35. Role of Digital Technology in Weather and Everyday Mobility

Ishita Sharma, Ambuj Kumar and Peter Lindgren
CGC - Aarhus University, Business Development and Technology, Denmark

INTRODUCTION

Weather and climate change have emerged as an important theme in the transport sector and researchers have demonstrated that human mobility can be strained by space, social relations and weather. The weather helps people to decide what to wear every day, but it also has an important factor in their daily life and mobility [1]. In general, good weather has a positive impact on mobility. As the process of urbanization continues, more and more people move to the city and according to the report by the UN, more than 6 billion people will be living in the cities. One problem of living in the cities is dealing with pollution and traffic congestion. These two areas have been a death within the long run, but one most important element of city-dwelling that has been left unattended is the mobility and how weather affects it in the cities.

Predicting human mobility patterns is not a major problem in geography or apical economics, but it has been applied in several areas such as urban planning, monitoring infectious diseases and epidemiology, and location-based service. Many models have been presented in 1930 to address the problem. The widely used method is a gravity model that relies on a specific parameter that has been fitted on systematic collection of data, the disadvantage of the method was that when any measurement required could be lacking, the model is entirely not applicable. The Empiric quantification of human mobility patterns is important in human planning and the social network structure especially in responding to disease threats in light of the rapid growth in globalization and urbanization. The research uses a Global Positioning System to data-log and tracks individuals depending on the prevailing weather conditions.

The topic has attracted researchers in the past decade, most researchers concur that human mobility is mainly affected by space, time and social contract, and the most important factor that affects human mobility is the weather which receives less attention and naturally ignored in various papers. Weather naturally affects mobility and when people check weather reports daily, they not only check where, to begin with, but they also consider where to visit, for example, people would like to walk in the amusement park ina cloudy weather. Understanding the relationship between weather and mobility is important in appreciating the technologies that can be applied in enhancing mobility through an understanding of weather patterns and the development of the spatial design.

RESEARCH QUESTION

Does the everyday mobility of an individual get affected in different weather conditions and how can the use of technology and tracking devices contribute to the betterment in spatial designing?

DATA COLLECTION

Before the commencement of data collections, there was a need for focus groups with the population representatives that represented the major centers of data to be collected. The study did not include children in the study as it had only two groups of individuals, the students and the working class of individuals. After the collection of data, the data was stored in an SQL format, the procedures for data collections and storage was approved by the institution that monitored the study. During data collection, a group of participants was selected and a total of 12 participants were used. In total there was a group of University students and working professionals [6]. The tracking device used in the research was the GPS Application. The two different groups of individuals were tracked for two days to monitor their choice of mobility under different weather conditions. Apart from observation, other types of data were collected from interviews, where four participants were interviewed on a set of questions attached (See Figure 35-1).

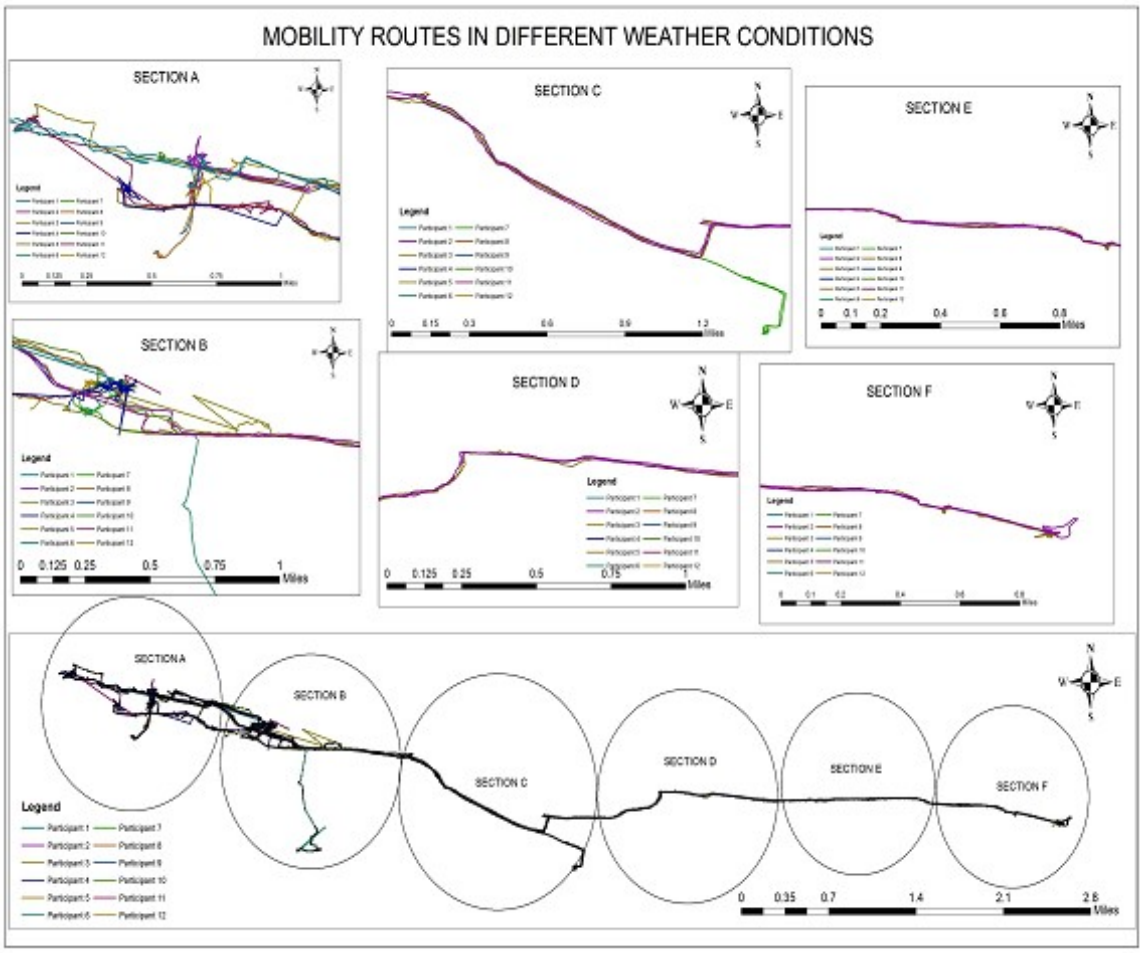


Figure 35-1 Mobility Patterns

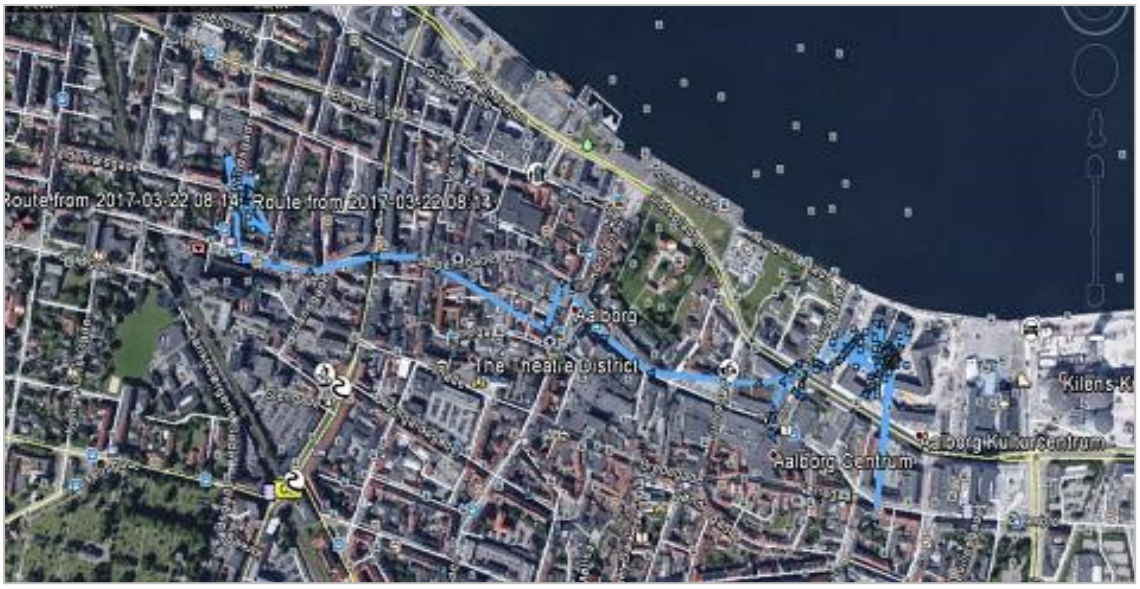
TRACKING MOVEMENTS

The GPS-data-loggers were continuously used in tracking the individual movements for the two days, the deployment of the device was agreed previously and the units were programmed to work in intervals of 3.5 minutes and they were set to turn off just after midnight. Since the sample population was few, the data log was easy to track. A data reduction algorithm that aggregated the consecutive GPS readings as located in the spatial windows became the sole source of information to identify the geographic positions and the locations of individuals within a given place [2]. As shown in the limitation part of the document, there were gaps in the data collected because there was data loss due to signal loss or incidents of individuals leaving a place and returning within very short notice. The Icluster algorithm that was used was given a threshold parameter time of 30 minutes that separated the gap types that showed that the individual visited the area after t minutes. Based on the errors that arose from using the data from the parameter time= 30, the time interval was reduced to t= 15. For each identified place, the total time of the visit was recorded on the GPS device, the data about the temporal patterns of visits was assessed by determining the times for a visit.

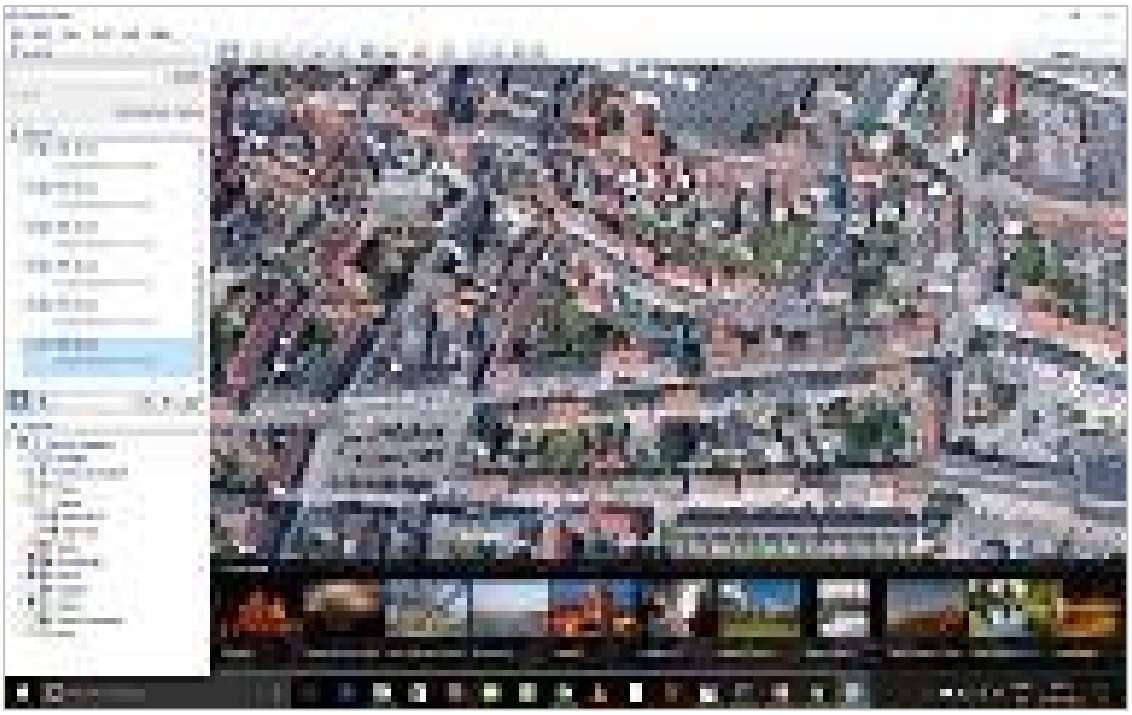
QUANTIFYING MOVEMENTS OF INDIVIDUALS

The data were quantified using the maximum likelihood methods that have been applied to the raw GPS data to fit various mathematical distributions such as linear decay, power-low and exponential decay. The movement kernels were applied to all individuals in the study for the same sex and also applied to different age groups. The ages were categorized in 10 year-bins because of the existence of the limited number of individuals which meant

narrower groups. The difference in age categories was also applied in data and to determine the different parts of the city visited, a spatial angular direction was applied in a special wavelet analysis [4]. In this study, the French Top Hat algorithm was applied. The major metric that is derived from fitting the wavelength function to the data is using the wavelength position variance. The peaks that have been derived from the individual variance indicated directions from the homes where the most visited places were located. The Monte Carlo Simulations was applied in separating true patterns from random fluctuations.



(a)



(b)

Figure 35-2 Interviewer Movements

DATA ANALYSIS

For analyzing weather, there are two parameters used, one is temperature, pressure, and humidity. For mobility, two major aspects will be focused on this paper, the average number of check-ins and an average number of movements and movement distances under different weather conditions. When analyzing the movements, the user checks in at different locations at a given weather condition is recorded. On whether the different check-ins at different places during different weather conditions were analyzed. From the general observations, there is correlation between pressure and mobility, in areas like Barcelona, the correlation between pressure and mobility is negative, showing that there is no correlation between the two, another example observation is that the individuals who were in Boston and San Francisco have had more check-ins but shorter movements in high-pressure days. In a city like Boston, the high pressure does not affect the average check-ins, but it leads to longer movements.

Other aspects of weather such as wind speed also affect individuals' movement, for example from the observation, checking volumes in many cities received negative speeds. The relation between check-ins and wind speed is not linear though. For other cities, wind speed has similar effects as showers.

RESULTS

The participants were mostly mobile between 10 am and 3 pm. During the sunny days, the mobility was observed in the open and shared spaces. Based on the mobility patterns, it can be summarised that the weather did affect the individuals who use public transport or the individuals who own cars. The individuals who live and study close to the city take public transport during the rainy days. [2] There were also observed stops in coffee shops and restaurants during light showers. Of the total individuals studied, only 38% showed regular and predictable movement patterns that relate to weather. In the case study, the impact of spatiality and temporary structured routines on the dynamics of transitions. The findings were also important in appreciating how technology can be applied to understand the role of weather on different check-ins in the city. The research, therefore, gives careful considerations of the human and social interactions when under adverse weather conditions, particularly in the rich urban centers.

The movements were also rare in windy and cloudy weather, this accounted for only 14% of the locations. The low movement during this time can be attributed to the fact that people tend to stay indoors anticipating rainfall. In the clear mornings, the movements were further from the participant’s homes and most movements were only 1km from the city, which formed the kernel of the human movements. As the weather became more adverse, the mobility decreased, the movement of the University Students were less affected by the rainy weather as compared to the Lecturer. The movement for males and females varied significantly but in cloudy conditions, more females, 67%, stayed indoors when compared to males at 34%. The special anisotropy decreased when only movements within the city were considered, the movement became non-significant at < 10 km from the individual’s home during cloudy and light shower weather conditions. Over the two days, there was a standard deviation of 3.6 and the probability of the individual's movements analyzed using Weibull distribution. In hot sun and cloudy weather, the amusement parks enjoyed most visits, while the majority of the students visited stadiums.

A. EFFECTS OF WEATHER

The weather impacted directly the movement in different areas, from professionals to food places. Temperature affected most movements, with most movements occurring in moderate temperatures when compared to under diverse temperatures. When the temperature was under 24oC, there was more movement than when the temperature was 32oC. Another factor that affected movement was the humidity, the movement was diverse under moderate humidity than the uncomfortable humidity. During the favorable humidity, the movements were outward from the participant's home during the adverse humidity where most movements end up indoors. [2]

B. RELATED WORKS

The work presents the first work on the use of technology to track human movement based on weather. Most studies on human mobility are based on the weather and transport[6]. The study had the advantage of applying technology to make people's mobility better compared to most of the researches that focus on the impact of weather on public transport. The research also focuses on the mobility of the users without physical constraints that makes the analysis more general and suitable for public consumption. The data set is global and since the individual used in the study are global samples, the data fairly represents the population with various tastes and preferences.

LIMITATIONS

The research had a limited number of participants. The devices used in tracking also did not give a fair location since some participants forgot to track themselves. Some of the participants were more mobile than others and therefore were unable to track themselves. A sample of the people studied were internationals hence their locations could not be studied. The rates of data loss and mismatch resulted from the data collected due to the participants dropping or not wearing the device, dead batteries or participants misusing the devices, to minimize the data loss, the raw data were individually explored such as eliminating the sites not visited by the participants. The data was also aggregated to avoid potential bias that may emerge from the description of movement behaviors.

Other limitations of the research include the errors that result from poor satellite geometry or multipath signal errors, other factors such as data collections within the buildings being poor due to satellite geometry, the transient of the visited locations can also be heavily affected by the frequency of data collections. Therefore, despite the reliability of the GPS systems, the information gathered might have also suffered from the limited data giving the full repertoire of the movements that have occurred and the data also affected by the scales and the data analysis methods used. The small number of the tracked individuals could not have enough information to be used the assessment of the temporal variation in patterns during and after a given change in weather conditions. The research, therefore, suffered from common limitations when covering mobility at spatial scales. Since the study was carried in two days, the chances of forgetting the GPS devices were low, however, the compliance rates could not surplus a 78% rate [3]. The project, however, was boosted by the social behavior of the participants who successfully cooperated with the scientists through focus groups, identified the concerns that individuals had especially on the use of GPS units.

CONCLUSION

For Denmark residentials, the rain shelters need to be put on sidewalks for sudden showers while keeping in mind the swinging showers, here are also need for rain sheds. From the study, it is evident that nice weather that is characterized by moderate temperature, slow wind, suitable humidity, and high pressure had a positive effect on the user's mobility. The mobility of the sample was less influenced in some categories when compared to other categories of travel such as professional obligations and entertainment.

REFERENCES

[1] Gonzalez, M., Hidalgo, C., Barabasi, A.L.: Understanding individual human mobility patterns. Nature453(7196) (2008) 779–7822.

[2] Cho, E., Myers, S.A., Leskovec, J.: Friendship and mobility: user movement in location-based social networks. In: Proc. 17th ACM Conference on Knowledge Discovery and Data Mining(KDD), ACM (2011) 1082–10903.

[3] Noulas, A., Shaw, B., Lambiotte, R., Mascolo, C.: Topological properties and temporal dynamics of place networks in urban environments. In: Proc. 24th International Conference on World Wide Web (WWW Companion), ACM (2015) 431–4414.

[4] B¨ocker, L., Digest, M., Prillwitz, J.: Impact of everyday weather on individual daily travel behavior in perspective: a literature review. Transport Reviews33(1) (2013) 71– 915.

[5] Hanson, S., Hanson, P.: Evaluating the Impact of Weather on Bicycle Use. Committee on Bicycle and Bicycle Facilities (1977)

[6] Nankervis, M.: The effect of weather and climate on bicycle commuting. TransportationResearch Part A: Policy and Practice33(6) (1999) 417–431.