



# Analyzing yachting patterns in the Biesbosch National Park using GIS technology

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## ABSTRACT

National parks with large flows of visitors have to manage these flows carefully. Methods of data collection and analysis can be of help to support decision making. The case of the Biesbosch National Park is used to find innovative ways to figure flows of yachts, being the most important component of water traffic, and to create a model that allows the estimation of changes in yachting patterns resulting from policy measures. Recent policies oriented at building additional waterways, nature development areas and recreational concentrations in the park to manage the demands of recreation and nature conservation offer a good opportunity to apply this model. With a geographical information system (GIS), data obtained from aerial photographs and satellite images can be analyzed. The method of space syntax is used to determine and visualize characteristics of the network of leisure routes in the park and to evaluate impacts resulting from expected changes in the network that accompany the restructuring of waterways.

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## 1. Introduction

Before authorities decide to limit visitor numbers in nature reserves, they could try to implement policies directed at obtaining a more balanced distribution of visitors. However, as it is difficult to predict how visitors will react to measures taken, one could try to model their behavior. Pedestrian flow models based on space syntax have been used successfully to solve problems of crowding in city centres. In nature areas, particularly wetlands, where a substantial portion of visits are made with yachts, one could therefore draw upon the similarity that exists between the behavior of pedestrians in streets and that of navigators in waterways.

The Biesbosch National Park in the southwestern part of the Netherlands near the estuary of the Rhine River is one of the largest and few remaining fresh water tidal areas in Europe. The park consists of a large number of rivers, streams and creeks with grass and reed lands in between, and forms part of a national network of leisure routes for yachts.

The park is situated between two large urban zones: the southern wing of the Randstad Holland, with the cities of Rotterdam and Dordrecht, and the urban region consisting of the cities of Breda and Tilburg in the western part of the province of North Brabant. This favorable location between areas of high population density and the growing popularity of yachting has resulted in a large recreational pressure. There is now a huge

demand for berths in yacht basins with good access to leisure routes around the national park.

For the past 25 years, there has been a policy to stabilize the number of yachts in the national park. The most radical measure was implemented in 1994 with the declaration of a ban on the extension of berths in yacht basins within a radius of 15 km around the centre of the national park (Schouten, 2005). This policy, known as the *stand-still principle*, is presently a point of discussion for the stakeholders in the region. Local authorities in the region are confronted with a shortage of berths, resulting in large waiting lists.

The main question is whether there are alternatives for this principle without the nature values of the park area being endangered. To assist in finding answers to this question, a number of investigations have to be made, among them the following:

- How have yachting patterns in the national park been developed over the past decade?
- How can we model these patterns to be able to evaluate the effects of policy measures related to the restructuring of waterways and the creation of additional recreational concentrations in the national park?

## 2. Land use policy

One of the possibilities to relieve recreational pressure is included in the recently proposed zoning plan as part of a

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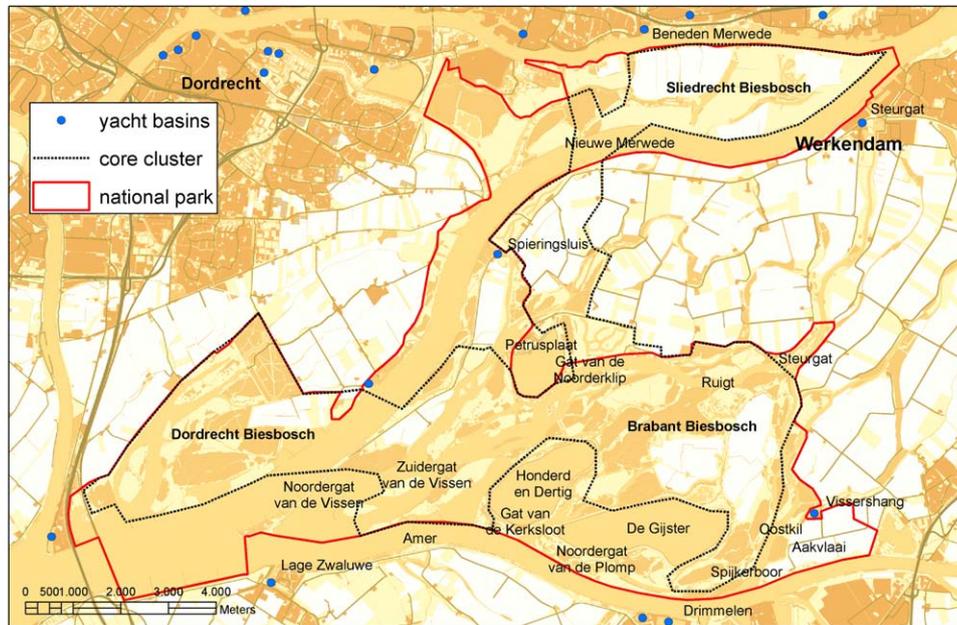


Fig. 1. Plan of the Biesbosch with existing yacht basins.

comprehensive management plan for the national park. This zoning plan distinguishes, with regard to recreation, between nature areas without recreational co-use in the core cluster (see Fig. 1), and with recreational co-use mainly in the periphery (Overlegorgaan Nationaal Park de Biesbosch, 2004). Recreational co-use is implemented through the establishment of a number of recreational concentrations. One of these areas, Aakvlaai, situated in the southeastern corner of the park, has recently been developed and, according to a count in 2005, already succeeded in relieving some of the pressure in other parts of the park (Schouten, 2005). The development of the Aakvlaai included the creation of a new substructure of waterways with a dense pattern. One would therefore particularly be interested in what could be the impact of restructuring the waterways related to the establishment of such concentrations on yachting patterns.

### 3. Space syntax

To evaluate this impact and related zoning policies, it is necessary to obtain information on existing yachting patterns first, and find ways to model these patterns. Such patterns are mainly the result of yacht owner behavior, which is guided by certain stimuli. A number of studies have been published that try to explain human behavior from the view of spatial configurations (Batty, 2004; Hillier and Hanson, 1984; Hillier, 1996). The method proposed in these studies is that of space syntax. This method consists of a set of theories and techniques for the analysis of spatial patterns. The general idea is that spaces can be broken down into components, analyzed as networks of choices, and then represented as figures and graphs that describe the relative connectivity and integration of those spaces. A growing number of publications refer to the use of geographical information system (GIS) in space syntax (Batty and Rana, 2002; Figueredo, 2005; Jiang et al., 1999, 2000), and a number of software applications have been developed. Space syntax is particularly applied to the modeling of vehicular and pedestrian movement in cities (Hillier et al., 1993; Penn et al., 1998). Desyllas and Duxbury (2000), for example, found in a study on pedestrian movement in London

that there exists a correlation between visibility of the spaces that pedestrians find themselves in and the size of pedestrian movement.

Considering the possible development of recreational concentrations in the national park and the supposed suitability of space syntax for the study of yachting patterns, three more specific questions can be formulated:

- How can a network of leisure routes be deduced from the yachting patterns found?
- How can space syntax be used to find important characteristics of yachting patterns?
- How can these patterns be modeled to evaluate the impacts resulting from the restructuring of waterways?

Information on visitor flows in the Biesbosch National Park is scarce. Surveys undertaken by means of questionnaires do not give an indication of actual behavior in relation to locations of yachts and routes followed, and no trends can be determined. Therefore, other means have to be found, which avoid the high cost generally involved in surveys. One solution is the use of aerial photographs with sufficient resolution to detect the location of individual yachts, sailing as well as moored in yacht basins and temporary harbors. A disadvantage of aerial surveys is that they are often out-of-date. This problem can be overcome using satellite images. Unfortunately, resolution of such images is often not high. However, new satellites offer images that approach the resolution of aerial photographs. In this study, aerial photographs taken at suitable days were used for the period 1996–2003, whereas a panchromatic SPOT image was available for such a day in 2004. Although it is not possible to deduce reliable information on flows of yachts from the location patterns obtained by aerial photo and satellite image interpretation, a route network could be determined by combining location data obtained at different moments in time and careful analysis of the linear patterns that emerge. For this purpose, a routine was used that allocates points representing locations of yachts to specific line segments, which together form a network of leisure routes. The routine also allowed the determination of volumes for each line segment.

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