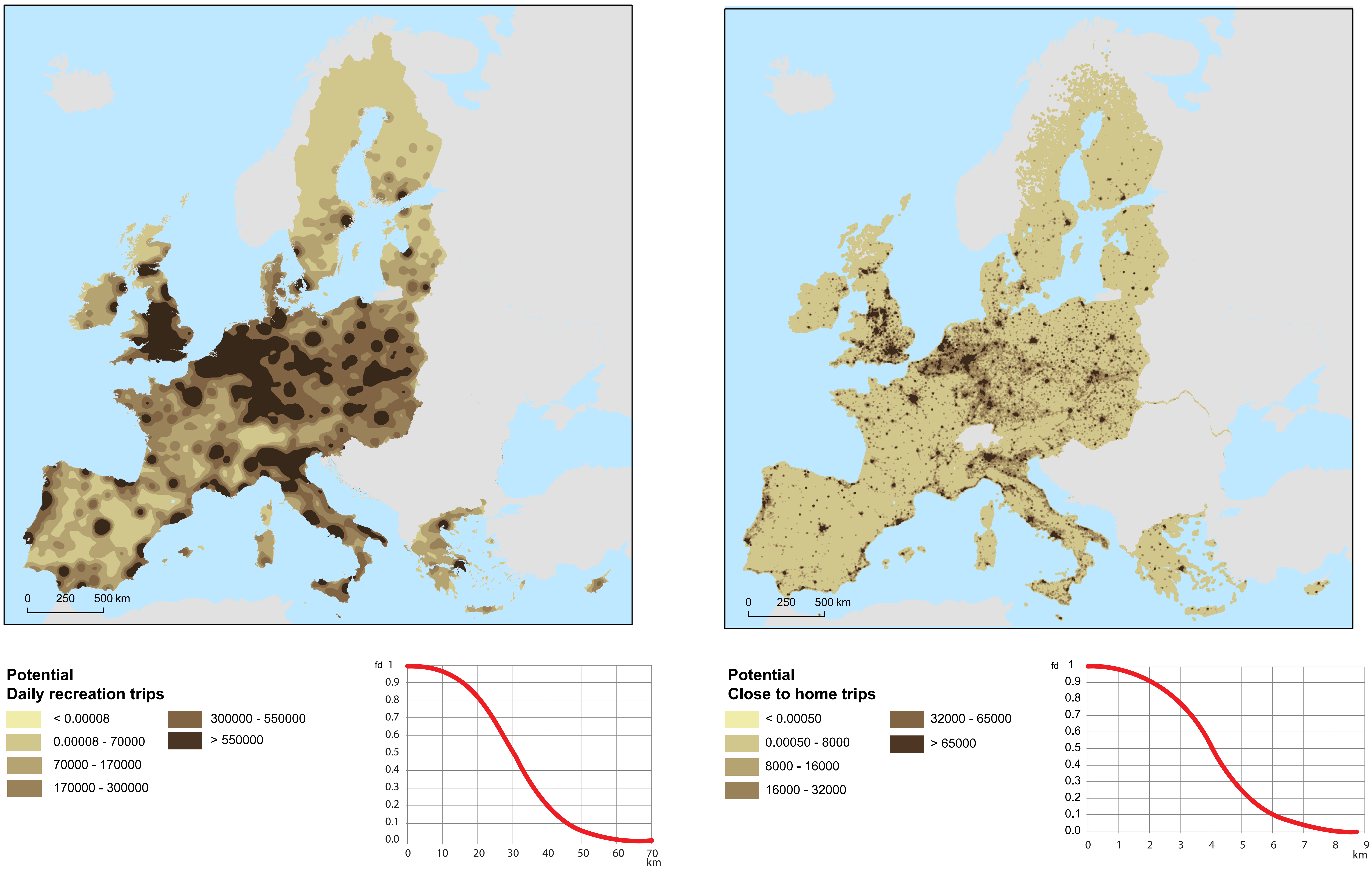

0
250
500 km
0
250
500 km
Potential
Daily recreation trips
< 0.00008
0.00008 - 70000
70000 - 170000
170000 - 300000
300000 - 550000
> 550000
fd
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
10
20
30
40
50
60
70
km
Potential
Close to home trips
< 0.00050
0.00050 - 8000
8000 - 16000
16000 - 32000
32000 - 65000
> 65000
fd
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
1
2
3
4
5
6
7
8
9
km

Figure 7

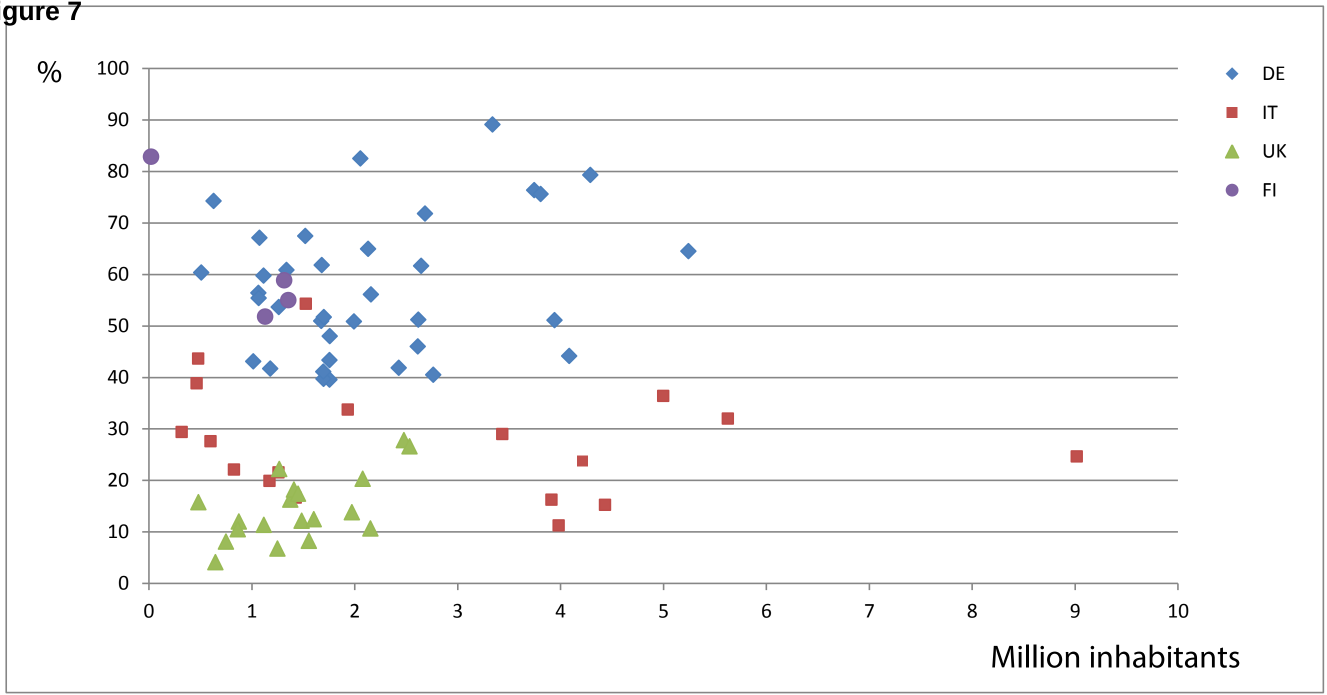
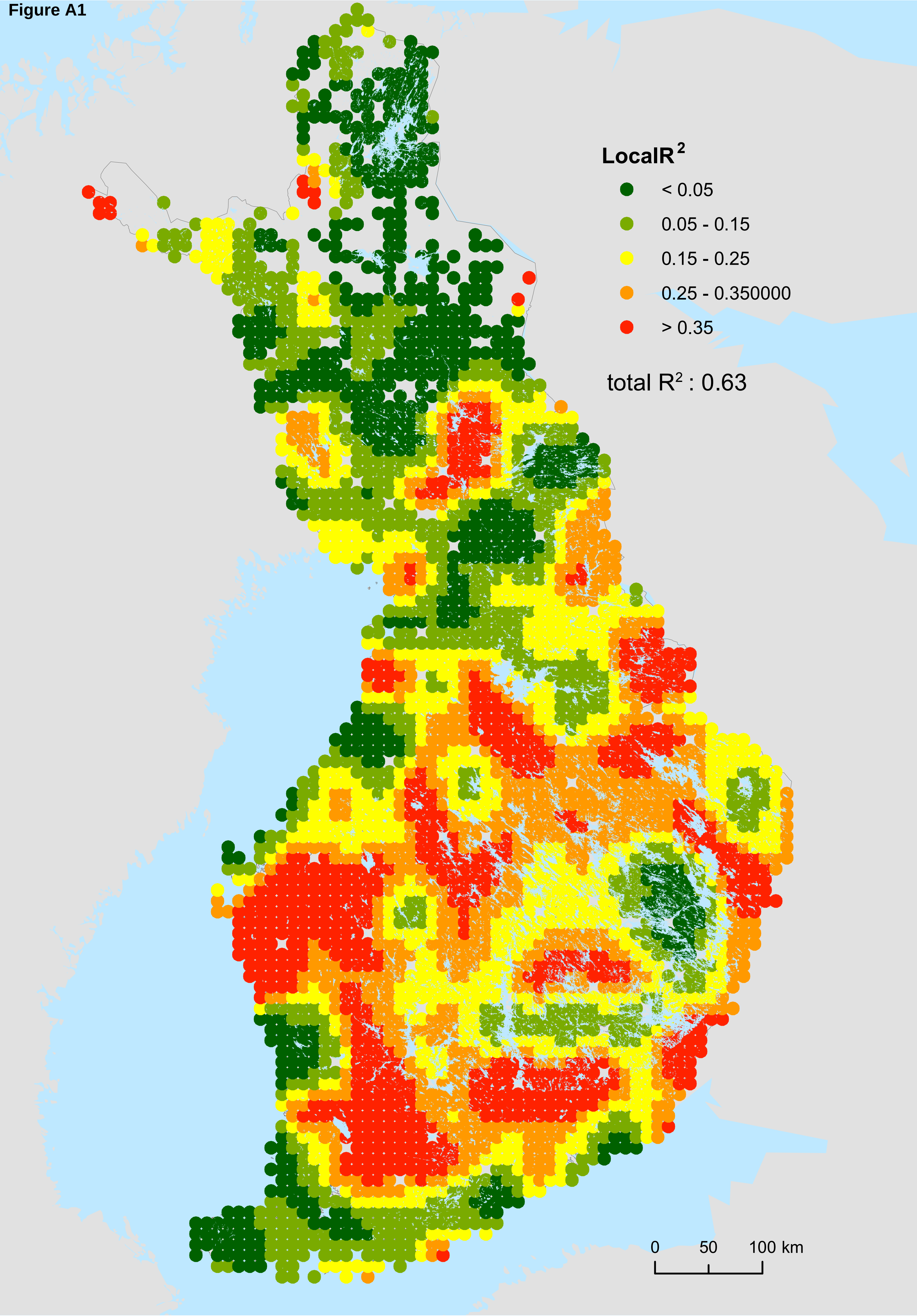

%
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Million inhabitants
DE
IT
UK
FI

Figure A1



LocalR^2
< 0.05
0.05 - 0.15
0.15 - 0.25
0.25 - 0.350000
> 0.35
total R^2 : 0.63
0
50
100 km

Figure captions

Figure 1: Conceptual framework for EU wide ecosystem assessments (from Maes et al., 2013)

Figure 2: Flowchart of the procedure to obtain recreation potential (W: water; NP: nature protection areas; DN: degree of naturalness; RPI: recreation potential index)

Figure 3: Recreation potential indicator for the EU

Figure 4: Remoteness /Accessibility map for the EU (Romania and Bulgaria are excluded for lack of input data)

Figure 5: The Recreation Opportunity Spectrum (ROS) for Europe

Figure 6: Potential population pressure on ecosystems assuming a 80 km travel (right) for daily trips (by car) and 8 km for short trips (left) (e.g. walking, running, cycling)

Figure 7: Distribution of population in NUTS2 regions vs number of potential trips to ROS class "high provision – easily accessible" for close-to-home trips (8 km) (% over total) (DE – Germany; IT – Italy; UK – United Kingdom; FI – Finland)

Mapping cultural ecosystem services: the case of outdoor recreation

Appendix A

Overview of outdoor recreation surveys carried out in various countries

The national outdoor recreation demand inventory (LVVI2), Finland

Statistics Finland, on an assignment of Finnish Forest Research Institute, conducted a LVVI2 population survey in 2009−2010 on a random sample of Finnish citizens aged 15 to 74 years (Sievänen and Neuvonen 2011). The data was collected using a web-based survey supported by mail questionnaire. The response rate was 37% and consequently data were received from 8895 respondents. The respondent's received questions about participation in outdoor activities, some basic descriptive questions of the most recent recreation visit close-to-home (day visits), and most recent nature trip (including overnight stay), plus socio-economic information. Characteristics of the most recent close-to-home recreation visit or nature trip were asked in more detail.

Results show that 25% of the cumulative distribution accounts for visits up to 250 m from home to the recreation site, 50% accounts for visits up to 1.5 km, 75% accounts for visits up to 6 km, the 100% of the cumulative distribution is reached at 360 km. Three quarters (75%) of the day visits lasted 0.25–2.0 hours and two thirds of the visits (68%) took place only at a walking distance from the starting point which in most cases was the respondents' place of residence. The average duration of a day visit was 2.1 hours and the standard deviation was 2.37 hours.

Interesting results that can be drawn from the survey and that provide a clear indication on the recreation behaviour of residents concern their preference for the destination type and the travelled distance. Survey statistics show clearly that areas where the use is based on public access to the land independently on who owns it (so called "everyman´s right") are very important for recreation by Finnish population, and that second homes also play a relevant role in recreation activities (Maes et al., 2012a).

A statistical analysis of the spatial distribution of second homes (Figure A 1) mapped as total number in 10 km x 10 km grid cells, and the length of the coastline (lakes and sea) in each cell gives as result a 0.63 R^2 showing a positive correlation between the distribution of second homes and the presence of water. Such correlation is likely to increase if more detailed data on the location of second homes is used.

Figure A 1

The national household survey and on-site survey data, Denmark

Two surveys conducted in Denmark were analysed: the national household survey from 1994 (Jensen and Koch, 1997) and a national on-site recreation survey in 592 forests and

other natural areas from 1996/1997 (Jensen, 2003). 2916 people between 15 and 76 years were randomly sampled from the national register and surveyed in the first case (response rate was 83.7%), 6987 people were surveyed in the North Zealand forests, representing a response rate of ca. 46%.
From the household survey, evidence shows that ca. 49% of visits to forests were made by car, the most frequent mode of transport, followed by going on foot (32%) and by bike (11%). Results show that more than 60% of the sample population in Northern Zealand appear to prefer coniferous forests to broadleaf forests. Sloped terrain and presence of water bodies also increase the likelihood of a forest being selected. As expected, larger forests appear to be more popular than smaller forests, however, with a declining marginal effect. Also sites close to the coast are more attractive than inland forests as the coefficient on the distance from coast is negative. The error term on distance to coast indicates a common substitutability between forests close to the coast and a difference in the substitutability with other forests.

Natural Environment Survey (MENE), England

The Natural Environment Survey (Natural England, 2011) is a national survey on people and the natural environment. The survey provides the most comprehensive dataset yet available on people's use and enjoyment of the natural environment. It includes information on visits to the natural environment (including short, close-to-home visits) as well as other ways of using and enjoying the natural environment. This dataset relates to the first two years of surveying from March 2009 to February 2011. The analysis of results shows that in the case of England the ecosystem type surrounding the trips origin is important, in fact classes like suburban, improved grasslands and arable and horticulture are mostly represented as destinations. On the other hand people travel longer distances to reach extensive/semi-natural environments (i.e. acid grassland, inland rock, heather, bogs, mountain habitats). More in detail 19% of visits were to sites close to water (river, lake, canal, beach, coastline); 14% to path, cycleway, bridleway; 13% to forest; 9% to farmland; 3% to mountain, hill, and moorland. The main visit destination was within 1.6 km of the respondent's home (or other starting point) for four out of ten visits. A further 26 per cent of visits took place within 1.6 to 3.2 km. The majority of visits (82 per cent) took place within 8 km of the starting point of the visit. The majority of visits to the natural environment (94 per cent) started from the participant's home. On average a visit to the natural environment lasted for just under 2 hours (Natural England, 2011).
Sen et al. 2011 in their study for the UK National Ecosystem Assessment report a positive impact of the share of woodland on total recreational visitor numbers. In particular, broadleaf forests, but also grasslands contribute to higher visitor numbers compared to arable land, furthermore, in the estimation of the site prediction model they note that some coastal areas exert a strong attraction on visitors despites low population density. They also underline "*the vital importance of placing recreational sites in areas which are readily accessible to large numbers of people*".

Common features in recreational behaviour, other countries

Studies cited in literature provide further information on characteristics of recreation behaviour: Bartczak et al. 2008 report that in Poland the vast majority (85%) of visitors go to forests for walking, though berry and mushroom picking is considered almost as important (80%), and that the average length of a single trip is around two hours. Bujosa Bestard and Riera Font 2009 report in their study that in Spain distance to coast is statistically significant, that variables concerning the proximity to non-attractive features ('burned areas') and disturbing land uses ('urban areas' and 'citrus-farming') have a negative impact on visitation probabilities, and that visitors prefer more peculiar and unusual species (*'Juniperus phoenicia'*) and 'broad-leaved' compositions rather than the most common 'mixed' forests. Kienast et al. 2012 found in their analysis in Switzerland that lakes and rivers are important attractors for nearby recreation, that occurrence of forest is generally positively correlated with people's presence, and that distance to residence considerably drives their model. In fact, their survey shows that to most respondents it takes between 5 and 15 min to reach the starting point of their nearby recreation journey. Goossen and Langers 2000 found that in the Netherlands areas of natural beauty and forests are preferred by walkers; sand, moor, dune areas and areas of natural beauty by cyclists; good water quality by swimmers; and all the groups like quiet settings. Brown et al., 2010 report that participation in outdoor recreation is increasing in Scotland, that woodland, hills and mountains are most appreciated as destinations, and that about 60% of regular outdoor recreation users travels a maximum distance of 5 miles to reach their destination. Lastly, naturalness was identified by Ode et al. 2009 as an important contributor to the formation of preference in their Internet survey based on landscape visualization.

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