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Editorial: Moving forward with mobile positioning data in academic research

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This special issue of the European Journal of Transport and Infrastructure Research (EJTIR) comprises three papers addressing some key issues in transport geographical research that use location tracking data. Preliminary versions of those papers were presented at the Mobile Ghent 2013 Conference. This event is part of a series of biannually held conferences on location-based services (LBS) that initially started in Tartu, Estonia. This editorial briefly points to the growing academic relevance of mobile phone tracking data and location-based services, describes the history and aim of the Mobile Ghent conference and gives a preview of the selected contributions.

Keywords: *mobile positioning, location-based services, GPS, smartphone, travel behaviour.*

1. From generating accurate data to exploring the added value of location tracking data

This special issue introduces some of the trends related to the use of location tracking and mobile positioning in transport and mobility research. While location tracking encompasses all forms of localization of an object or person over multiple timestamps, mobile positioning refers specifically to the localization of a mobile phone – and by extension its bearer – by means of multilateration of radio signals between multiple cell towers, via Bluetooth, Wi-Fi or simply using GPS technology installed on the phone. Given the widespread adoption of smartphones in contemporary Western societies, the use of mobile positioning has become increasingly popular among transport geographers over the past decade. Mobile positioning has found applications in, among others, public transport planning and management (e.g., Padrón et al., 2014), car traffic monitoring (Herrera et al., 2005) and pedestrian travel (Versichele et al, 2012).

While the early research focus was principally on overcoming various technological barriers to generate adequate data sets for transport studies (e.g., Spinney, 2003), the biggest challenge nowadays is to distil valuable information from the huge location data sets available. Although it is often assumed that devices such as GPS, mobile phones, smartphones, etc. enable to unambiguously detect the location of people in time-space, and therefore record their behaviour in the most objective manner possible, people nowadays also receive real-time information about, for example, delays in traffic or the availability of shared bikes in their vicinity so that their

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behaviour can also be altered or changed by these mobile positioning devices. In that case, the question remains to which degree location tracking data can still be used to gain insights in people's behaviour in time and space.

2. Mobile Ghent 2013 conference

In order to discuss the latest developments and trends in the field of location tracking and mobile positioning, a two-day conference was held in Ghent in October 2013. This conference continued a series of previous meetings in Estonia. From 2008 onwards, every two year the Geography Department of the University of Tartu (Prof. Dr. Rein Ahas) organized the Mobile Tartu conference. These meetings have led to a close collaboration the geography departments of the University of Tartu and Ghent University and hence in 2013 the conference location was occasionally moved to the city of Ghent.

The conference in Ghent brought together researchers and experts from around the world to discuss emerging topics and cutting-edge research findings across multiple fields related to mobile positioning and location tracking. The conference attracted of experts with different backgrounds almost 70 participants. The program stimulated discussion on technological advancements during parallel sessions on tracking technologies and GPS tracking specifically. But also empirical results were presented and discussed in parallel sessions on a wide range of topics such as travel behaviour, activity spaces, traffic and energy, commuting, non-motorized and motorized transport, tourist tracking and location-based services. The program also included five keynote lectures, each discussing different technologies, empirical results and applications. Prof. Dr. Martin Raubal (ETH Zürich) discussed the usefulness of location-aware mobile eye tracking. Prof. Dr. Bin Jiang (University of Gävle) presented insights into the dynamics of human activities in cities based on the use of social media. Prof. Dr. Stefan van der Spek (TU Delft) commented on the use of GPS tracking and Bluetooth scanning to understand user patterns in the built environment of the city. More general discussions on theoretical, methodological and empirical challenges when using mobile positioning data were given by Prof. Dr. Bert van Wee (TU Delft) and Dr. Tim Schwanen (University of Oxford). The main conference was also preceded by a one-day PhD seminar. This seminar provided a forum to nearly 20 PhD students to present their early stage research findings, meet peers who share the same research interests, and introduce themselves to established senior members in the field.

3. Selected contributions

The three selected contributions in this special issue address some specific aspects related to the application of location tracking data in transport and mobility research. The first two contributions discuss the collection of GPS traces and the conversion of this type of data into a usable form. These two contributions are state-of-the art examples of how location tracking data can inform . The third contribution is a rather philosophical discussion that presents a theoretical framework on the interaction between smartphone apps and individuals' physical mobility.

The first contribution by Deng, Denman, Zachariadis and Jin uses GPS taxi traces to model the transport network performance of the road network in terms of traffic delay and speed. The collection of actual traffic delays and road traffic speed is often a very expensive and time-consuming task. However, such data is essential in modelling urban transport in terms of efficiency, congestion and emission. Mobile positioning data such as GPS traces offer new opportunities, but for operational and privacy reasons GPS traces can often be sampled only sparsely. Hence, Deng et al. explore the usefulness of such low-frequency sampled GPS traces of taxis in the city of Beijing. One important challenge is the spatial transformation of the GPS data. The GPS positioning coordinates in continuous space (latitude-longitude pairs) are translated into topologically valid road network-based representations. This is facilitated using map-matching algorithms which typically integrate GPS positioning data with spatial road networks to identify the continuous-space with its correct network-space. The accuracy of this map-matching algorithm depends on the quality of the spatial road network but also on the sampling rate of the GPS data. Using low-frequency GPS data thus imposes an additional challenge. The authors therefore developed a novel method based on a path inference process. Their method builds on previous work by Rahmani and Koutsopoulos (2013) but differs in methodology, scale, observational dataset and research aims. Doing so, they were able to gain valuable insights into the spatial and temporal patterns of traffic speeds on heavily congested urban networks like the one of Beijing.

Contrary to Deng et al. who used GPS traces to model the aggregated performance of a road network, Feng and Timmermans used GPS traces on a more disaggregated scale in order to model individual activity behaviour. GPS-based travel surveys are often used as an alternative to traditional survey methods because it allows the automatic recording and collection of spatial and temporal information about people's activities and trips. However, characteristics such as transport mode and activity type (or trip purpose) are then to be inferred a posteriori. A variety of procedures to transform GPS traces into segmented activities and trips have been proposed in literature. A common approach is a sequential procedure where GPS traces are divided into activities or trips using an empirical time gap value (e.g., an activity is recognized if the time gap is shorter than 120 seconds). The transport mode and activity type are then detected for each portion of the segmented GPS traces. However, compared to transport mode detection methods, methods detecting activity type still remain relatively inaccurate. This is due to inter alia the unique spatial and temporal characteristics of all different activities. Timing and duration of activities may vary considerably between different activity types (e.g., regular 8 hour work activities for which the commute happens during peak-hours compared to irregular and short daily shopping activities which occur before or after peak hours). Information on activity type however remains a key aspect in modelling travel behaviour considering the derived nature of transport demand. Feng and Timmermans therefore propose an advanced approach to infer activity types from GPS data collected in the Eindhoven and Rotterdam regions in the Netherlands. Their approach incorporates both aggregated temporal information and spatial attributes into a learning-based model. Because of the inherent difference in activity characteristics, detecting activity types can be treated as a kind of classification problem. The performance of their approach is therefore investigated based on three popular machine learning algorithms (i.e., Bayesian belief network, decision tree and random forest). Highest accuracy was obtained in the random forest model.

The contribution by Schwanen describes the first two contributions as considering GPS devices as merely an instrument that passively tracks the movement of individuals and vehicles. However, GPS devices can enter transport studies also in another and more direct way, as Schwanen explains. Such tracking devices can also actively affect people's everyday mobility through physical space. This is particularly relevant for the use of smartphones, and especially the mobile applications (apps) they support such as *My Cycle Hire* (providing real-time information on bike availability at a particular docking station) and *UbiGreen* (offering users small visual rewards if they take 'green' transport modes more often). These devices could therefore play a useful part in the bringing about the urgently required deep cuts in the consumption of fossil fuels by the transport sector. Nonetheless, the interaction between mobile phones, apps and physical mobility are only partly understood so far. Academics' understanding of how those devices becomes rooted in everyday mobility practices remains limited. This is in part because those devices tend to be understood and examined in instrumental terms as tools. This means that often the ways in which their deployment is also a cultural process that generates numerous, partially unanticipated, effects is not fully grasped. Schwanen's contribution outlines a framework for analysing the use of location-aware devices 'on-the-move' as a cultural process by focusing on the subjectivities – the possible ways of thought and action – those devices help to bring about for individuals during mobility. To this end, his contribution draws on a range of theoretical registers and concentrates on the habits that enable and shape mobility. His key argument, then, is that understanding the potential contribution of location aware mobile devices to reduced energy consumption in transport requires an analytical focus on the co-evolution of mobility, mobile device, the individual's subjectivity and the context in which mobility takes place.

The aforementioned contributions have been selected after rigorous peer-review. They reflect cutting-edge thinking about the use of mobile positioning in transport and mobility research and will hopefully inspire the readership of the European Journal of Transport and Infrastructure Research to further advance the field.

References

Herrera, J.A., Work, D.B., Herring, R., Xuegang, B., Jacobson, Q. and Bayen, A.M (2010). Evaluation of traffic data obtained via GPS-enabled mobile phones: The mobile century field experiment. *Transportation Research Part C*, 18(4), 568-583.

Padrón, G., García, C.R., Quesada-Arencibia, A., Alayón, F. and Pérez, R. (2014). Using massive vehicle positioning data to improve control and planning of public road transport. *Sensors*, 14(4), 7342-7358.

Rahmani, M. and Koutsopoulos, H.N. (2013). Path inference form sparse floating car data for urban networks. *Transportation Research Part C*, 30, 41-54.

Spinney, J.E. (2003). Mobile positioning and LBS applications. *Geography*, 88(4), 256-265.

Versichele, M., Neutens, T., Delafontaine, M. and Van de Weghe, N. (2012). The use of Bluetooth for analysing spatiotemporal dynamics of human movement at mass events: A case study of the Ghent Festivities. *Applied Geography*, 32(2), 208-220.