40 Monitoring visitors in diffuse nature areas, a case study in the Belgian Ardenne

Johanna Breyne, **Kevin Maréchal**, **Marc Dufrêne**, University of Liège, Belgium

Nature-based tourism and recreation are ecosystem services that have the potential to benefit human wellbeing, as well as local economies (Haines-Young and Potschin, 2010). They can therefore represent an important political argument to conserve and restore nature areas (Schirpke et al., 2018). However, for these contributions to be acknowledged, they should first be monitored. The number of visits to nature areas has been recognised as one of the major indicators to assess nature-based tourism and recreation (Schägner et al., 2018). Visiting frequencies are, for example, crucial for the estimation of economic contributions. However, for diffuse nature areas with multiple entry and exit points, this data is often scarce, scattered and imprecise. Recently, innovative technologies have allowed to obtain more continuous and/or detailed data for both small and larger areas (Kellner and Egger, 2016).

Our research used two of those methodologies to estimate visitor frequencies in nature areas: 1) an analysis based on passive mobile phone positioning data and 2) automatized image analysis based on photos issued from camera traps. Our case study area concerns the Ardenne forests, located in southern Belgium (Walloon region) for the period spring 2018 - summer 2019. The aim of this research is to improve ecosystem services assessments concerning nature-based tourism and recreation and, by doing so, facilitate ES being taken into account by site managers and policy makers in the sustainable management of nature areas.

For the mobile phone positioning data, a contract with the main Belgian mobile phone operator was established covering 5 periods (250 days in total) and 14 zones. These latter zones (about 15% of the Walloon territory) were selected based on population density and percentage of nature cover. Provided data are aggregated per day (8-19h) and per zone, and include visitor numbers (extrapolations based on the operator's market share), as well as details on the origin, nationality, type of stay and duration of the visit. For the analysis, only non-functional visits of more than 1-hour were included; residents of the zones were excluded.

For the automatized image analysis, twenty camera traps were placed in four of the main forest areas of the Ardenne, with 5 cameras per area. These locations superpose with the zones for mobile phone positioning data. In coordination with local administrations, the cameras were placed on trails frequently used by visitors or near points of interests (e.g. wildlife observation towers). Except for some rare cases of theft and technical defaults, the cameras operated a yearlong. This resulted in about 800 000 images that were analysed using an automatic detection and identification model (Mask-RCNN). The model was set to detect and identify three objects of interest, related to the main user profiles: persons, bikes and dogs. Model outputs included date, time and the number of objects per category. The precision of the model was verified by manually analysing a test sample (1% of the overall dataset). Also extreme outliers were manually checked.

The mobile phone data analysis revealed 8 million of visits, of which 4 million concern local recreation and 4 million touristic visits, the latter including 5% of regionals, 27% of nationals and 20% of internationals. About 4 million visits concerned short stops (1-3h) and 4 million long stops (>3h). Half of the touristic visits (52%) were combined with a local stay. The observed visitor frequencies showed a high spatial and temporal variation, which differed according to the visitor's nationalities.

Concerning the image analysis, 230 000 photos have been retained for analysis, resulting in 500 000 observed visits. Model precision resulted high for persons, but showed lesser results for bikes and dogs. An example of model detection is provided in Figure 1.

For both methodologies, variations in visitor frequencies primarily related to weekends, followed by location, holidays and the respective season. Mobile phone positioning data allowed for monitoring larger areas and establishing specific visitor profiles. Camera traps on the other hand

allowed for revealing small scale variations and identifying main user profiles. A comparison of both datasets showed high correlations for some areas, though smaller correlation for others.

A main issue for mobile phone data was the large cell size of the operator network, which did not allow for distinguishing in a 100% accurate way between nature and non-nature visits. Also the cost of acquiring this data is significant. The main issue related to camera traps was the importance of its positioning and the lower precision for non-persons. Future improvement might a.o. concern the inclusion of a self-learning process in the model to improve precision. Both methodologies provide substantially more accurate data, quantitatively as well as qualitatively, on nature-based tourism and recreation, compared to the traditional statistics available for our case study area. The insights obtained from this study could help site managers and policy makers in decision-making processes on sustainable natural resource management. For example, nature reserves are traditionally set aside areas without public access. However, the ambition to increase the number of reserves, and the reported over-frequentation of other nature sites, opens the question of public access to nature reserves (Dufrêne, 2018). Information on visitor frequencies, behaviour and the proportion of infractions of similar sites elsewhere, can help to determine which sites to open to the public or not.

References

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