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Predicting transgressions of the social capacity of natural areas

Sjerp de Vries, Martin Goossen

Alterra, Green World Research
P.O. Box 47, 6700 AA Wageningen, The Netherlands
Email: s.devries@alterra.wag-ur.nl

Abstract: Within the urbanized Dutch society, the social function of forests and nature areas is becoming more and more important. The same holds for agricultural areas. However, planning and management tools for this social function are almost absent. This paper presents a tool to be used by policy makers at regional and higher levels. By means of a normative analysis the local supply of and demand for nature-based recreation are confronted with each other. Because of its normative nature, the analysis does not offer a good description or prediction of actual recreational behavior. However, it does offer insight into where, according to the policy norms, the local supply of nature-based recreation opportunities cannot accommodate local demands. The method has been applied nation-wide and outcomes are momentarily used to substantiate spatial claims to develop new recreation areas.

INTRODUCTION

Besides their ecological function, the social function of forests and nature areas is becoming more and more important in the Netherlands. This is signified by the title of the new act for nature management: "Nature for people, people for nature" (LNV, 2000). Also agricultural areas are changing from production to consumption spaces. However, data, norms, and planning tools for the social function are almost absent. This makes it difficult for policy makers to do justice to this function, especially in the Netherlands, where spatial claims for different functions often exceed the available amount of land. In this paper we will describe the development and use of a planning tool for the recreational function of forests and nature areas, as well as agricultural areas. The tool is intended to serve policy makers at regional and higher levels.

In this paper we will limit ourselves to the two most popular outdoor-recreational activities in the Netherlands: walking and cycling. Although these activities sometimes take place in a built-up environment, green environments are generally preferred. This is why in Dutch recreation policies the accommodation of the desire to undertake this type of activity in a green or natural environment is a common goal. Moreover, since it is seen as a basic type of amenity, this desire should be accommodated at a local level. Furthermore, meeting local demands at a local level is thought to help to minimize leisure mobility (by car).

The above policy goal raises the question when the local supply of nature-based recreation opportunities may be considered sufficient to cover the local demand for this type of opportunity. In this paper a method to answer this question is described, as well as its nation-wide application. For an extensive description of the method the reader is referred to De Vries and Bulens (2001).

The structure of the paper is as follows. To begin with, the inventory of the local supply of nature-based recreation opportunities is presented. This includes the normative determination of its social capacity. Second is the presentation of the local demand assessment, especially on the norm day: the day on which supply and demand should be in equilibrium. This is followed by the procedure for the confrontation of supply and demand. Fourth the outcomes of a nation-wide application of the method will be reported. Finally, the method and the practical usability of its outcomes will be discussed.

THE SUPPLY INVENTORY

The basis of the supply inventory is the GIS-database on land use of Statistics Netherlands (CBS). In this database 33 types of land use are distinguished. However, not all of these types have a reception capacity for nature-based recreation in the form of walking and/or cycling. Criteria that were used to decide which land use types had a positive capacity for land-based outdoor recreation are the following:

- it should be a predominantly green area with some significance for outdoor recreation
- by and large the type of land use should be publicly accessible
- 'man-made' attractions should not dominate the area; it should be a resource-based facility
- the reception capacity of the area should be significant

All infrastructure types were assigned zero capacity, even dirt roads. The latter may be of recreational significance, but capacities are assigned to areas (that may include recreational infrastructure). Areawise the small roads themselves are of little significance. Residential areas were also assigned no capacity. Although they may be used for recreational activities, they were not considered green enough. Campgrounds and other types of holiday resorts were excluded because in general they are not open to the public.

A few refinements were made with regard to the remaining types of land use. To begin with, all nature areas that are known to be (completely) closed to the public, were also assigned zero capacity. A GIS-database compiled by Goossen and Langers (1999) was used for this purpose. The most important refinement deals with the category "areas for agricultural use, with the exception of cultivation under glass". As one might imagine, this is a quite extensive and diverse category. That is why it was split up into six subcategories.

It is known that not all types of agricultural area are considered equally attractive for recreational use. Especially very open areas are not very well liked as an environment for walking and cycling (see Renemann et al, 1999). Using a GIS-database developed by Dijkstra and Van Lith-Kranendonk (2000) agricultural areas with 95% or more low cover were defined as open agricultural land. The remainder was considered enclosed agricultural land.

Considered even more important was the density of the recreational infrastructure: quiet country roads, dirt roads, cycle and footpaths. Goossen and Langers (1999) developed a GIS-database that describes the density of this type of infrastructure for the Dutch countryside. It was decided to distinguish three levels of density: low, medium, and high. The average density in these three categories was 13, 37, and 74 meters per hectare. The three density levels were crossed with the two openness levels to create six categories of agricultural land.

Assigning capacities to land use categories

Before assigning capacities, first we have to determine what we mean by the term 'capacity'. Different types of capacity may be distinguished: social, ecological, physical, traffic. We defined capacity as the maximum acceptable user intensity of an area, predominantly from a social point of view. We placed an upper limit on this capacity: it can never be higher than the maximum user intensity that can be expected given an ample supply of the type of area. This proviso has been made to prevent that a capacity that 'technically speaking' is available, but will never be used in practice, will unduly influence the analysis. This may happen in case of low quality areas.

The capacity of a type of land use is expressed as the maximum acceptable number of people that can make use of this type of area per day, per hectare. Most of the capacity figures are derived from previous studies (LNV, 1984; Provincie Zuid-Holland, 1999). Only for agricultural areas the figures are based on the maximum number of people willing to recreate in this type of area, rather than the number of people that could 'technically' recreate in this type of environment. The density of the recreational infrastructure was considered a major factor.

In second instance the capacity figures, which used to be for the combined category of activities, were split up for walking and cycling. This was done according to best professional judgement. Although the exact division is open to discussion, it was thought helpful to be able to make a rough distinction between opportunities for walking and opportunities for cycling. In table 1 the capacity figures for different categories of land use are given in terms of the number of recreation places it offers.

Land use category	**Walking**	**Cycling**
wet natural	3	1
dry natural	6	2
agricultural (excl. greenhouses)		
- high density infra & open	0.3	0.9
- high density infra & enclosed	0.6	1.8
- medium density infra & open	0.1	0.5
- medium infra & enclosed	0.2	1.0
- low density infra & open	0	0.2
- low infra density & enclosed	0	0.4
Forest	9	3
Beach	8	0
city parks & green areas	8	2

Table 1: capacity figures for different types of land use (number of persons per day per hectare).

Some of the land use categories were also assigned capacities for other types of activities, such as sitting, playing & sun bathing. Parks, for example, were assigned a capacity of 90 for this more stationary type of activity. Specific recreation sites (within a larger recreation area) were assigned a capacity of 100 for this type of activity. However, for a large part these recreation areas consist of forest or nature areas, and were assigned capacities for walking and cycling accordingly.

THE DEMAND ASSESSMENT

In the demand assessment differences between people are not taken into account. This does not mean that such differences do not exist. However, a study by De Vries (1999) has shown that already at the level of small residential areas the population tends to be so heterogeneous that these differences average out to a large degree. As a consequence, only demand characteristics for the average Dutchman are needed as input. By multiplying this with the size of the population of a residential area, the total demand originating from that residential area is known. We will start with the latter.

Because the analysis takes place at a local level, the residential areas should be small is size. For this reason neighborhoods were chosen as spatial units of origin. The Netherlands is divided into over

10,000 of such neighborhoods. The average size is about 340 hectares. Statistics Netherlands (CBS) offers a register that includes the number of inhabitants of each neighborhood, as well as a GIS-database with the neighborhood boundaries. For the present situation the 1995-version of this database was used.

Since the supply capacity is defined on a daily basis, the demand for recreation opportunities also must be expressed on a daily basis to allow for a confrontation. However, while the supply capacity remains more or less the same for all days of the year, this obviously does not hold true for the demand. On some days the demand is much higher than on other days. That is why a norm day must be decided upon. This is the day on which supply and demand should be in equilibrium. Confrontation on a yearly basis does not seem very useful, since then days with overuse and days with underuse may average out. Traditionally the fifth or the tenth busiest day is chosen as norm day. We have chosen the fifth busiest day.

The percentages of the Dutch population that participate in the activities walking and cycling on this fifth busiest day have were derived from empirical material as far as possible. Two sources were used. On the one hand this was the 1995/'96 day trip study of Statistics Netherlands (CBS, 1997). This study offers data on day trips that last at least two hours (including transport). The average yearly number of such day trips with walking as the dominant activity is 4.3 (including jogging). The yearly average for bicycling is 2.8. These figures include non-participants.

Based on previous studies, it was assumed that 1.2% of the total yearly number of trips for this type of activity will take place on the norm day (Goossen & Ploeger, 1997). For walking and cycling combined, this is 8.6 % of the population (see also Provincie Noord-Holland, 1996). This leaves us with one problem: not all trips with walking or cycling as the dominant activity will last two hours or longer. And also, or especially, the short trips will make use of the local supply of recreation opportunities. This means that these short trips have to be added to the long trips. The assumption is made that after adding the short trips to the long trips the norm day will still be the same day.

The number of short trips to be added was determined using a different study, performed by the province Zuid-Holland (1998). In this study a sample of the population of this province was questioned regarding its recreational behavior on three days that were likely candidates for the norm day, namely sundays in the late spring with reasonable to good weather conditions for the time of the year. These data suggested a ratio of long to short trips of about one to one. Using this ratio, the participation percentages on the norm day would be 10.4% for walking and 6.7% for bicycling.

An alternative way of arriving at norm day percentages was based solely on the study of the province Zuid-Holland. This province conducted the same study twice: once in 1993 and once in 1997. In each year the figures for two sunny sundays were available. Averaging these figures over both sundays and both years led to the following percentages: 11.4% for walking and 6.2% for cycling. Compared to the previous figures, the participation rates are a little bit higher for walking and a little bit lower for bicycling. However, the province Zuid-Holland is among the most highly urbanized within the Netherlands. The aforementioned day trip study of the CBS shows that in highly urbanized areas there is a tendency to walk somewhat more and bicycle somewhat less, compared to the national average. That is why it was decided to stay with the first figures: 10.4% for walking and 6.7% for bicycling.

THE CONFRONTATION

By far the easiest way to perform a demand-supply confrontation would have been to look at the number of inhabitants of, for example, a municipality, and to confront this with the recreational capacity available within this same municipality. However, such a confrontation has several drawbacks. To begin with, not all municipalities have the same size. In the Netherlands sizes may differ by a factor 50! Furthermore, in such an analysis people living in a small, rather urban municipality would not be 'allowed' to make use of the excess capacity of a neighboring, more rural municipality. That is why a different type of procedure was chosen. This procedure will be described below.

The neighborhood was chosen as the smallest unit of origin. Using the center of a neighborhood as point of origin, a norm distance was selected. This is the distance within which the local supply should be sufficient to accommodate the local demand. In the present analysis the norm distance was set at 10 kilometers (airline). This is the average of the maximum distance from home after one hour of walking (5 km) and that for cycling (15 km) at a leisurely speed (by road). Another hour is required to get back home. A maximum trip duration of two hours, excluding the time used for stops along the way, is thought to cover the vast majority of the walking and cycling trips made by the Dutch. Note that transport by car to an attractive destination area is not included in this normative analysis. Consequently the time spent on traveling by car, or another form of motorized transport, should not be taken into account when determining the trip duration.

The next step was to determine the capacity that was available to each inhabitant of a neighborhood within this norm distance. However, there is an important distinction between the capacity that is within reach, and the capacity that is available on a per capita basis. For the latter it does not suffice to merely divide the total capacity present within the

10-kilometer zone by the number of inhabitants of the neighborhood. The same supply unit may also be within reach of other neighborhood centers. And the same capacity should not be allocated twice, or even more often.

To avoid this, we started our analysis at the supply side. First the GIS-data concerning the supply were converted from vector to grid format for ease of calculation. Gridcells of 25x25 meters were used, because some categories of land use are characterized by quite small continuous areas but very high reception capacities (e.g. parks). The reception capacity of such a gridcell is 625/10000 that of a hectare. The centers of the neighborhoods were also converted from a point into a grid theme. Next, for each supply cell it was determined which neighborhood centers were located within 10-kilometer distance of this cell, and what the total number of inhabitants of these neighborhoods was. Subsequently the capacity of the supply cell was divided by this total number of inhabitants. Finally, these per capita capacities were summarized for all supply cells within 10 kilometers of the center of a neighborhood. This cumulative figure gives the available capacity per person within the neighborhood. The above procedure was performed for each activity separately.

On a more technical note, the whole procedure was performed within ArcView, extended with the Spatial Analyst module. Especially the neighborhood statistics available within this module have been used. Scripts were written to make the analysis easy to repeat. The outcomes for each neighborhood were stored in new variables added to the attribute table of the neighborhood theme, one for each activity. This made them available for subsequent analysis.

If the available capacity per person for a given activity equals one, then for every person in the neighborhood there is a place to participate in this activity. To be more specific: a place within 10 kilometers of his or her neighborhood on every day of the year, without that social capacities are transgressed. However, since not all inhabitants will participate in the given activity on the same day, lower amounts of available capacity are acceptable. In fact, if we express the available amount per capita as a percentage of one, we have a supply figure that may be directly confronted with the participation percentage for the activity on the norm day.

By subtracting the supply percentage from the demand percentage neighborhoods with insufficient local supplies may be identified. In those cases the percentages are positive. By multiplying a positive percentage with the number of inhabitants of the neighborhood, the size of the deficit may be determined. This more or less completes the description of the confrontation procedure. A final note is that the procedure allows for the deficits of the neighborhoods to be aggregated to larger spatial units of origin, such as municipalities.

THE RESULTS

Using supply data for 1996 en demand data for 1995, supply and demand were confronted according to the procedure described above. In first instance the confrontation was performed for walking and cycling separately. In second instance the confrontation was repeated, but now under the assumption that walking and cycling are perfect substitutes for each other. This implies that a lack of supply for walking may be compensated by an excess supply for cycling.

A first result of the procedure is the available capacity per capita. Figure 1 shows a map for this characteristic when walking and cycling are assumed to be perfect substitutes. In this case the required capacity per capita is 17.1%. Not surprisingly, the capacity per capita is lowest in the most urbanized areas of the Netherlands. By multiplying the positive values of this characteristic that remain after subtracting the required 17.1% with the number of inhabitants, deficits in terms of recreation places are determined.

Table 2 shows the deficits for the Netherlands divided according to the four quarters (see figure 1). Clearly the deficits for both activities are highest in the West quarter: this quarter comprises over 90% of the total deficit in the Netherlands. Furthermore it may be pointed out that assuming a perfect substitutability between walking and cycling does not help much in reducing overall deficits. Presumably there are only a few regions in which a large deficit for the one activity can be compensated for to a considerable degree by an excess supply for the other activity.

Quarter	**Walking**	**Cycling**	**Substitutable**
North	19,800	0	4,300
East	3,000	0	300
West	338,200	169,800	488,300
South	15,200	1,600	8,700
Total	376,300	171,400	501,500

Table 2: Deficits for the four quarters of the Netherlands in 1995, using a 10-km norm distance (number of recreation places) .

To assess the sensitivity of the outcomes with regard to the norm distance, the analysis was repeated using a distance of 5 kilometers. The results show that although the deficits increase, the increase is rather small, given that local demands now have to be satisfied within a much smaller action radius (see table 3). While the potential supply surface decreases by a fourth, a national map (not presented here) indicates that the deficits increase mainly in regions in which isolated cities are found. When the region as a whole is quite urbanized, deficits now are more concentrated within the larger cities. On the other hand, in the residential areas just outside the 5-km reach of big cities deficits become smaller. There is a relocation of deficits, rather than an overall increase.

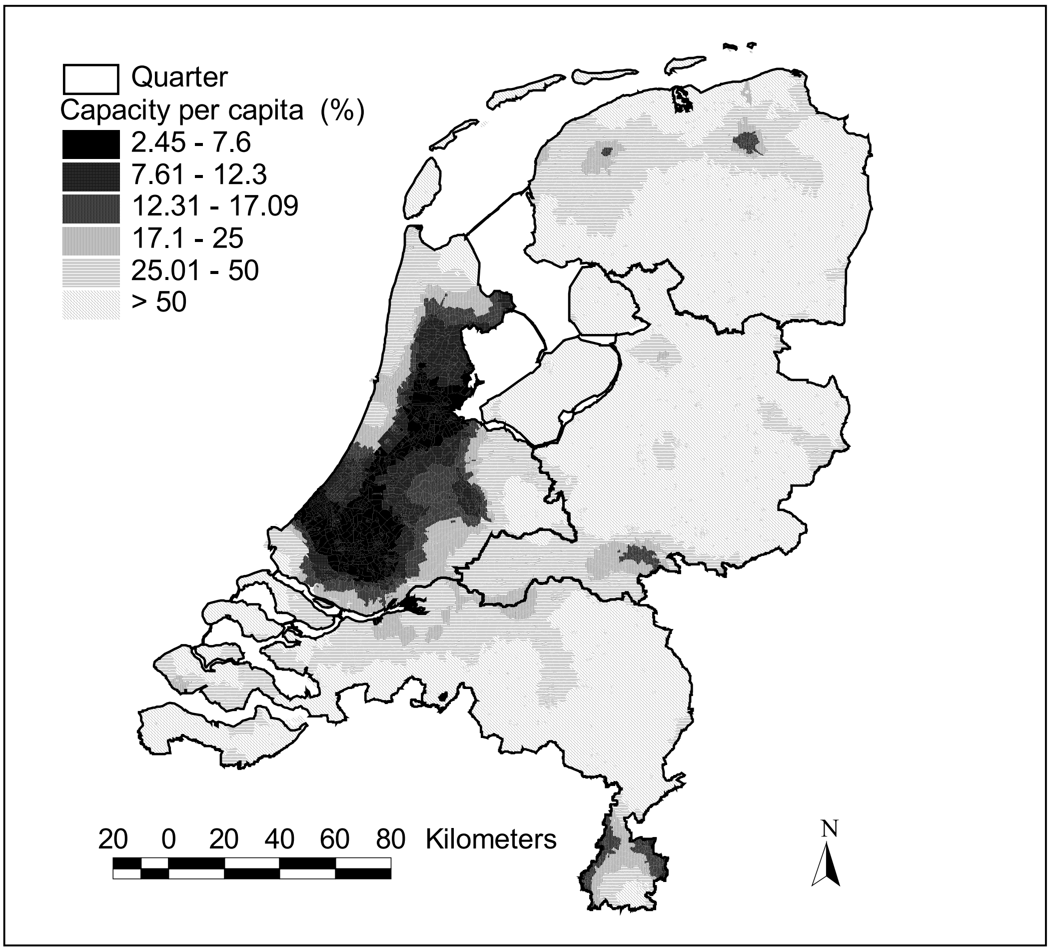

Figure 1: Available capacity per inhabitant for walking and cycling (when substitutable) in 1995, within a 10-km distance (by neighborhood).

Quarter	Walking	Cycling	Substitutable
North	28,200	4,900	22,400
East	21,200	2,600	14,800
West	378,400	188,300	535,600
South	40,000	9,900	37,700
Total	467,800	205,800	610,500

Table 3: Deficits for the four quarters of the Netherlands in 1995, using a 5-km norm distance (number of recreation places).

In first instance the deficits are expressed in terms of recreation places. They may be translated into deficits in terms of hectares. The conversion ratio depends on the type of land use. Suppose we use forests, as one of the most efficient land use types, to reduce the deficits that result when using a 10-km norm distance. In that case the amount of new forests required to eliminate all deficits within the Netherlands for walking & cycling under the substitutability assumption is (501,500/12 =) about 41,800 hectares. One should remember, of course, that usually new forests are not located on new land, but replace another type of land use. The recreational capacity of the afforestation area according to its present type of land use should be subtracted to get the correct figure for the gain that is realized.

DISCUSSION

In this paper a method to assess to what extent the local supply of recreation opportunities can accommodate the local demand for such activities has been presented. An important criterion to judge any new method, is its validity. Are the outcomes generated by the method valid? In answering this question it should be kept in mind that the present analysis is a normative one: it does not aim to describe actual recreation behavior as accurately as possible. This implies that empirical figures regarding actual behavior are not the ultimate criterion to decide on the validity of the method. Moreover, to the degree that the method is descriptive of actual behavior, it may become impossible to detect deficits: 'ought' and 'is' will coincide more and more.

On the other hand, if large deficits have no effect on the local population whatso ever, one may question the reason to match local supply with local demand. Although the latter is a policy issue rather than a scientific one, we would like to suggest a number of possible effects. We will only discuss 'direct' effects, i.e. concerning recreational experiences and behavior. To begin with, recreational behavior may not be affected by the supply to demand ratio. In that case more people than is considered desirable will make use of the local supply of opportunities. This may affect the quality of the recreational experience. Quietness is known to be highly valued aspect of the outdoor recreational experience (Reneman et al., 1999).

Recreational behavior may be affected by a bad local supply situation in at least two ways. People may participate less often, or they may decide to recreate further away from home. Empirical evidence from a study by De Vries (1999) clearly shows that a bad local supply situation (according to objective criteria) leads to a significant increase in car mobility. Moreover, the areas that show the largest deficits in the present study are by and large the same ones that are judged as poorly by Dutch citizens in this previous study. In this respect the face validity of the method seems high.

Other aspects of validity are robustness and reliability. To start with the latter, the method is highly reliable as far as the supply input data are concerned. The land use database is fairly accurate. As for the capacities assigned to each type of land use, this is a normative choice, not an empirical fact. The demand input data are somewhat less reliable. This is not because of the number of inhabitants of a neighborhood, but because of the participation rates on the norm day. Although the CBS day trip study is thought to yield reliable results, this study only deals with day trips that last at least two hours (including transport). The number of trips shorter than two hours had to be estimated. However, since two procedures to arrive at the total number of trips generated quite similar results, we feel confident that the demand input data are quite acceptable.

As for the choice of the fifth busiest day as norm day, once again this is a normative choice. However, indications based on a study by Visschedijk (1997) suggest that using the 10-th busiest day would not have led to drastically lower participation rates. For several forests, the number of visits on the 10-th busiest day seem to range between 0.85 and 0.90 of that on the 5-th busiest day. Of course, this not only benefits the reliability of the method, but also its robustness. Regarding this robustness, in this paper it was shown that halving the norm distance did not affect the outcomes as much as one might have expected beforehand.

Probably the method is the most sensitive to changes in the capacity assigned to the six categories of agricultural land use. As a whole, the category of agricultural land use is by far the largest in terms of the number of hectares concerned. Consequently, changing the capacity of this type of land use a little will already have a large impact on the supply capacity in many areas. For example, according the figures used here, the average capacity per hectare of agricultural land in the province of Zuid-Holland for walking and cycling is 0.8. The province itself uses a figure of 1.7 (Provincie Zuid-Holland, 1999). This results in a difference of more than 100,000 recreation places, or more than 8,000 hectares of forest.

The assigned capacities are normative figures: they are thought to indicate the social capacity of an area. However, the fact that they are normative, does not mean that the values are arbitrary. The logic is mainly based on the (expected) density of the recreational infrastructure and the visibility of other (recreational) users of the area. This is the reason for the high capacity figure for forests: a high density of infrastructure, combined with a low visibility of other users. This line of reasoning has also led to wet nature areas having a lower capacity than dry nature areas. However, the exact figures to be used remain open for discussion.

It may be noted that the method described here only deals with a quantitative confrontation of supply and demand. It gives an answer to the question whether there is enough space to accommodate the local demand for recreation opportunities. It tells us little about the quality, or attractiveness, of this space. In general a higher capacity per hectare is not meant to indicate a higher attractiveness. This is only the case for open versus enclosed agricultural areas, because here supply may easily exceed demand. Apart from this, recreation places are assumed to be substitutable regardless of the type of land use that generates them. Of course the method could be refined. For example, we could demand that at least 50% of the demand has to be satisfied by recreation places generated by forests and nature areas. This would be a first start to bring quality considerations into the play. Differences in attractiveness within a specific land use category are more difficult to take into consideration: these would require addition data.

After having discussed the validity and the limitations of our method, a next question is its practical usability. It it of use to our target group: policy makers and spatial planners at regional and higher levels? We are confident that it is. In a small country such as the Netherlands the spatial claims of different sectors (housing, infrastructure, industry, agriculture, nature, recreation) often exceed the available amount of land. This makes it important to be able to substantiate these spatial claims. It is also important to be able to quantify the claims. This is exactly what our method offers. For this reason the outcomes of a prognosis for the year 2020 according to this method, are being used by the Dutch Ministry of Agriculture, Nature Management, and Fisheries, under whose competency outdoor recreation falls.

Furthermore the method also shows where the supply deficits are largest. This makes it possible to evaluate the efficiency of spatial plans in reducing these deficits. This efficiency is not only affected by the type of area (land use), but also by the location of the new areas. Momentarily such an evaluation is performed for the province of Noord-Holland. Preliminary results suggest that not all planned recreation areas are optimally located in this respect.

In short, the fact that this newly developed method is already being used intensively, confirms it is of practical use. This does not necessarily imply that the method is a very good one (although we tend to think it does pretty well). It is also the case that up till now it is more or less the only one in its kind (as far as we know). Its use therefore also demonstrates the need for methods and tools to help policy makers and spatial planners to do justice to the social function of green spaces.

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