The influence of the weather upon recreation activities

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Abstract The day of the week, as well as the weather, have an important influence on the kind and degree of use of an area for recreational purposes. One might expect a higher number of visitors over the weekend and whenever the weather is fine, than on rainy workdays. But the degree of influence of the respective factors, i.e. of the weather and day of the week, and their interaction is unknown. Only knowledge of existing relationships between the numbers of visitors and weather, as well as the weekday, permits a detailed description of recreational attendance levels in a certain area. Such knowledge is essential for an efficient visitor management of protected areas and tourism regions. For one year, video-monitoring was used at several entrance points to the Danube Flood Plains National Park to continuously register visitors. Data related to visitors, such as daily totals of all visitors and daily totals of separate user categories were correlated with meteorological data and the day of the week. The influence of certain meteorological elements, such as air temperature, clouds, precipitation, ..., and thermal comfort indices such as the Physiological Equivalent Temperature (PET), on the use of the National Park for recreational purposes was identified and evaluated with the help of statistical modeling. Reliable models can be obtained for the daily totals of visitors, as well as for specific user groups with high attendance levels (i.e. hikers and bikers). The day of the week has the greatest influence on the number of visitors. The Physiological Equivalent Temperature also plays a substantial role concerning the frequency of visitors per day, in particular for bikers and hikers. The usage patterns of joggers and dog walkers were difficult to model as they show less dependence on weather and week-day related factors. Among other findings, one result of the study is a model for the prognosis of attendance levels and the presence or absence of separate user categories depending on the factors weather and day of the week.

Keywords: Recreation • Visitor monitoring • Prognosis of attendance levels • Thermal comfort index

Introduction

The problems caused by leisure activities in protected areas have been a subject of particular interest in recent times. The comprehensive understanding of recreational use is absolutely necessary for the sustainable and effective management of protected areas (Coch et al. 1998, Eagles et al. 1999). If the results of meteorological research are included in the prognosis of the number of visitors and the user categories, these must be subject to the criteria of being suitable for planning and practicable. Climatic or weather data can only be included as a planning factor when both the planner and practitioner are capable of completely understanding and implementing the information provided by these data (Höppe et al. 1987).

Although thermal comfort can be achieved in the research area on most days of the year by adjusting one's clothing and activities accordingly, the weather still has a major influence on leisure and recreational behavior. There has been widespread research into the relationship between recreational activities and the weather (De Freitas 1999, Gibs 1973, Hunziker 1997, McCalla et al. 1987, McColl et al 1990). The dependence of human well-being on the weather and climate is a well-known phenomenon. In particular the thermic component of the atmospheric effects, which consists of air temperature, wind velocity, humidity and radiation, has the major influence on the behavioural fine-tuning (Auer et al. 1990, Höppe et al. 1997, Jendritzky et al. 1999, Höppe 1999). In order to avoid misinterpretation of the effect of the magnitude of these influences coupling of meteorological parameters is to take into consideration (Jendritzky et al 1979). The individuals perceive weather as a combination of temperature, humidity, cloudiness and wind, sunshine, solar radiation and complex values for human hygro-thermic sensitivity (Hoffmann 1980, Blüthgen 1980, de Freitas 1999, Hammer et al. 1990). Harlfinger (1978) showed, using the subjective evaluation of sultriness, just how greatly the preceding weather character could effect one's subjective wellbeing.

Biometeorological research in connection with thermic comfort has resulted in a considerable increase in knowledge for applied research and the implementation in everyday planning and management. In this connection the Physiologic Equivalent Temperature must be mentioned. This enables the layperson to compare the thermic conditions felt in the open air with his experience gained indoors. (Jendritzky et al. 1979, Höppe 1997, 1999).

Also the threshold of heat stress is measured using the Equivalent Temperature. The Equivalent Temperature is the measure of the total content of tangible and latent heat in the

air. The surrounding air temperature can be evaluated using the Equivalent Temperature threshold value. An additional complex value is the Effective Temperature (Auer et al. 1990, Hammer et al. 1986). It is the temperature that a seated, appropriately dressed person feels in a wind-still, saturated environment. Becker 1972, based on numerous test series, allocated the human sense of temperature to the chill value and classified these values.

Materials and methods

The Danube Floodplains National Park is situated to the east of Vienna, the capital city of Austria, with a population of 1.6 million. A portion of about 2.400 ha of this zone – the research area and so called Lobau - actually lies within the Vienna city boundaries and is a traditional local recreation area. In 1996 the Danube Floodplains were declared a National Park. This resulted in the protection of the floodplains gaining in importance compared to their use as a recreational area, which had been the major focus for many decades. The park management now has the task of fulfilling both the demands posed by intensive daily recreational use and by the need to protect the floodplains' forest ecosystem. In order to deal effectively with the high number of visitors, the park management needs in-depth information on the leisure and recreational usage of the area. Therefore, the Institute for Landscape Architecture and Landscape Management, commissioned by the Viennese City Council, investigated certain components of recreation activities i.e. data on the number and structure of the visitors to the area as well as their spatial and temporal distribution.

Permanent time-lapse video recording systems were installed at five entrance-points to monitor recreational activities (Leatherberry & Lime 1981, Vander Stoep 1986), the whole year round, from dawn to dusk. Data on the recreational use, collected over one year, were available. (The type of video system installed made it impossible to identify individual persons, thus guaranteeing anonymity.) For the analysis of the video tapes only 15 minutes per hour of observations were taken into account. This had no negative impact upon the significance of the results (Brandenburg et al. 1996, Brandenburg 2001, Muhar et al. 1995). The data based on 15-minute evaluations were verified with data of an analysis of a whole hour by using linear regression with a R^2 value of 0.9 (Brandenburg 2001). The daily number of visitors to the Lobau were used for modeling. Days, when there was a loss of data of more than three hours at one of the video stations, were not included in the model. Therefore, 206 complete data sets of daily totals obtained when all cameras operated without failure, were available. A portion of the remaining data sets were used to verify the model. When

analysing the video tapes the following data were registered: date, day of the week, time, videostation, number of persons in a group, direction of movement, user group (bikers, hikers, jogger, ...) and the number of dogs.

In addition, on four days and at 12 entrance points to the park, visitors were counted and interviewed about their motives, activities, duration of visits and needs, etc.. The survey took place on a Thursday and the immediately following Sunday, once in spring and once in summer. To collect as much data as possible the survey was conducted on days with fine weather. The total sample size was 780 interviews.

Meteorological data such as air temperature, precipitation, wind velocity, vapor pressure, relative humidity and cloud coverage and global radiation were provided by a nearby meteorological registration station of the Central Institute of Meteorology and Geodynamics in Vienna (ZAMG). Depending on the meteorological parameters 2 p.m. data, the day mean or categorized factors were used for individual stages of the visitor modeling. In addition, using meteorological parameters thermal comfort indices such as the Equivalent Temperature, the Effective Temperature, the Cooling Factor (Becker 1972) and the Physiological Equivalent Temperature (PET) were calculated by 2 p.m. data of the meteorological elementes. The calculation of the Physiological Equivalent Temperature was done by the RayMan Program (Matzarakis et al. 2000).

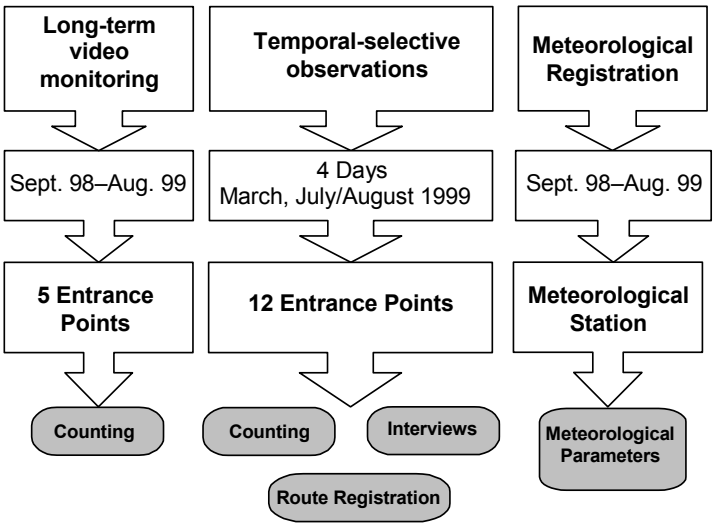

Fig. 1 Methods of data gathering

As a tool for studying the interaction between recreational use and external influences the univariate analysis of variance was used. The contribution of each variable factor in explaining the total variation of the dependent variables can be investigated independently. It is also possible to investigate their specific interaction. Using categorized factors with a variance analysis it is possible to depict non-linear connections.

Table 1 Description of the main input variables

number of the visitors	daily totals
number of the separate user	daily totals
separate user categories	biker, hiker, joggers, dog walkers
day of the week	workday (Monday to Friday), weekend or holiday (Saturday, Sunday, Holiday)
precipitation	occurrence (> 1 mm), non-occurrence (0-1 mm) at main activity time
cloud cover	categorized according to 10 th degrees of cloud coverage (Auer, 1990) bright (< 2/10), fine weather (> 2/10 - 5/10), cloudy (> 5/10 - 8/10), dull weather (> 8/10)
cloud cover of the last seven days	mean of the 10 th degrees of the last seven days
air temperature	days´ mean
air temperature of the last seven days	mean of the days´ mean of the last seven days
Equivalent Temperature (Teq)	categorized according to Robitzsch-Leistner (Auer et al. 1990) Teq = Ta + 1,5e, Ta = Air Temperature, e = Vapour pressure (hPa) humid (> 56 °C), slightly humid (56 – 49,1 °C), comfortable (49 – 35,1 °C), cool (< 35,1 °C)
Effective Temperature (Teff)	categorized according to Auer et al (1990) Teff = Ta - 0,4 * (Ta - 10) * (1 - RF/100) Ta = Air Temperature, RF = Rel. Humidity humid (> 24 °C), slightly humid (24 – 20,1 °C), comfortable(20 – 16,1 °C), cool (< 16,1 °C)
Chill Factor	calculated and categorized according to Becker (1972) A = (0,26 + 0,34 * v 0,622) * (36,5 - Ta) mcal/cm^2*s, v = Wind Velocity, Ta = Air Temperature hot-sultry-uncomfortable (0 - 4), warm-comfortable (5 - 9), mild-pleasant (10 - 19), cool (20 - 29), cold – slightly uncomfortable (30 - 39), moderately – very uncomfortable (40 - 49), unpleasantly – extremely cold (50 - 59), unbearably cold (60 - 70)
Physiologic Equivalent Temperature	categorized according the Ashrae scale very cold (< 4 °C), cold (4 – 8 °C), cool (> 8 – 13 °C), coolish (> 13 – 18 °C), comfortable (>18 – 23 °C), mild (>23 – 29 °C), warm (>29 – 35 °C), hot (>35 – 41 °C), very hot (> 41°C)

Results

In order to better understand the visitor structure and, therefore, to interpret the results accordingly, a short overview of the recreational use of the study area is given.

More than 90 percent of the visitors interviewed came from Vienna and more than 60 percent of the interviewees visited the Lobau at least once a week and stayed for up to two hours. The Lobau can therefore be called the "Green Living Room" of a large number of the visitors (Arnberger et al. 2001). The Lobau is visited by about 600,000 people per year. The main visiting period is between March and October, highest frequencies could be observed in May and on Sunday afternoons, when all categories of visitors can be found in the Lobau. The main year-round users of the Lobau are bikers with 58 % and hikers with 37 %. The main visiting period for bikers is the summer, for hikers it is spring. Joggers can be mainly observed between March and September. Considering the average number of visits per week for the whole year covered by the survey, a considerable increase in the number of visitors over the weekend can be observed; the highest number of visitors was registered on Sundays and public holidays. On workdays, the number of visitors is fairly even, independent of the user categories.

In the first modeling experiments for predicting the attendance levels using the variable day of the week and only meteorological parameters such as cloud cover, cloud cover over the last seven days, precipitation during the day, wind velocity during the day, the day's mean air temperature and air temperature over the last seven days, no satisfactory results were obtained, particularly in interactive areas.

In the final model for the daily visitor totals - without any distinction between the various user groups such as bikers, hikers etc. - the differentiation between workday and weekend, the PET value according to the Ashare scale, occurrence or non-occurrence of precipitation at the principle activity times as well as the type of cloud cover, were all included. Even though cloudiness is used in the calculation of PET, it is also necessary as a main effect for explaining visitor numbers. This can be substantiated by the theory that, among other factors, the brightness of the sky is decisive for a person's psychological feeling.

It is necessary to develop an individual model, using partially different parameters, for each user group. This can be based on the greatly differing demands of these individual groups.

Reliable models can be obtained for the total number of visitors per day as well as for specific, large user groups (i.e. hikers and bikers).

Table 2 Explanatory value of the total number of visitors per day and the user categories

Extent of interference	Total number of visitors	Bikers	Hikers	Joggers	Dog Walkers
Workday, weekend and holiday	high	high	high	small	moderate
Precipitation	moderate	moderate	small	existent	existent
PET	high	high	moderate		existent
Cloud Cover	moderate	moderate	small		small
Interaction between weekday and PET	moderate		small		existent
Cloud coverage of the last 7 days			very small	existent	existent
Air Temperature of the last 7 days		moderate	very small		
Value of model	adj. R^2=.834	adj. R^2=.844	adj. R^2=.744	adj. R^2=.291	adj. R^2=.440

To summarize, it can be said that the day of the week has the greatest influence on the number of visitors. The Physiological Equivalent Temperature (PET) also has a major impact on the number of visitors per day, in particular on cyclists and walkers. Precipitation and cloud cover have a moderate influence on the number of visitors. The current modeling experiments show that the weather over the previous 7 days does not play an important role on the number of visitors. But it is assumed that, among other things, the weather of the previous days has an effect on very high attendance levels.

To evaluate the model, data records, not included in the model creation, were used to test these models. The control of the correlation between the observed daily totals and the predicted totals - using a linear regression - results in a determinacy of almost 90% for the model of the daily totals of all visitors.

Discussion

The availability of the discussed data on visitor monitoring permits a statistical evaluation on the correlation between the total daily number of visitors, as well as for specific user categories, and the day of the week, meteorological parameters and comfort indices. The fact that it is difficult to predict the daily number of visitors of a specific category, such as joggers, is partially due to the fact that different decision-making patterns are decisive in the considerations of whether to jog or not.

Another problem arises from the size of the sampling. One specific group - swimmers - was not dealt with in this article because the sample size was too small to be used in an analysis using the univariate analysis of variance. In order to model low-frequency user groups it is necessary to incorporate sophisticated statistical methods such as regression trees (Ploner et al., submitted). Another possibility would be to increase the sample size by carrying out the survey over an extended period of time.

The demonstrative power of the model for days with peak loads, which means very high attendance levels, is not yet satisfactory. Particular emphasis must, however, be placed on these days because they are of importance for the supervision of the park and its ecological system management.

Along with other aspects, the weather reports influence the behavior of visitors planning a brief vacation. Tourism experts repeatedly reported that guests failed to appear as soon as bad weather was forecast. This was also true in those cases where the actual weather situation completely varied from the forecast. Weather forecasts play a less important role in the leisure activities of those people living in the proximity of the recreational area. The importance of the weather forecast on those travelling more than one hour in order to reach the area will be of major significance (Ammer et al. 1991). It must also be assumed that certain users react more strongly to these reports than others. Therefore the weather prognoses are absolutely necessary when estimating the number of visitors.

Relevant, practice oriented and reproducible data is required to enable leisure and recreational planning. This data must: be easily interpretable, permit simple further digital processing; be principally quantitative and result from continuous and simple data collection. This applies to the archiving of the current weather data, data from weather forecasts and visitor data.

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