Master thesis

Leisure and Weather at Rotterdam

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Abstract

This study was designed to discover people's daily leisure behavior respond to different weather conditions, and also if the transportations and individual specific characteristics matters regarding to the leisure issues. The factors taken into considerations are based on the results of previous studies that are related to leisure activities and temperature, transport and individual characteristics. However, until now, as temperatures and transportation issues were more focused, the other factors such as winds and individual characteristics were less been paid attentions to. In contrast, this study aims to explore a more comprehensive understanding, including possible factors in those three aspects. The research was carried out among the residents in Rotterdam.

The case of Rotterdam yielded a considerable amount of questionnaires regarding to people's daily travelling among the city. 1953 respondents have ever participated in the survey program and 13752 records have been collected. For each trips, the related variables concerning the weather conditions, transportations, individual characteristics, geographic coordinators were recorded. Subsequently, statistical analysis and clustering effects have been analyzed by using different statistical or geographical information analyzing methods, in order to answer the research questions.

The results indicated that, generally, the people in Rotterdam prefer a warm and no precipitation day with a wind speed around 2~4 m/s to spend their leisure time. And more specifically, temperature has positive effects to the shopping, like most of the previous studies. It also have negative effects to physical activities. No precipitations is preferred for most of the people, and also there is a 'threshold' for the wind speed, which is the most suitable wind speed for leisure activities. A few dominant places for leisure activities has been found, i.e. the Centrum, Vlaardingen, and Spijkenis. However, the attractions of those places contribute more to make those places to be famous for leisure, instead of the environment or municipal transport.

Particularly, depends on different transportations, how it matters for people's leisure activities varies. Temperature will change people's choices for cycling and walking but do not change the destinations. Meanwhile precipitations have less influences to the transportations, but do change the destinations. Moreover, people who using public transport or private cars are more likely to be unstoppable under adverse weather. In addition, a few correlations has been found between leisure activities and the individual characteristics. It indicated that to some extent the individual characteristics matters.

The study therefore advocates a more comprehensive understanding about how Dutch residents acting confront different weather. And as the results could largely depends on the research area, more studies should conducted at the other cities or countries. Quantitative analysis can give answers to research questions, but the understanding is not deep. Future studies should more focused on the individual characteristics. And policy makers should take more care about the weather exposed travelling. All these may result in fairly opportunities for all residents to enjoy a high quality leisure time.

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1. Introduction

1.1 Background

Weather and climate conditions play an important role in people's daily life. Increasing numbers of researches were done and focused on this area that discusses the relevance between the weather and aspects of people's life, e.g. health, travelling, livability, accessibility, hazards emergency, etc. Governments' policies, which aim is to promote people's healthy and sustainable lifestyle dealing with different kinds of weather, should be carefully considered in order to offer a better living environment for every citizen.

Moreover, the predesigned daily travelling or weekend entertainment schedules may be, to some extent, influenced by the changing weather outside. Not all bad weather conditions can be tolerated as some activities are merely suitable and enjoyable during some particular weather and climate conditions. For instance, people are less likely to have a trip to the beach or play basketball outdoors on a heavily rainy or windy day. Instead, it could be a good choice to do these activities in a sunny and warm day (Connolly 2008). And when discussing about the different kinds of weather conditions, as we can see from previous literature in this fields, precipitation and sunny weather are not the only factor that matter. Temperature and wind status influence people's decisions making for various mobility issues too (Böcker et al. 2013). These factors will affect whether people will go out or rest indoors, how they spend the time at the destination, where the destination is, what kind of transportation they will use for the commuting.

In addition, it has been concluded that once people have more disposable time and higher income, leisure purposed activities could be one of the more important aspects of their lives (LIU et al. 2001). As approved, among many other purposeful activities, leisure and recreation have become the most important trip purposes in order to have a better life quality in recent years (Simma, et al. 2001). This makes leisure space analysis and related topics a meaningful research field in the urban and geographical study area.

However, when considering the existing relevant research articles from last century, the influence of the environment and its connection to leisure activities has been considered, but few investigations have been taken into practices. One of the possible reasons could be that the meteorologists and leisure specialists who studied this fields have few research intersections and rarely communicate with each other. Also, the atmospheric conditions are not the only factor that will influence the leisure decisions, so the linkage between the weather and leisure behavior is often difficult to demonstrate (Smith 1993). Even though some research for this topic has been done in recent years, more empirical researches are still needed at some typical urban or regional environments.

While urban studies and urban planning pay more attention to the distribution of residents' leisure activities, a more comprehensive understanding of how the distribution of leisure is organized and it has been influenced by weather is still needed for the sustainable and effective management of these city areas (Brandenburg et al. 2001, LIU et al. 2001).

Therefore, for this master thesis, the impacts of the weather will be the main topic i.e. how the weather has an influence on people's daily life will be discussed. The thesis will focus on the leisure activities of people, as the leisure and recreational place could be an increasing important part for all residents.

While the scholars have focused on weather and leisure and some contributions have been made recently, knowledge about the daily weather and travel commuting is still somewhat limited. For current studies, scholars paid more attention to long-term leisure travelling across city rather than daily leisure activities in a city and not all the existing researches have a sufficient data base for a long term societal analysis. In this thesis, the daily leisure among a city scale is the research topic and a systematic study will be done to support the research requirements. Rotterdam is a typical city with a large highly developed metropolitan area and an adequate diversity among the citizens, e.g. ethnically, economically and in terms of age and sex. Therefore, we choose Rotterdam as the empirical research object.

The result could help governments make better public policy decisions about leisure space planning, transportation systems improvements, access utilities at public space, expose weather shelter facilities arrangement, etc. Also, the knowledge about the influence of weather on leisure could be referred to some other cities around the world which have similar climate types (yearly average heat, precipitation and wind etc.), societal background and geographical situations.

1.2 Objectives and Research Questions

As discussed above, the focus of the thesis is about the weather's influences on people's leisure activities (destinations), the various societal backgrounds of people and the different transportation modes that they use for getting to their leisure destinations. Therefore, there are several steps in order to achieve the objectives.

Firstly, the research process will dedicated to analyze the destination choices of the leisure trips among the respondents within the Rotterdam city area. The research aim is to explore whether specific areas are emerging as dominant destination choices where inhabitants spend leisure time. The results about the clustering area shown on the map could help discover the area where people usually spend the leisure time and also define these areas on a geographical scale for the following comparison process. The ultimate objectives of the destination clustering analysis is to help show how much the weather has an influence on the people's choices to these popular leisure area.

Secondly, this research is about analyzing the socio-economic factors (age, sex, ethnics, income, education, etc.) that lie in the respondents' societal background. Among the existing literature, the impacts of the weather on people's daily life have been pervasive together with distribution analysis at some specific areas. However, the relevance of the societal background for the connection between weather and distribution of leisure destination is neglected. Mentally perceptions and experiences of weather conditions may

vary from persons to persons within different ethnic backgrounds, lifestyle, age-cohorts, genders and health conditions, between or within countries (Sun, Chen et al. 2001, Böcker, Dijst et al. 2013). Therefore, when analyzing how much the leisure activities will be influenced, the societal background should be taken into consideration, which is needed in order to get an accurate result.

At last, as the transportation matters for an individual to decide where to go, the last question about the weather and leisure is how much the transportation will have an influence on people's choice for leisure. It could be easily assumed that weather will, to some extent, have influence to people's uses of transportation and then affects people's decisions for leisure activities. For this aspect, transportation could be considered as a mediation factor that could possibly be important for the answers.

Research Questions

In order to achieve the objectives, below is a few research questions that should be answered:

1) To what extent does weather influence leisure activities (separate the weather into temperature, precipitation and wind)?

2) To what extent do the destinations of leisure activities have a clustering effect and if yes, are there some dominant destinations for leisure activities?

3) Whether the mode of transportations matters and how?

4) Whether the individual characteristics of the people matter and how? (Will people in different age, sex, income and education etc. have different leisure choices?)

1.3 Reading Guide

The following paragraphs is the literature review, followed by the research design, analysis and conclusion and discussion.

The literature review will review the existing relevant works and see what conclusions that have been made are useful for the assumptions of our study and what conclusions are questioned. An overview table of the possible factors would be given at the end of chapter 2.

Chapter 3 is the research design. Firstly, the research model will be introduced, and then the study area with the general information about the geography and climate. The followed data part shows the useable variables, and then the method (Kernel Density) would be introduced.

Then in chapter 4, first we show how different weather conditions would affect people's preference for the leisure activities, and then the destinations of leisure are shown on the

geographic map. A map of the popular areas where people go for four different kinds of leisure activities would be given. After that we show how the transportations and social background affect people's choices for leisure.

The last chapter is conclusions and discussions; it will discuss why this topic is important and what is lacking for the previous studies. Also it give an overview of what we can conclude from Chapter 3 and 4. After that, we will give policy recommendations and suggestions for future studies.

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2. Literature Review

2.1 Leisure

There is a considerable amount of literature discussing the weather impact issues including the following research topics: influence on public transportation choices, the physical activities indoor and outdoor, the destination of the leisure purpose activities, the travelling path, the duration times for leisure in different weather conditions, the shopping space in the city, etc. However, depending on where the research area is located, the influences of the weather on every aspect of the daily activities could be different (see review: Böcker et al. 2013).

For the existing relevant literatures and encyclopedias, the definition of leisure activities varies from different sources. It is because for people's different activities, the aim, behavior, time, environment is so complicated that building a simple classification system can never be an easy task. However regarding to the previous literatures, in this empirical research, the leisure activities in Rotterdam can be defined as: the human activities spent away from business, work and domestic chores. It excludes the activities spent for some necessary daily activities (eating and sleeping for example) and some other compulsory activities (such as education, church). However, the differentiation between the leisure activities and unavoidable activities is still subtle, for example, sometimes people do work oriented tasks for pleasure as well as for long term utility (Goodin, Rice et al. 2005). It means that the motivation of the activities could be related to several aims rather than just one aim. Moreover, certain 'leisure activities' that people do could not actually be related to leisure and relaxing purpose. For example, athletes exercise and do physical activities in order to catch up with higher standards in competitive sports rather than just for relaxing, while other people may do physical exercise for leisure purposes only. Moreover, it is also reasonable that when a host of a villa does gardening in order to keep up with the standards of gardens from his neighbors, it cannot regarded as a leisure activity, unlike when others do nature relevant activities just for relaxing. In addition, when considering the social function of leisurely activities, the definition of leisure becomes much broader and more sophisticated. And in fact, for the literature reviewed in this part, there are also subtle differences among the articles.

In order to give a brief overview of the previous literature and make the following analysis part clearer, we performed a systematic summary and classified the related leisure activities into four categories. The defined leisure activities in this thesis are: 1) Shopping - considering the consuming activities of people and store locations issues; 2) Culture/Entertainment/Café - considering the relaxing culture experience, coffee, restaurant, and party time etc.; 3) Physical Activities - for the physical activities that are not for competition purpose but for relaxing or social purposes, e.g. jogging, biking, playground, Frisbee, etc.; 4) Park/Water/Nature, relevant to the grass land or activities on the water, e.g. boating, basking in the sun, etc.

The following paragraphs will discuss all these potential leisure-purposed activities, including the motives, research items and their relevance to the weather or social context.

Shopping

Weather influences shopping through many ways, e.g. the transportation, the accessibility of the public space, the time people spend on the commuting, the body tolerance of the people and even the mood. Research has found that there is some correlation between the weather and the sale of the stocks. Moreover, it is explained by Cao and Wei (2005) and Kamstra, Kramer et al. (2003) that weather can have influences on the people's mood to do consumer activities. Therefore, even though the indoor person is sheltered from the weather, he is still under the influence of the weather before he really decides to do any kind of leisure activities.

In the marketing aspect, Shopping is strongly influenced by the weather, the sales of certain consumer products vary in different kinds of weather conditions. This phenomenon could indirectly indicate that the attendance of people who choose shopping for their leisure time could be influenced by the weather. Moreover, King and Narayandas (2000) find that there is a correlation between the consumption of Coca-Cola vending machines and the weather conditions. This result could help to readjust the price of the production by predicting how many people would consume it in different weather conditions. Agnew and Palutikof (1999) and Roslow, Li et al. (2000) indicated that certain kind of weather will increase or reduce the willingness of people to do shop for clothes and have influence on the sales of the clothes. In general, the higher the temperature the higher clothes consuming will be. Moreover, food and drinks are also found to have more sales in summer than winter.

In the other aspects, certain weather conditions are regarded as physical barriers. To some extent, when the weather is negative for some leisure activities, it will reduce the people's ability to reach the boundaries of shopping space. In this way, the negative weather conditions can make the shopping place less attractive because it becomes harder to get there, and that reduces the traffic around the shopping store together with the sales (Steele 1951, Parsons 2001).

Some of the previous studies analyzing the influence of the weather focused on the changing mood of people in response to the weather conditions. For instance, Persinger and Levesque (1983) found that 40% of respondents reported that mood will be affected by various precipitations such as sunlight, wind and temperature conditions, and these affect the decision making about whether or where to have leisure. Moreover, the people's mental response to the weather will also have different influences through different seasons (Keller et al. 2005).

In summary, weather could have influences on people's leisure shopping time directly or indirectly. People will adapt their behavior to the changing outside weather, traffic, and environment together with their inner mood (Parker et al. 2000). At last, the leisure shopping place would be regarded as a changing dependent variable, which could be represented with a Kernel density map of leisure. This is going to be analyzed and shown in Chapter 4 of this master thesis.

Entertainment

Regarding the entertainment leisure time, it relates to certain activities people spend for relaxing with a social or educational aim in a public space. For example, culture exhibitions, museums, coffee time, eating in a restaurant, party time, etc.

Unlike for the shopping which had some connections with the economic marketing and economic growth, the influences of the weather conditions on the culture & entertainment related leisure activities has been paid less attentions to by the scholars. Most of the culture & entertainment activities are relating to the analysis of tourism attraction and other literature focus on the entertainment behavior of people.

The consensus of the study between the daily travel patterns and the long term or long distance tourist is under the assumption that people are aware of what kind of weather they are going to confront or 'enjoy' during their travelling time. Therefore, people will possibly adjust to the positive or negative weather, and this will cause some changes for the dependent variables (culture & entertainment activities). Regarding tourism, Butler (1986) set a theory in which he sets two classes of factors that have to be considered. The first one is about the spatial economic factors, which is related to the distance, accessibility, transportation costs and the physical attributes of the destination. The second one is about the natural and environment variables, which is related to predicated environment, climate and scenery. To some extent, the study of the tourism can be referred to the short time daily recreational activities, as the travelling and daily entertainment activities are both happiness purposed activities and they both have to deal with the weather issues (Butler 1986, Martin and Belén 2005). In this case, the climate is one of the possibly influencing factors when people making decision for some entertainment activities. There is a trend where people seek to settle at those spaces that offer the most comfortable feeling and opportunities to enjoy the time without the worry of the weather (Martin and Belén 2005). Depending on what kind of recreational activity it is, the preference of weather could vary for different situations. Therefore, as a conclusion and advice from the previous research, Palomares (1964) recommend that the planning should not only use the advantage of weather to promote some recreation activities in some place with ideal weather and climate conditions, but also to adjust the programs to prevent the people from being exposed to the adverse microclimate and micro weather (wind, temperature, precipitation, etc.) conditions.

A few works were investigated to the recreational activities behavior. Rind and Strohmetz (2001) found that if the weather matches the people's personal preference, there could be more consumption in the restaurants and also the tipping for the server. Rind (1996) also found similar results about the suitable weather's positive influence on restaurant consumption and tipping.

Physical Activities

As health issues are a primary consideration for individuals' daily behaviors, the topics that are associated with health are strongly promoted by the social science scholars. Previous studies on outdoor physical activities can cover different countries on all continents. Temperature and wet conditions in different season and month could be a significant factor for the time and duration adults and kids join physical activities. Therefore,

little empirical evidence is found to support a poor correlation between the weather and the participation of physical activities (Tucker et al. 2007). Also, the level of influences varies under different context.

According to Humpel, Owen et al. (2002) there are consistent associations between the mental feeling for an environment and the physical activities for adults. However, few of the variables are related to the weather conditions. Instead, the scholars focus on the existing neighborhood environment factors. In another review to discover the influences from the weather and climate, not only are the factors about the daily weather condition analyzed, but also the age of the people are taken into consideration (Tucker and Gilliland 2007).

Seasonal variations in statistics are referred to in some research; however, depending on different research locations the results are also different. Few evidences approve that the attendance of the physical activities of people in the warm season are generally lower than the cold seasons. Baranowski, Thompson et al. (1993) found that the attendance of physical activities reduces while the mean of temperature of the season increases, and the least number of people do outdoor physical activities in July. Pivarnik, Reeves et al. (2003) find out that the number of non-leisure time participants are significantly ($p<0.001$) higher in the winter than in the winter. And meantime, Bergstralh, Offord et al. (1990), Burdette, Whitaker et al. (2004), Levin, Jacobs Jr et al. (1999), Constantinos, Chedzoy et al. (2004), Plasqui and Westerterp (2004), Ross and Gilbert (1985), found a higher level of participation of physical activities among the respondents in the warm season rather than the participations in the cold seasons. Moreover, the largest amount of the attendance of people is usually found in the summer, i.e. around July and August. The lowest attendance is found in winter.

Also, the existing literatures focused on the daily weather conditions, Currie and Develin (2002) found out that the participants prefer a dry and not windy day to do exercises. And King, Castro et al. (2000) found that bad weather can be a decisive factor when people want do exercise outside. Lindsey, Han et al. (2006) found out that when people walk, run or do other physical activities, they are doing it at a certain trail in different temperature and daylight hours. Moreover, it was found find that a sun shining day is more preferred by people, i.e. the temperature will increase the people at leisure time at the place while precipitation will reduce approximately 40% people to join physical activities. Uitenbroek (1993) found a correlation between the snow day and the participation of physical exercise. It concluded that more snow conditions will decrease the number of people who go outside. Also, there are slight differences between rural and urban dwellers. There is an average level of two percent difference for people to join leisure time physical activities between the urban (8.9%) and rural (10.9%) in response to different kind of weather conditions.

Park, Water, Nature

Regarding the nature leisure activities, the existing literature focuses on the short distance nature traveling in and out the city area. However, to the writers' knowledge the limited literature discusses people's relaxing within the city, while trips to the park, jogging,

or other social activities with leisure purpose is obviously important for people living in the city. Moreover, existing literature has focused on the skiing, boating, camping etc. which are all outdoor activities, and positive effects have been found.

Smith (1993) analyzes the economic efficiency of the recreations industry in UK in different seasons and compares skiing economics between Ontario and Scotland, which is also the research done by McBoyle, Wall et al. (1986). They find that in the winter season, as the temperature raises there is less opportunities for the ski tourism. However, the attraction for Ontario does not decrease. The reason is that as the skiing is less attractive, the attraction of the summer nature scene increases. Therefore, when considering the seasonal changing weather, there could be a negative or positive effects from the weather to the leisure activities, but the number of participants at a certain place could be less influenced. Moreover, the different results about the long term research would largely depend on the scale of the research, i.e. weekly, monthly, seasonally, or yearly.

In addition, as the current global hot topic is global warming, scholars also pay more attention to the contrast between the winter and summer at certain nature and water locations. More specifically, it is related to the growing facility of skiing at a snowing city or seashore playgrounds at a seaside city.

2.2 Leisure and Destination

There has considerable amount of literatures discussing about the leisure destination topic. For example, to some extent, short period climate change will also cause some changes, and it may substantially decrease the number of trips on certain days, especially those activities for leisure purpose (Koetse et al. 2009). Meantime, it has been found that weather can change the travel behavior and then change the leisure destination choice (Cools, Moons et al. 2010). Sabir, van Ommern et al. (2011) focuses on individuals' prediction for the weather. They concluded that wind and precipitation negatively influence the decision to go to the beach contrasting with other destination. Moreover, weather condition should be considered as a natural force in the contextual variables when analyzing spatial issues in leisure (De Ceunynck, Kusumastuti et al. 2011). However, to some extent, public facilities can contribute to the attractiveness of the place for people to spend leisure time. For instance, a park with nice scenery and outdoor places with a water area nearby are more likely to be the first option for people to have leisure activities (Pozsgay et al. 2001). The difference between outdoor activities and indoor activities has been considered as an important correlative variable for tourists' choice for skiing in Switzerland (Simma et al. 2001).

However, when considering the destinations which people choose for leisure activities, firstly, it is related to the spatial analysis of the place where people are recorded to have leisure activities there. Moreover, it is related to the underlying factors that generate this outcome. For the existing literature, there are several aspects that have been discussed for the destination issues. Traffic and transportation topics are the factors most related to the destination choices, together with the weather factors. The urban and suburban road

transportation could be the underlying factors that reduce or support people's capability constraints, which means the biological, mental and instrumental limitations (Dijst, 2009). Secondly, the destination issues have been discussed, i.e. the spatial clustering of some areas are the more popular destinations where people could go and have leisure time. Also, the spatial clustering is related to the attributes and environments of research area (Wu et al. 2006, Novák et al. 2007, and Böcker et al. 2013). Therefore, considering the destination issues, they can be divided into two steps of analysis. Firstly, the transportation with travel behavior of people, and then, the destination choice of the respondents where they went for leisure trips.

Transportations and travel behavior

Most of the study on the travel behavior is about Northwest Europe, North America and Australia, where it is reported to have a wet, mild windy, and a warm summer climate. Most of the other countries and other possible climate variables at other places are not included in existing literatures (Dijst et al. 2013). Therefore, for the current study, there is a need to expand the research area in order to cover more climate conditions human could face in their real life.

However, when referring back to the existing achievements that have been made, some literature did focus on the travel duration, the time, transportations, and the route, etc.

For the travel times, Koetse and Rietveld (2007) indicated that the transportation system and people's adjustment to the transportation statues could be largely affected by the weather. Negative weather will result in a deterioration situation. For example, Unrau and Andrey (2006) indicated that there is an approximately 10% traffic speed drop on the urban high way in Toronto during intense rain. Also, in a global view, usually the rain will cause the decrease of traffic speed and increase the possibilities for traffic jam and the travel time (Ibrahim et al. 1994, Kyte et al. 2001, Maze et al. 2006).

Other literatures focus on the transportation mode choice. As walking and cycling would make people more exposed to the weather conditions, the adverse weather, e.g. uncomfortable temperature, precipitations, wind speed are expected to have more influence on the people's travelling and commuting, while the car seems to guarantee its users weather-sheltered trips under all kind of weather conditions (Dijst et al. 2013) and public transportation will protect most part of the people's trip except the way to the transport stations.

Moreover, scholars should take the weather forecast into consideration that, in fact, it is possible that people have already made decision before they leave because weather forecast can be a good information source to help them make decisions. In other words, weather affects people's preference for transportation or travel behavior. However, only a few studies are based on the weather forecast (Dijst et al. 2013). While Kilpeläinen and Summala (2007) found significant impacts from the weather forecast to the drivers' travel time and route planning in their study in Finland. For another research, Khattak and De Palma (1997) found a few correlations between the weather forecast and the drivers' travel behaviors in Brussels. Meanwhile, as the walking is expected to be under big

influence of the weather, there is a research done by (Cools et al. 2013) discussing about the walking people's reaction to the precipitation by using stated-adaptation methods.

Another point of the impacts on transportation is under the background of the global warming, which means the research area and time scale are usually bigger than the daily life issues. Koetse and Rietveld (2009) reviews not only the daily travel patterns and the related factors, but also discusses the changing of global transportation system under the climate changing background.

Destination clustering

There are a lot factors that lie within the relationship between the weather and the destination, therefore, within this complicated topic, scholars mainly do research in two ways. Firstly, as the factors are unknown, destination choice is discussed by analyzing the possible factors that influence where the destination should be. Secondly, as the destination choice is easily to be shown on the map of research area, it is reasonable to do a research project by using spatial analysis theory and techniques.

An action space model is used when analyzing the possible destinations of people under different kinds of factors, including the weather conditions. Dijst and Vidakovic (2000) develop the theory by using the spatial reach and the action space concept. It explains the activities places in two ways, firstly, from the position of the place; secondly how far the individual can reach. Considering the person's ability of how far he could reach is not the same from person to person. This theory could be utilized for different urban study topics, for instance the transportation, traffic, spatial economics of different social groups, etc. However, when analyzing the destination of people's daily leisure activities, the different weather conditions should be considered as a strong factor.

In addition, for the studies' focus on the destination location for the leisure activities, the literature take spatial modeling into consideration. Existing literatures aimed to find a behavior pattern of certain activities in a city area, analyzing the underline factors and the existing results. By using the cartographical map project, it can help us to find the reasons and show the results of spatial clustering.

Wu and Cai (2006) analyzed the spatial modeling of suburban people's leisure time in Shanghai by using the concept of 'recreational belt around metropolis'. He focused on reasons and factors that drive the people to do leisure and recreation activities in certain places. Three key factors have been found: firstly, the demand of people to do weekend recreations, which where affect people's decision about whether to go and where to have fun. Secondly, it's the facilities that are available for the leisure travel, which will affect people's decision about the choice which place to go among a group of possible leisure destinations. The third factor is about the transportation attributes that are relevant to the recreation place. Also, the existence of certain leisure dominant places is found and shown on the map in Wu and CAI's (2006) work. It approved that certain places could act as dominant leisure places.

While previous literature regarding the ReBAM (recreational belts around metropolises) emphasize different factors and dominant places, Jansen-Verbeke (1986) focuses on the difference between the people living in urban and people living in sub-urban. It found big differences among the recreation activities, daily commuting and travelling trip. Also, certain areas and cities are becoming the focus, as Preobrazhensky and Krivosheyev (1982) indicated in their research on the leisure and recreational space clustering effects in the former Soviet Union. Other works have also been done around the world: in the United Kingdom, Germany, Japan and China etc. (Maier 1975, Bihu et al. 1997, Wu et al. 2006). However, to the writer's knowledge, only a few existing literatures have discussed the leisure and recreation destinations in the Netherlands.

Additionally, individual and household specific characteristics will also have influence to the decisions among different groups of people. However, few literatures focused on these factors. Dijst, Böcker et al. (2013) indicated some possible intermediate factors, e.g. the geographical, social, economic and demographic characteristics, etc.

2.3 Leisure and Weather

In this thesis, weather is the key variable. One objective of this paper is to discuss how the weather will influence people's behavior for leisure activities, i.e. the related different kinds of leisure activities, transportation, destination, etc. However, regarding the existing literatures, Koetse and Rietveld (2007) indicated that, in fact, little attention has been paid by the scholars to the changing weather patterns. However as a consensus for the classification of the diverse weather conditions, previous scholars agreed to put the weather into three kinds of categories (Dijst et al. 2013). The three groups are: 1) Precipitation, such as rain, which can generate wet environment. It is expected to be the most important factor that will influence the weather exposed people. 2) Temperature, including the physically recorded Celsius and degrees F^0 by the thermometer and individuals temperature perception of the environment. 3) Wind, with bellowing, equally important when compared with the rainy and temperature factors. In fact, another weather category should been taken into consideration. That is the inclement weather, including the storm heavy rain and hail. However, few theses have focused on this topic with the leisure activities. The reason could be that in the inclement weather, people would choose safety other than the relaxing. Therefore, in an inclement weather day, people would more likely spend the time indoor or reduce their time outside. Few records are expected to be found and the results would make the research meaningless.

Temperature

The existing literatures relates to temperatures in several aspects, and the scale of the research period ranges from daily to weekly, monthly and yearly. Temperature is focusing on the usual warm and cold temperature, excluding the extreme torridity and iciness weather. However, most of the current scholars emphasize their study on the seasonal scale analyses (Böcker et al. 2013), as there could find a more obvious difference from the spring to the summer and winter.

There should be two processes when people make decisions about doing leisure activities. The first one indicates the decisions before they go; it is about the preference of the destination in different weather conditions. Secondly, it is about the transportation choice influenced by different kinds of weather. However, there is more literature focusing on the second part, i.e. transportation. Regarding the preference of the leisure destination, the existing literature is mostly related to tourism topics, which focuses on long-term travelling.

For the transportation, temperature will have more influence to the weather exposed transportations. Müller, Tscharaktschiew et al. (2008) indicated that there is a compensation effect between the cycling mode and weather-shelter transportation (i.e. the car and public bus and train transport). Cycling increases from the winter to the summer, and the private car and public transportation decrease in the other way round.

Temperature is believed to directly affect people all around, in another words, everyone is exposed to the temperature, but not to wind and precipitation. Therefore, the temperature could have more important influences than the precipitation and wind on the travel behavior (Cools et al. 2010). However, the result of the temperature varies at different locations. Studies that located in the Europe agree that temperature has a significant positive influence on walking and cycling, while it could have negative effects on private car and public transportation use. Meanwhile, some research done in the North America conclude that there could also be a decrease of the private car and public transportation usage during cold weather, which means the temperature could also be a positive factors to the car and public transportation use(Guo et al. 2007, Shih et al. 2011, Tang et al. 2012).

In another aspect, existing results have shown that there are positive effects from warm temperatures, and this is approved by the researches that have already been done at Chicago, Vienna, Montreal, San Francisco, Gothenburg, Athens, Japan and Taiwan, etc.(see review:Dijst, Böcker et al. 2013). Also Chan and Ryan (2009) and Tucker and Gilliland (2007) have also shown similar results in their review about the temperature. Warm weather has positive effects on people's attendance to outdoor physical activities.

However, there are still some arguments about the effects of weather on the leisure activities. Spinney and Millward (2011) did a research about the correlation between the weather factors and the leisure activities attendance at Halifax, Nova Scotia. Results show that the temperature's influence depends on what kind of activities people attend. The maximum temperature will have positive effects on the relaxing and waiting, sports, movies, and other outdoor activities, however, meanwhile, the maximum temperature shows a negative coefficient for active sports, hobbies and crafts and leisure driving. Aaheim and Hauge (2005) have given similar arguments that depending on certain leisure activities, the impacts of temperatures is different. They find that temperature will reduce the ambition to do mission tasks, but instead, it will increase the attendance if people choose to take leisure purposed activities.

Precipitation

The impacts of precipitation are represented in some literatures, and when regarding to how much the influences could be, it is often related to the precipitation level. Precipitation primarily influences people's accessibility to walking and cycling. Even though the private car and public bus or train is weather-sheltered, people will still be affected during their transfers. Moreover, the precipitation will affect people's preference to certain place. For example, going to the beach in a rain is obviously not a good idea. It means the precipitations could possibly change the destinations.

Trip decision is influenced by the precipitation's effect on the transportation. Several studies have shown that the rain has negative effects on people's private car usage. Research has been done in the United States, Australia, Canada, and Scotland, etc.(see: Böcker, Dijst et al. 2013). Meanwhile, for the bus and train transportation taken by the residents, Guo, Wilson et al. (2007), Hofmann and O'Mahony (2005) and Tang and Thakuriah (2012) find a decrease of passengers for the public transportations when the rainfall raises. Conversely, Rose (1986) indicated an increase number of passengers in the public transportation increase in the colder and snowing day. It could be explained by the fact that in cold weather people are more likely to choose public transportation for their leisure as the bus can protect them from the cold, while walking and cycling is becoming more difficult.

Simultaneously, the precipitation will affect people's decision about what they want to do and where to partake in the activities. However, the level of the influence from the precipitation also varies among different places.

It is reported in the study taken by Spinney and Millward (2011) that the precipitation affects the people in Halifax to join the leisure activities in some way, and precipitation does not have the same impacts to different kinds of leisure purposed activities. More precipitation will contribute to more relaxing, movies and socializing activities. Also, it will have positive effects to the indoor physical activities and increase the people to do hobbies and nature relaxing. On the other hand, the results show that precipitation will decrease the number of people who do outdoor sports, outdoor active leisure and driving. Connolly (2008) analyses the American Time Use Survey, and argues that the bad weather, for example the precipitation, would reduce the number of people that have time for leisure activities In counter, people would spend more time on working on the rainy day. For the male, the gap between leisure time in a rainy day and leisure time in a not rainy day is about half an hours. Also, the gap depends on the locations, the driest place has the largest gap between leisure time and work time. And male work less if yesterday is rainy. Hourly paid workers are more likely to be influenced by the precipitation than the regularly paid office workers.

Wind

As the temperature and precipitation are usually taken into consideration in the weather topic, wind is easy to be ignored when compared with these two topics. Similarity to the precipitation and temperature, wind is also analyzed in two aspects. Firstly, it is related to the preference for transportation. Secondly, it is related to people's preference for different destinations under the wind.

Regarding to the transportation part, influence of wind varies for different situations. For the car using, Maze, Agarwai et al. (2006) find a 80% decrease of the number drivers on the rural high way when it is snowing and the speed of wind is 40 mph, while 20% of drivers will do the same when the speed of wind is slow.

In addition, the influence of wind on the cycling also varies among the studies. Thomas, Jaarsma et al. (2013) represents a negative effects from the wind to the number of people who choose cycling to leisure, while Sabir, van Ommern et al. (2011) finds that only when the wind speed is higher than 4 Beaufort, the wind will have significantly negative impact on the people who want to choose cycling. This research result is supported by two Australian scholars. There is a threshold for the wind; if the wind exceeds this threshold it could have negative influence on cycling, while if the wind is too small, the impacts is not so significant (Böcker, Dijst et al. 2013). Also, Sabir, van Ommern et al. (2011) also found that there is a negative correlation coefficient between the wind and the people to go to beach and spend leisure, the strong wind (>7 km/hr.) counts 81% of the coefficient.

Wind also affects the willingness of people to continue or cancel the leisure activities, as it is expected, wind would make it more difficult to achieve the expected leisure activities. In the study of Cools, Moons et al. (2010), respondents are less likely to attend the leisure trips during a windy day, as it could cause a delay in arrival and make the leisure time more risky.

However, how the destinations of leisure activities been effected by the winds has been paid less attractions, in contrast with the temperature and precipitations. In fact, Sabir, van Ommern et al. (2011) found that the wind, together with the precipitation has more negative impacts on some specific leisure trips than the temperature, e.g. beach leisure.

2.4 Individual and household specific characteristic

Except for the external environment, the individual and household characteristics also matter for people who make decisions about their leisure trip. Weather, transportation, destination are all outside factors that contribute to the arriving accessibility. However, the individual characteristic is expected to contribute to people's different preference for leisure space. Therefore, this could also be an important factor. The review written by Böcker, Dijst et al. (2013), indicates that this still needs to be researched on. The personal perception and experience of weather could be different if the respondents have different age, sex, ethnic, health, income statues, have private car or not, lifestyle, and nationalities.

For instance, regarding to the health of the people, Chan, Ryan et al. (2006) found that the weight matters when discussing about the people attending physical activities. The obese are more likely to have physical activities than the people who are more emaciated. Considering age, approved form the review about effect of weather on physical activities written by (Tucker et al. 2007), adults are less influenced by the weather in contrast with adolescents. Sun, Chen et al. (2001) studied the space of leisure of the elderly people, and he found that the leisure space of elderly people is not affected by the seasonal changes,

but what they do for leisure is not the same. And the scope of their outdoor activities is influenced by the seasonal changing weather. Moreover, depending on the sex, age, education, and income, the elderly people have different preference for the leisure, time, duration and the place.

For different countries, people's reaction to the weather is also, to some extent different. As discussed above, while Australians could be more influenced by the precipitation, the Dutch are not. Also, differences from national background have been found by Thorsson, Honjo et al. (2007). While Swedish people have positive reaction to the hot weather and are more likely to enjoy the recreation leisure time outdoors, Japanese people, spend more time seeking for shade when they have similar weather situation.

Therefore, as the existing literature studies the difference among the household and individual specific characteristic, it do not represent a comparison for each factor. A systematic contrast for how much the influences would be with different characteristic should be done to support the societal context aspects.

2.5 Leisure, weather, transport and individual characteristics

To sum up, regarding this research in the existing literature, different leisure activities, weather condition, transportations and individual characteristic have been paid attention to. However, not all the factors are relevant for the existing work. Below is the tale about which two topics have been analyzed within each literature that has been reviewed upon.

	Shopping	Entertainment	Physical Activities	Nature, water, etc.	Leisure in general
Preference	√	√	√		√
Weather	+ / -	+ / -	√	√	√
Temperature	√ / -		√ / +	√	√
Precipitation	√		√ / -	√	√
Wind	√		√ / -	√ / -	√
Transportation (Cycling, car, bus, etc.)		√		√	√
Clustering					√
Social / Environment		√	√		√

Table 1: Reviewed factors about leisure activities and weather, transportation, etc. ("√" means existing literatures has taken the factors into considerations; "+": there has clear positive influence from the factors on the left to the leisure activities; "-": there has clear negative influences)

Therefore, it could be easily concluded that previous work will focus on different factors when considering the four different leisure activities. When talking about shopping, previous works paid attentions to the weather factors, and both negative and positive effects have been found. It can be explained that weather situations can influence people's mood easier than other factors, and this, affects people's decision for shopping. While considering the entertainment, transportation is the main factors that could affect

people's willingness for entertainment. However, both weather and social aspects are also taken into consideration. Moreover, temperature, precipitation and wind will have different effects to the physical activities, and for the reviewed literature, warms temperature seems to have a positive effect, whereas precipitation and wind have negative effects. Nature and water activities are not a hot topic, but temperatures, precipitation and wind will still be taken into consideration when long-term nature traveling is the main topic.

In addition, when considering the leisure activities in general, few scholars used spatial technologies to analyze the relevance between the leisure activities and other factors (Wu et al, 2006, Novak et al 2007, Bocker et al, 2013).

Moreover, it is also reasonable to have an assumption that weather could influence people's leisure activities by influencing the transportation firstly, and then affecting the leisure by different transportation that they have to take. Therefore, for the existing reviewed literature, there are some works that have done some analysis of the relevance between the weather and transportation. Below is the table that shows the existing works.

	Temperature	Precipitation	Wind	Weather in General
Transportation (Cycling, bus, etc.)	+ / -	+ / -	+ / -	√
Transport behavior (Time, route, trip number etc.)	√	+ / -	√	√

Table 2: Reviewed factors about weather and transportations. ("√" means existing literatures has taken the factors into considerations; "+": there has clear positive influence from the factors on the left to the leisure activities; "-": there has negative influences)

The relation between weather and transportation is more complicated. Both positive and negative aspects could be found for the influences from the weather/transportation model. Meanwhile, the relevance is not that simple. It is not simply positive or negative when considering some factors. For instance, a wind threshold has been found when considering how the wind affects the cycling. Sabir, van Ommern et al. (2011) have found that negative effects occur only when the wind speed is higher than 4 Beaufor. Bocker et al. (2013) have similar conclusions in their reviewed works.

There is already some literature talking about this topics, however, the findings are not sufficient enough when talking about the whole picture. Previous works, to the writer's knowledge, focus on one or two aspects for their works. A systematical work is needed in order to analyze how each factor affects the leisure activities. Long-term systematical data is also the key point to answer the given research questions.

In addition, as the clustering map has already been used as a way to show results on the map, few existing works have used this technology to show how the leisure destinations shown on a specific area, i.e. Rotterdam. The use of visualization technology to show spatial differences could be an advice for the future research.

3. Research Design

3.1 Concept Model

This thesis pays attentions to all the potential factors that could have influences to people's daily leisure activities. Before analyzing, there should be a consideration about all the possible environmental factors. As shown in the literature reviews, a few aspects have been taken into account for the previous studies. Considering that, it is reasonable to assume that people's leisure activities can be impacted by the following aspects: the weather situations, people's transportation preference for leisure, household and individual specific characteristics, and the locations of the destinations.

As discussed above, weather conditions are related to the temperature, the rainfall and the wind level. Only the normal weather is included while the inclement weather is excluded, as in fact, the respondents could rarely suffer inclement weather. The daily max, average, and real-time situations have been recorded in the questionnaires in order to get a more comprehensive understanding.

As for people's choices for transportations, walking, cycling, private car driving and public transportations, are assumed to be the four options for people. It is reasonable to consider whether the weather affects transportation. In any way, transportation is assumed to be an important factor in the following concept model.

Moreover, as the household and individual specific characteristics played a relatively important role in previous studies, we will take people's ages, sex, education, ethnicity, body weight, and income into consideration. All these factors are shown in the concept model below. It is also assumed that people with different characteristic would have different behavior for their leisure activities. We assume that people with a car could possibility travel further for their leisure activities and be less affected by the weather conditions, while people who only have a bike are rarely possible to travel a long distance for leisure, especially in an unfriendly rainy or windy weather.

It is also important to define the results of people's choices for leisure. In this thesis, two aspects will be considered. The first one is the definition of the four kinds of leisure activities and the other aspect is the destinations coordination. In the literature review, it is shown that four different kinds of leisure activities were usually taken into consideration for the previous studies, i.e. shopping (clothing etc.; errands shopping excluded), culture/entertainment/cafe etc., the sports (both indoor and outdoor activities are included), and the nature related activities (parking and watering etc.). The destination coordination represent the x and y coordination in the geographical system on the map. It is the best way to show how the leisure activities are organizing and changing within the Rotterdam area. In this thesis we will specifically calculate how people's choices for leisure activities are distributed and change under different situations (different weather conditions, transportations, individual and household-specific characteristics etc.). It is the best way to discover how the weather affects people's leisure activities. Below is the concept model of this thesis.

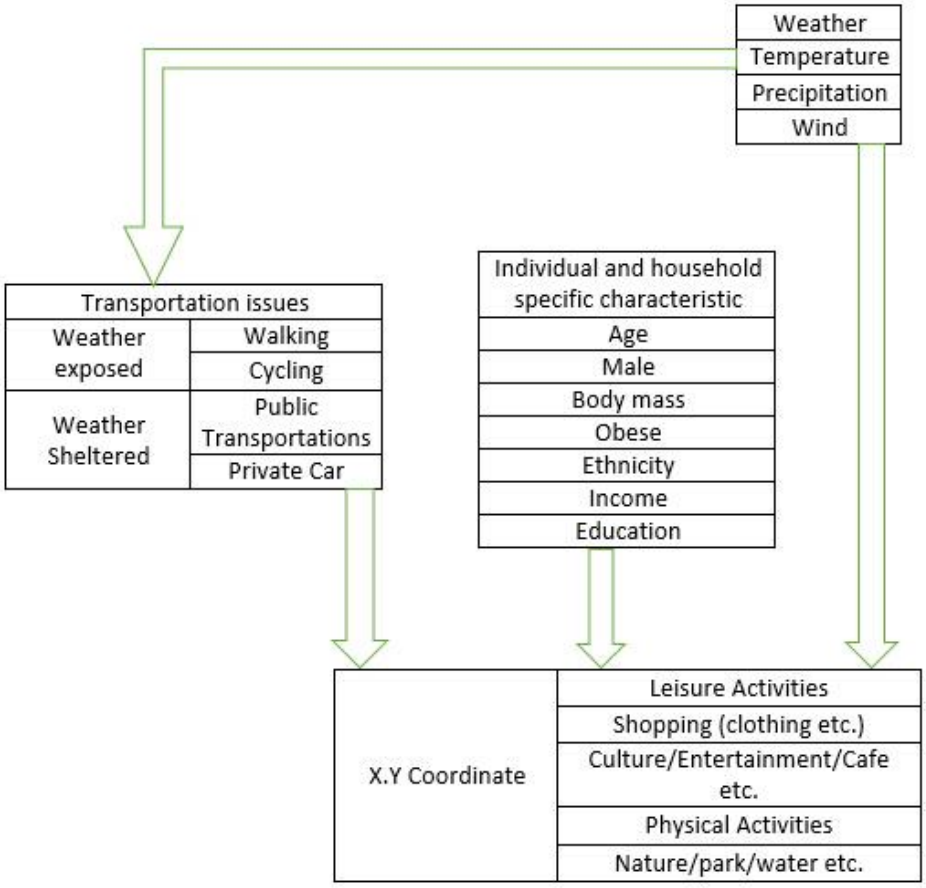

Figure 1: Concept Model

Moreover, in this concept model, the weather influences the leisure activity choices in two ways. Firstly, the weather has a direct influence on people's leisure activities, which means people's preferences for leisure changes when we consider the three different weather factors. Secondly, transportations issues and individual characteristics are acting as 'intermediary's factors', which means that weather would change people's choices for leisure by changing people's preference for transportations first, and on top of that, their individual characteristics also matter.

3.2 Study Area

The study area of this thesis is Rotterdam. This modern city lies in the south-west of the Netherlands and it is the second largest city of this country. It has a municipality population of 618,467 and a metropolitan area of 1,178,953 square meters. Moreover, it is one of the largest international maritime ports in the world.

Starting as a dam constructed in 1270 on the Rotte River, Rotterdam has grown into a major international commercial and cultural center in Western Europe. Also, this seaside city is believed to be one of the most famous and industrialized city with a complete city infrastructure. All the residents could have a chance to enjoy their leisure purposed activities somewhere in and around the city. And of course, all the four kinds of leisure

activities discussed above could be satisfied within this city or not far away from it (Leiden, Hague, or Utrecht are also famous for some leisure activities).

Geography

The geographical center of Rotterdam lies on the south west corner of Netherlands with the coordinates of 51°55'N 4°30'E, which in fact is the location of Noordereiland on the river in the city. Because of the river, Nieuwe Maas, the city is divided into two parts, the northern part and the southern part.

Figure 2: Satellite image of Rotterdam (Screenshot from Google Earth)

Most of the urbanized areas lie within 5 to 7 kilometers both sides of the Nieuwe Maas. Along the river, on the east there is the Port of Rotterdam, while most of the living areas lie on the west side. Out of the city area are villages and the countryside. The Hague and Leiden are not far away to the north-west of the city.

Moreover, as the main research objective of the thesis is to analyze how the people in Rotterdam act in different weather conditions, only people who live in Rotterdam would be considered. In another words, all the starting points of the records are located in the city area. However, the destinations are not all located in the city, 18.2% of the trips are heading to destinations outside the city. These trip records will not be calculated in the mapping process.

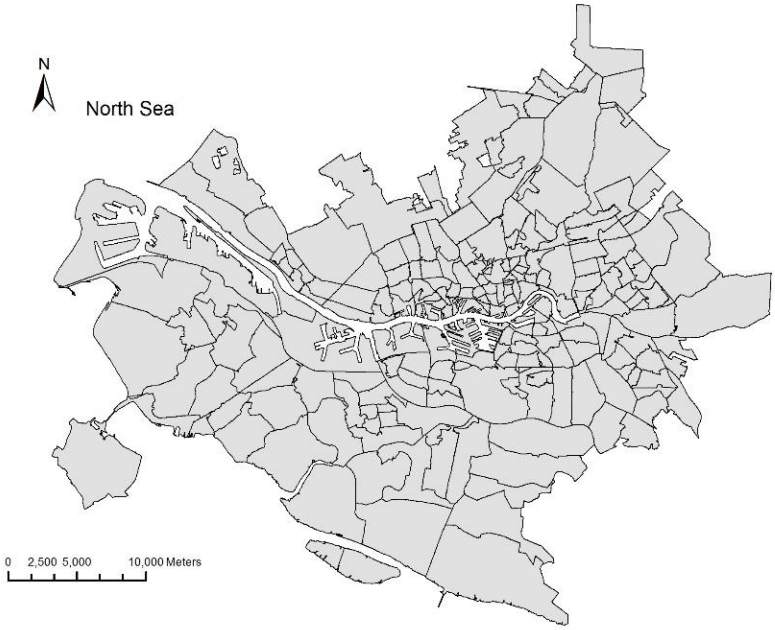

Figure 3: Postal code divisions of Rotterdam

For the starting point of each trip which are provided in the questionnaires, only the postcode is known, instead of the x and y coordinates. Therefore, when considering the starting point of a trip, mapping the postcode area is more realistic than the precise geographical coordination. The map above shows how the different postcode areas are organized in Rotterdam. In fact, while there are 213 different postcode zones in Rotterdam, only 151 of those have more than one respondent in this data base.

Climate

Rotterdam is located next to the North Sea, not far away from the North Atlantic Ocean. When considering the geographic and climatic classification, Rotterdam is classified as a temperate oceanic climate (Koppen climate classification Cfb), similarly to the rest of the Netherlands. Oceanic climates are generally located in mid-latitude countries of most continents. Usually it has a warm but not hot summer and cool but not cold winter. Moreover, it has a relatively narrow annual temperature range.

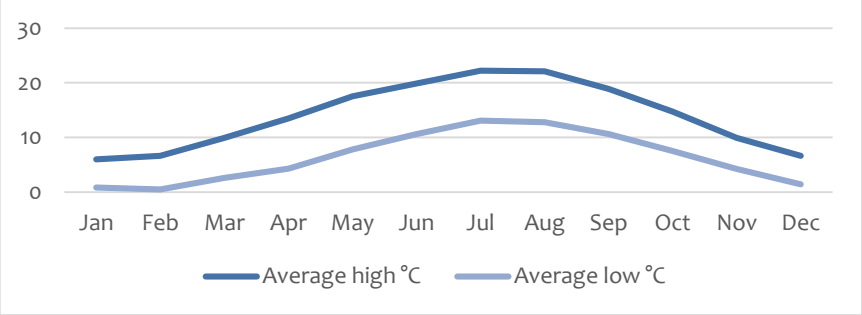

Table 3: Monthly average temperature, high point and low point (Source: Royal Netherlands Meteorological Institute (1981–2010 normals, snowy days normals for 1971–2000))

The monthly average high temperature of Rotterdam reaches the highest point at around 22 °C in July and August, and reaches the lowest point at around 6 °C in January. Meanwhile, the average low temperature presents the same tendency, reaching the highest point at around 13 °C in July and the lowest point at around 0 °C in February. The average low temperature is higher than the freezing point.

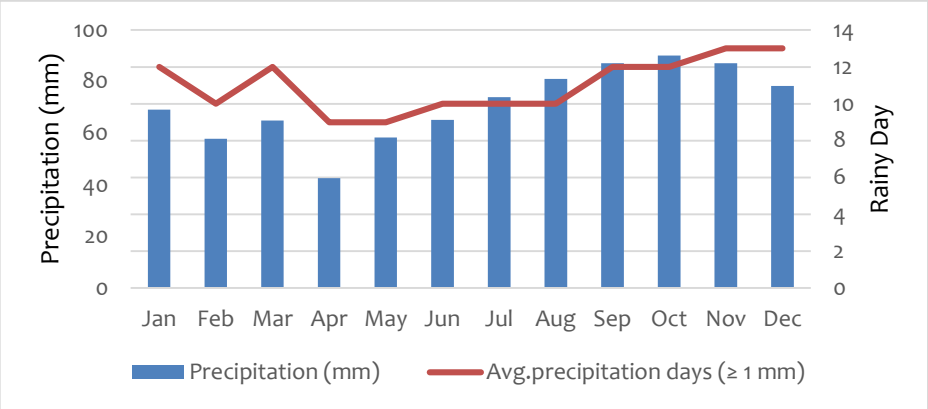

Table 4: Monthly average precipitation and rainy days (Source: Royal Netherlands Meteorological Institute (1981–2010 normals, snowy days normals for 1971–2000))

During the autumn, from September to November, Rotterdam has the largest monthly average precipitation - more than 80 mm each month. During the spring, especially in April, there are the least amount of precipitations, i.e.42.6 mm a month. The precipitation days (rainfall higher than 1 mm) do not vary significantly; most of the months have a more than 10 precipitation days, except April and May. November and December have most precipitation days. During these two months, there is an amount of more than 13 days that has >1 mm rainfalls.

3.3 Data

The data for the research is based on questionnaires that have been issued at the Greater Rotterdam area. 1953 respondents have participated in the survey program, and more than 950 diaries are fully completed. Most of the travelling diaries are digitally recorded into the data base for this research (921 out of 950). All the respondents are selected with the help from an Internet questionnaire agency. Every respondents that participated is older than 18 and all of them are randomly selected from four different types of residential areas in the city, i.e. the inner-city, outer-center, suburban and rural area.

Each respondent had to fill in diaries for each day in a week, and recorded every trip that they made in a single day. Therefore, the number of the questionnaires that have been collected is several times bigger than the number of respondents. In fact, as each respondent recorded at least several diaries for this survey program, as a result, a total number of 13752 records has been collected into the data base for this research.

Variables

Below is the summary of the variables that we have in the questionnaire surveys. Variables names indicate the data that has been provided, and a few explanations are given.

Table 5: Summary of related variables

Category	Variables name	Explains
IDENTIFIER	Respid	Respondent ID
	Dayid	Day ID
	Tripid	Trip ID
	Tripnr	Trip Number
WEATHER	Ta_daily_max	Daily max Temperature
	Ws_daily_avg	Daily average Winds
	Psum_daily_avg	Daily average Precipitation
	Ta_max_class	Class of max Temperature: <0, 0-5, 5-10, 10-15, 15-20, 20-25, 25-30, >30 (^{0}C)
	Psum_class	Class of average Precipitation: 0mm, 0.01-1mm, 1-5mm, 5-10mm, >10mm
	Ws_class	Class of average Winds: 0-2m/s, 2-4m/s, 4-6m/s, 6-8m/s, >8m/s
	Ta_hourly	Hourly Temperature (^{0}C)
	Ws_hourly	Hourly Winds (m/s)
	Psum_hourly	Hourly Precipitation (mm)
DIARY_VARIABLES	Destination	Motivation classified as: home, work/study, shop (errands), shop (clothing etc.), service (bank/hairdresser), someone else's home, culture/entertainment/cafe., sports accommodation, park/water/nature, other, bring/picking up persons.
	Motive	Motivation classified as: work/study, errands (incl grocery shopping), social visits, leisure (incl fun shopping).
	transport mode	Cycling, Walking, Public transport, Car
QUESTIONNAIRE	Age	
	Male	Male or not (1=male/0=female)
	body_mass_index	Body mass Index
	Obese	Obese Person (1=yes/0=no)
	Nonwestern_ethnicity	Ethnicity (1=nonwestern/0=native Dutch)
	hhincome	Income: €2000-€3000, €3000-€4000, >€4000, unknown, <2000
	education	Education: higher, middle, unknown, lower
GEO_VARIABLES	postal_code	Postcode of home
	dest_x	Destination X coordinate
	dest_y	Destination Y coordinate

The variables are sorted into five categories, which are: 1. Identifier: give a serial number of each trips; 2.Weather: details about the three weather conditions; 3.Diary_variables: the motivation of each trips and transportation issues; 4.Questionnaire: the individual and household characteristic; 5.Geo_variables: the locations of home and destinations.

Each respondent could report several related trips. For the individual and householder specific characteristics, the obesity factor is evaluated by the respondents themselves. For the ethnicity, we focus on the nationality in order to distinguish whether the respondent is a native Dutch person or not. Other characteristics are age, sex, body mass, income and

education. Therefore, in this data base, we could find a sufficient diversity for the different background of the respondents.

There are two variable categories to distinguish: what is the motivation of each respondent and what they did at the destinations. The first one is the 'Destination'. There are 11 kinds of motivations: the home, work/study, shopping (errands etc.), shopping (clothing etc.) service (banking/hairdresser etc.), someone else's home, culture/entertainment/cafe etc., sports, nature (park/water etc.), bringing or picking up persons and other undefined activities. In this thesis, 4 of the 11 motivations are regarded as motivations for leisure: i.e. shopping (clothing etc.), culture/entertainment/cafe etc., sports, nature (park/water etc.). Then, the second variable category is 'Motive'. It was divided into four different related groups, i.e. work/study, errands (including grocery shopping and picking up persons), social visits and the leisure activities (including fun shopping). Therefore, when considering leisure activities, there are two ways to distinguish the respondents' motivation.

Summary of Individual and Household Specific Characteristic

As the respondents are randomly selected, the individual and household specific characteristics of the sample are expected to have a similar percentage in contrast with the demographic data. However, to some extent, when comparing with the actual situation, the composition of the sample shows a disparity. Below is the contrast between the sample and demographics.

		Sample	Population*
Age	18-25	7.7%	**12.6%
	26-45	35.3%	28.2%
	46-65	45.6%	27.1%
	66-80	11.0%	10.9%
	>80	0.5%	4.1%
Sex	Male	49.6%	49.2%
	Female	50.4%	50.8%
Obese	Obese	13.5%	-
	NOT Obese	86.5%	-
Ethnicity	Non-Western	9.7%	30.8%
	Native Dutch	90.3%	69.2%
Income	<2000	28.8%	-
	2000-3000	23.5%	-
	3000-4000	22.0%	-
	>4000	10.6%	-
	Unknown	15.1%	-
	Average in Euros		2767
Education	Lower	25.1%	72%
	Middle	37.4%	20%
	Higher	36.9%	8%
	Unknown	0.6%	-

Table 6: Sample composition and representativeness

**Statistic for the Rotterdam Rijnmond COROP region (source: CBS, 2013)*
*** Population aged 15-25*

Both the demographic data and the questionnaire data base are collected in 2013, and in fact, the percentage of each factor of the sample is somehow close to the actual population situation.

As the percentages of people of different ages are based on the total population, the actual percentages of people of different age in demographics should be lower than the percentages of the sample. In fact, both the sample and population column represent a higher amount of middle aged people from 26 to 65 compared to the amount of young people under 25. In addition, the income of the sample matches the overall situation. While the average income of the people living in Rotterdam is around 2767, 23.5% of the respondents hold an income more than 2000 euro and less than 3000. Moreover, 28.8% respondents hold an income less than 2000 euro and 32.6% of respondents have an income more than 3000 euro (22.0%+10.6%). There is a minimal amount of people older than 80 in the sample and demographics.

However, the ethnicity data is somehow different from the general situation. The sample has a much higher native Dutch people while the demographics shows that there should have more non-western people living in the great Rotterdam region. This difference could be ignored if we assume that the ethnicity is not an important factor to make people different in such an international modern city. For the education part, the sample represents a much higher percentage for the higher educated group, while there are only 8% of people who have the same education level as in the general demographics. However, it is reasonable that higher educated people are much keener to fill out an Internet survey.

Totally, even though in terms of ethnicity and education the sample shows a disparity when compared to the general demographics, still, the age, sex, and income have similar results with the general situations. Therefore, it can be concludes that the data base is reliable and representative for the research.

		Sample
Car	0	17.8%
	1	49.6%
	>2	32.7%
Bicycle	No	10.0%
	Yes	90.0%
Public Trans Card	No	66.1%
	Yes	33.9%

Table 7: Vehicle ownership and public transportation accessibility

Furthermore, for the transportations, most of the respondents have more than one car in their family, and nearly half of the people have just one car. Then, most of the Dutch people have a bicycle (more than 90%), which is normal for the Netherlands. However, only 33.9%

of the respondents have a Public Transportation Card while the other 66.1% do not have one. This can be regarded as underrepresented.

3.3 Methods

In order to achieve the objectives to show how the previous different variables affect individuals' leisure activities, there should be two steps to analyze the influences. First step is to make charts and graphs to analyze and illustrate how much the percentages of different leisure activities would be changed in different situations. After that, the second step is to visualize the different cluster areas on the map of Rotterdam. If dominant leisure places exist, there would be a comparison between the results, analyzing the differences and conclusions.

Statistical analysis

This part will analyze the influence of the weather on the leisure activities by using charts and tables. We considered both the total amount and the percentage of different activities that people would take part for different temperature, wind, and the precipitation. More specifically, the leisure motivation is also separated into four kinds of activities, i.e. the shopping, culture/entertainment, physical activities and nature/park/water activities etc. This way, it can give us an overview to what extent the weather influences the different leisure activities. Not only the influences between the weather and leisure activities, the transportation and the individual specific characteristic would also be considered.

Geocoding and mapping

A large number of spatial analysis tools could be used in order to get an understanding of the point patterns located on the map. The most promising tool for the geographical distribution is the Kernel Density Estimation (Chainey S 2005, Sabel C. 2006). This estimation would also be applied in this thesis.

There are two reasons why this estimation is more suitable. Firstly, the Kernel Density Estimation depends on the locations of each existing points on the map, and then draws a scale where there could be a higher probability for a specific phenomenon to occur again. For example, when researchers want to analyze the risk of a transport accident in a city, the Kernel Density Estimation is preferred to be used because it could give the researcher an area where there could be causes for these accidents to happen. This could be a guideline for the research to start next steps and find out the causes. For the same reasons, Kernel Density Estimation is also used for some topics which are related to crime, industry development, and retail store locations, etc. Secondly, by using this tool, it is easy to give an arbitrary spatial distribution map of the whole area. Therefore, by calculating the records in the geographical system, finding out the dominant area and mapping it on a map would be convenient for both the researcher and the reader to understand the situation in a short time.

Formula and Algorithms

The Kernel Density Estimation works by building a calculated model for each point on the map. Firstly, given an exactly bandwidth, the coverage radius could be regulated. After that, it evaluates how many events lie within the coverage radius of each point, and calculates the distance from each event to the center by using the mathematical formula below:

$$f(x, y) = \frac{1}{nh^2} \sum_{i=1}^{n} K \begin{pmatrix} d_i \\ h \end{pmatrix}$$

In this formula, *f(x, y)* is the result of the density estimation for each (x, y) point on the map. Specifically, n means how many points are in the coverage radius; h is the radius of the kernel density; and K is a function of this estimation. At last, d_i is the distance between the location (x, y) and the other observations in the kernel circle. Therefore, after a systematical calculating (repeat the formula for each point in successive), every point on the map could have a value. After that, the density map could offer an opportunity for us to observe the differences about the value for each point (x, y) on the map and then classify the point into different groups (or colors). Finally, the distributions of the calculated values of each point could be visualized on the map.

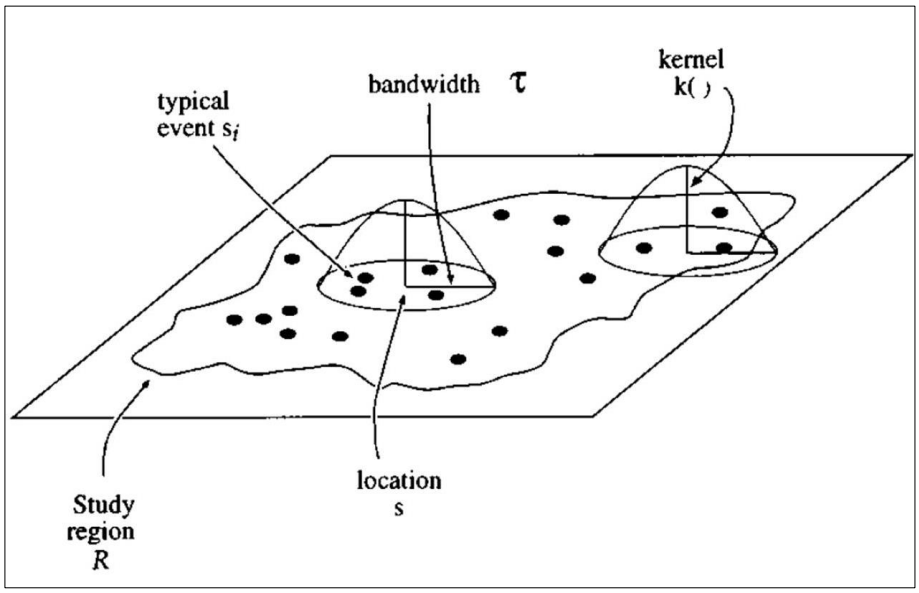

Figure 4. Kernel estimation of a point pattern (source: Bailey and Gatrell, 1995)

From the figure above, it is understandable that the bandwidth could be an important factor that affects the resulting distribution map. The bandwidth affects the radius of the observation area and determines how many observation could be located in the circle, and then, the results will influence the value of every point (x, y). However, it is also acceptable that if the bandwidth lies within a relatively reasonable range, the result will not have a big difference if the aim is searching the dominant spaces. The place where people mostly go for leisure activities will still be easily recognized, because the center of the highest density will not change. In order for that to happen, after considering the scale of the great

Rotterdam area and the sufficient data base, in this master thesis, we set the bandwidth to be 2000m. This bandwidth will make the scope of dominant place in the resulting density map easy to recognize. More specifically, in the Kernel Density running process, the output cell size is 30 m, which could make the maps meticulous and precise enough.

4. Analysis

4.1 Weather effects on Leisure activities

When considering about people's choices for leisure, there are two aspects would been taken into consideration. The first step is to consider the totally amount of the leisure trips that has been made. It will explain people's preference for all these four kinds of leisure activities in different weather conditions. However, the changing curve of totally trips number does not make sense as it does largely depends on the records that has been made. Thus, the second step is needed because of that. This step is to analyze the changing of the percentage of the four different leisure activities in different weather conditions. More specifically, in this step, both the hourly weather conditions and the daily classified average weather conditions would be considered. It is because that hourly weather is expected to affect people's behavior more, rather than the daily average weather. But it can also matters for a comprehensive consideration.

Temperatures influences

From the figure 5, the totally number of leisure trips that have been made in different temperatures follow the trends that each kinds of leisure activities has the largest numbers of recorders among 5 ^{0C} to 25 ^{0}C. Too cold or too hot temperature will prevent people from doing leisure activities. However, it doesn't means that people prefer to go for a leisure activity in this temperature scope, in fact, it means that most of the recorders were recorded among 5 ^{0C} to 25 ^{0}C.

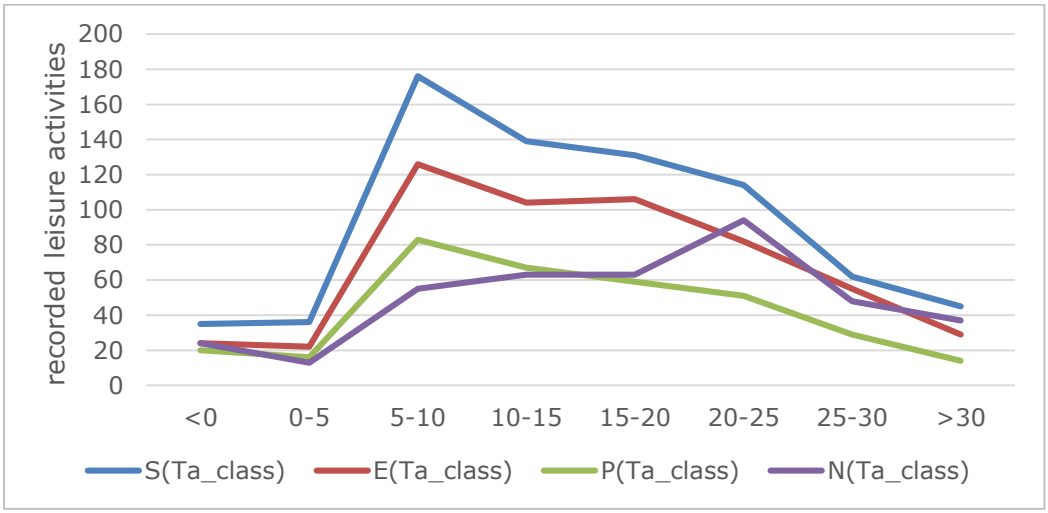

Figure 5: Totally amount of recorded leisure activities in different temperature. (S: shopping, clothing etc.; E: entertainment/culture/cafe etc.; P: physical activities/sports; N: park/water/nature etc.)

However, as it is shown in this figure, it can still conclude that before around 15 ^{0}C, there are more people prefer to go for physical activities and sports rather than the park/water/nature. However, when it is hotter than 15 ^{0}C, more people are willing to go outside for a nature relax. Moreover, when it is hotter than around 5 ^{0}C to 10 ^{0}C, each kinds

of leisure activities are all keep decreasing except for the nature related trips. Then, around 20 °C to 25 °C, the nature leisure activities become more popular than the culture entertainment related activities. After that, nature related activities also turn to decrease, which could be the result of the decreasing records.

Moreover, under any circumstances, shopping has the largest amount of records among all the four kinds of leisure activities. Culture and entertainment related activities could be regarded as the second popular. And when it is colder than 15 °C, nature place is the last option people want to go and when it is hotter than that, sports related leisure is the activities people do not want to go most.

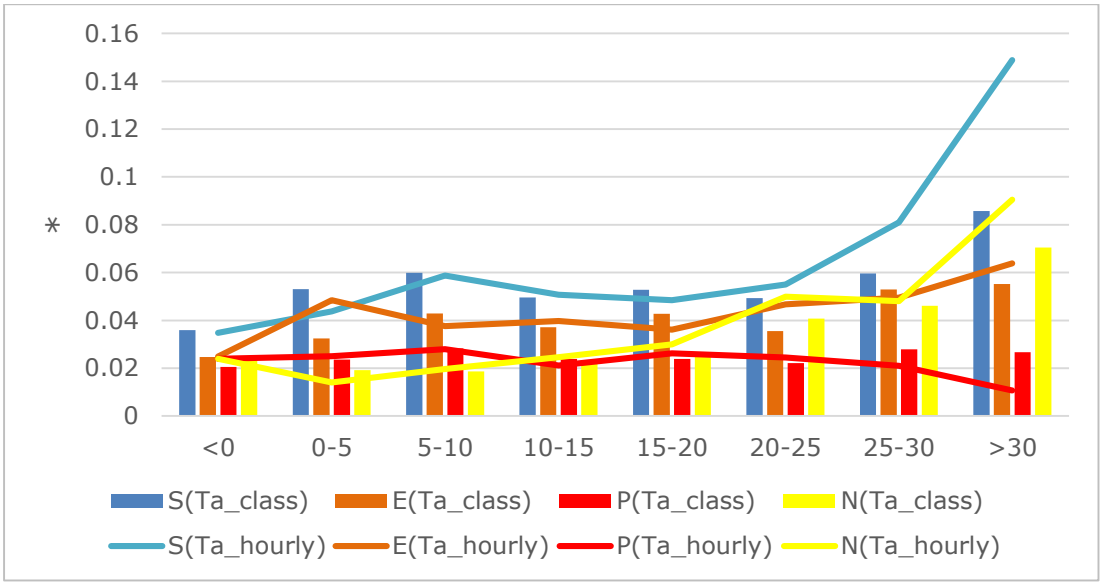

Figure 6: Percentage of leisure activities in different temperature. (S: shopping, clothing etc.; E: entertainment/culture/cafe/etc.; P: physical activities/sports; N: park/water/nature)

**percentage = amount of each leisure activities / amount of totally trip records*

Sum up, it can conclude from the figure 5 that nature activities would increase when temperature raise. Moreover, in figure 6, it shows that, not only the nature activities will raise when temperature raise, but also the shopping related and culture & entertainment related activities. When considering about the how much percentage each activities could reach when it is hotter in figure 6, the shopping would be the most popular one, which means that while it is hotter, the weather make most of the people go shopping rather than the other activities. And that is the same for the culture & entertainment related activities. Even though in figure 5 people would have less activities when it start getting hotter, in figure 6 the culture & entertainment related activities could still be the preference of people as they has less willing to go outside and do something for leisure.

In contrast, physical activities would not be the last choices for most people when it is getting hotter. Among all the activities in figure 6, the percentage of recorded physical activities start to decrease when it is warmer than around 20 °C, and the totally percentage is largely lower than the percentage of the other three leisure activities.

Precipitation influences

As precipitation is expected to have more influences on each persons, as the drops would directly contact the human body if they are at outdoor and weather exposed. Moreover, the two figures below has approved the assumption in the previous studies that precipitation could have negative effects on all of the leisure activities, especially for the possibly outdoor activities.

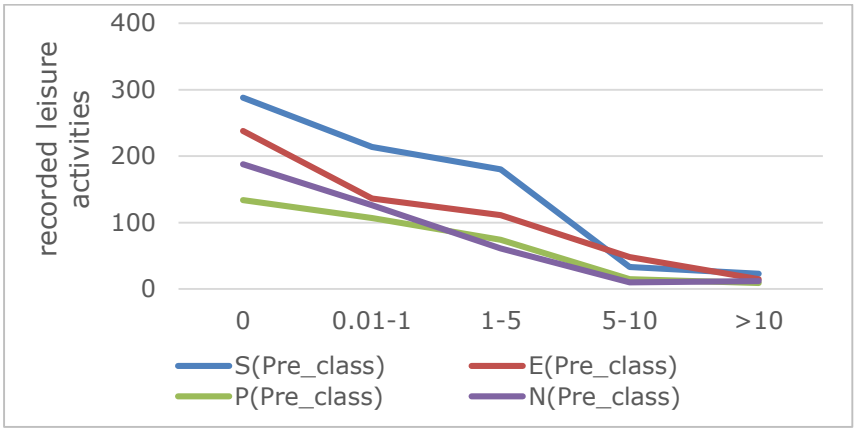

Figure 7: Totally amount of recorded leisure activities in different precipitation classes. (Pre_class: precipitations class; S: shopping, clothing etc.; E: entertainment/culture/cafe etc.; P: physical activities/sports; N: park/water/nature etc.)

It has shown that if there is no drops, all the four kinds of leisure activities would have the largest amount of trip records. And once there the rain comes, from the range "0.01 – 1 mm" to the range ">10 mm", the records of leisure activities would decrease when the precipitations is increasing. No more than 50 records could be found for each kinds of leisure activities when the precipitation is more than 5~10 mm.

However, among all the four kinds of leisure activities, shopping is still the most popular leisure activity in every conditions.

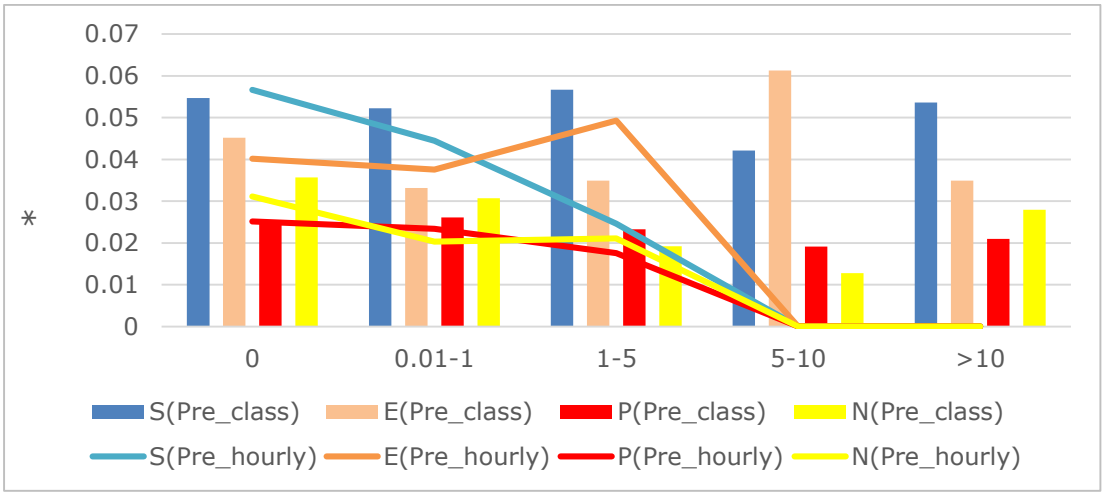

Figure 8: Percentage of leisure activities in different precipitations situations (mm). (Pre_class: precipitations class; Pre_hourly: hourly precipitations)

**percentage = amount of each leisure activities / amount of totally trip records*

Firstly, contrast with the precipitation class records, the hourly precipitation is much "sensitive" to the weather. It means that when the precipitations is larger than 5 mm, the "Pre_class" categories still have a relatively high amount of records, but the "hourly precipitations" curve has already reach zero. Therefore, as the precipitation is approved to have negative effects, it is reasonable to conclude that when people make decisions about trips, people are more likely to care about the instant weather. In another word, it is actually the hourly precipitation that prevent people from doing leisure activities, rather than the daily average precipitation conditions.

Secondly, there is a trend that if the precipitations increase, the percentage of each kinds of leisure activities would decrease. Only the culture & entertainment related activities meet a nearly 1.2% incensement among the range 5-10 mm. However, there is not large amount of decreases until the hourly precipitation reach around 5mm.

Sum up, it can conclude that precipitation has a negative effects for most of the leisure activities, and when the precipitation is less than 5 mm, the negative effects is not apparently. However, once if the precipitations is more than 5mm, there would meet a great decrease for the participation of the leisure activities.

Winds influences

Considering about how winds affects the leisure activities, the figure 9 shows that negative effects or positive effects is not clear, but there is "threshold" of the wind speed that people are more prefer for leisure.

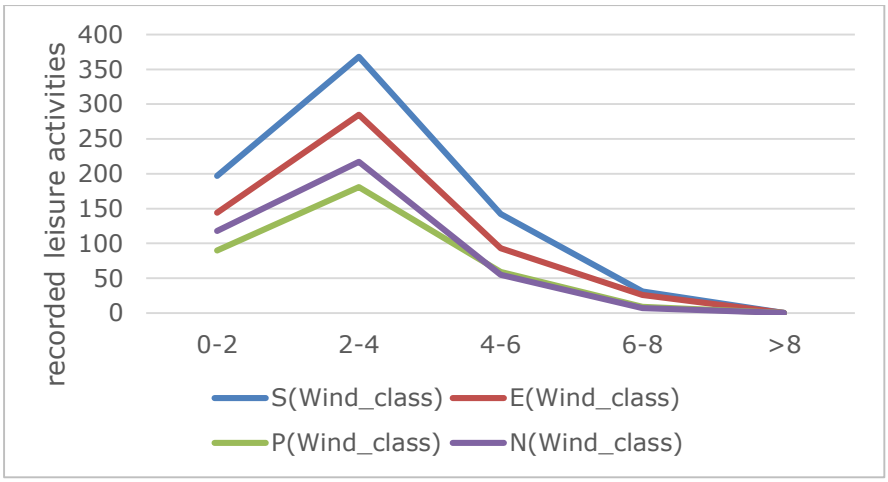

Figure 9: Totally amount of recorded leisure activities in different wind classes (m/s). (Wind_class: classified wind speed; S: shopping, clothing etc.; E: entertainment/culture/ cafe etc.; P: physical activities/sports; N: park/water/nature etc.)

In fact, the influences from the wind to the leisure activities is not just positive of negative, when the wind speed is lower than around 2-4 m/s, the curve represent a positive effects from the wind to the leisure activities. There is more people who go for leisure under a 2~4 mm wind then the people who go leisure under 0~2 mm wind. However, when the wind

speed is more than 2~4 mm, the higher wind speed it is, the less leisure activities records could be found.

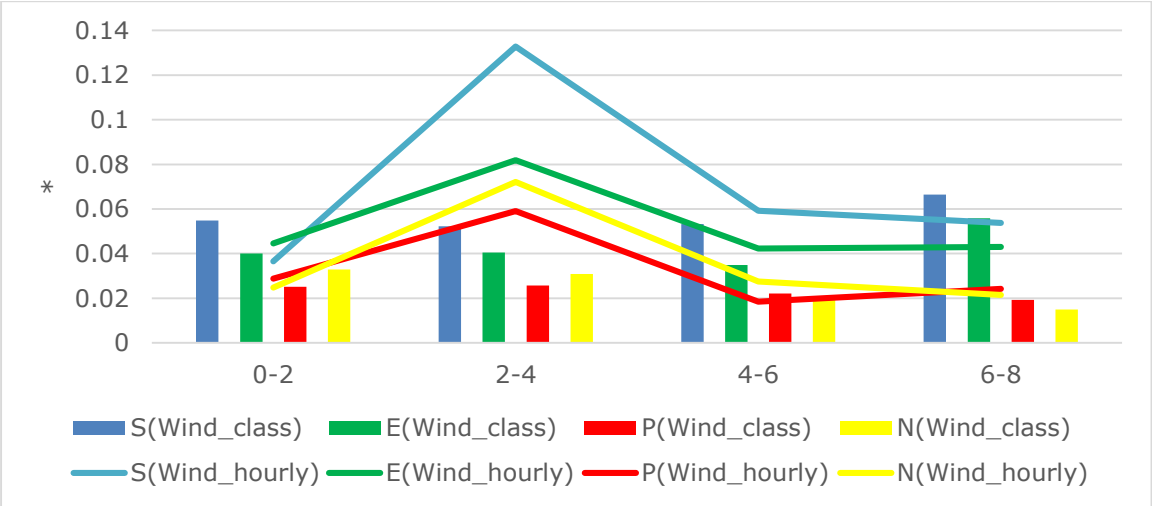

Figure 10: Percentage of recorded leisure activities in different wind speed (m/s). (Wind_class: classified average winds; wind_hourly: hourly wind speed).

**percentage = amount of each leisure activities / amount of totally trip records*

Considering about the changes of the percentage of each activities in different wind speed, there exists the same trends with the previous figure.

In one aspect, the hourly winds matters. When the people are on the trips to the destination, if the hourly winds speed is lower than around 2~4 m/s, the higher speed, the more possibility the people would choose for a leisure trips. However, when the wind is higher than around 2~4 m/s, the higher wind speed would prevent the respondents from doing leisure activities.

In the other aspect, daily wind never matters for the participants of each leisure activities as there are not big changes when the daily wind class increase. Therefore, same as the precipitation, when there comes a windy day, the people only care about the instant weather when they were planning to go outside for leisure. And people are more prefer to go for leisure only when the instant weather conditions are suitable. As it is shown in this figure 10, the suitable wind speed is around 2 – 4 m/s.

In conclusion, firstly, for the temperature, when the temperature is among the range 5- 25 °C, there would be a larger amount of leisure records. If the temperature is lower than 5 °C or higher than 25 °C, the temperature will make people have less interest for the leisure activities. And for the percentage of each leisure activities, shopping is most popular leisure activity for all the time. And temperature has a positive effects for people to join a leisure activities, except for the physical activities. Secondly, precipitations have negative effects for each leisure activities, and the respondents are more sensitive to the instant precipitation situation rather than the daily average weather conditions. Thirdly, for the wind speed, there is a threshold around 3 m/s. below the 3m/s, there is a positive effect from the winds to the leisure activities, and above the 3 m/s, the influences become

negative. Higher winds speed make the people less likely to go for a leisure activities. And moreover, among all the four kinds of leisure activities, shopping is always the first option when people want to have leisure time, and physical activities are usually the last choice of people for leisure.

4.2 Leisure Activities Destination Map

Leisure Destinations

Destination map shows that how the different leisure activities distribute on the map. And more specifically, by using the Kernel density map, it can easily find out what are the differences between each kinds of leisure activities. The four maps below show the locations of shopping, culture/entertainment, physical activities and natures, respectively. Only the trip records with x, y coordinators would be displayed.

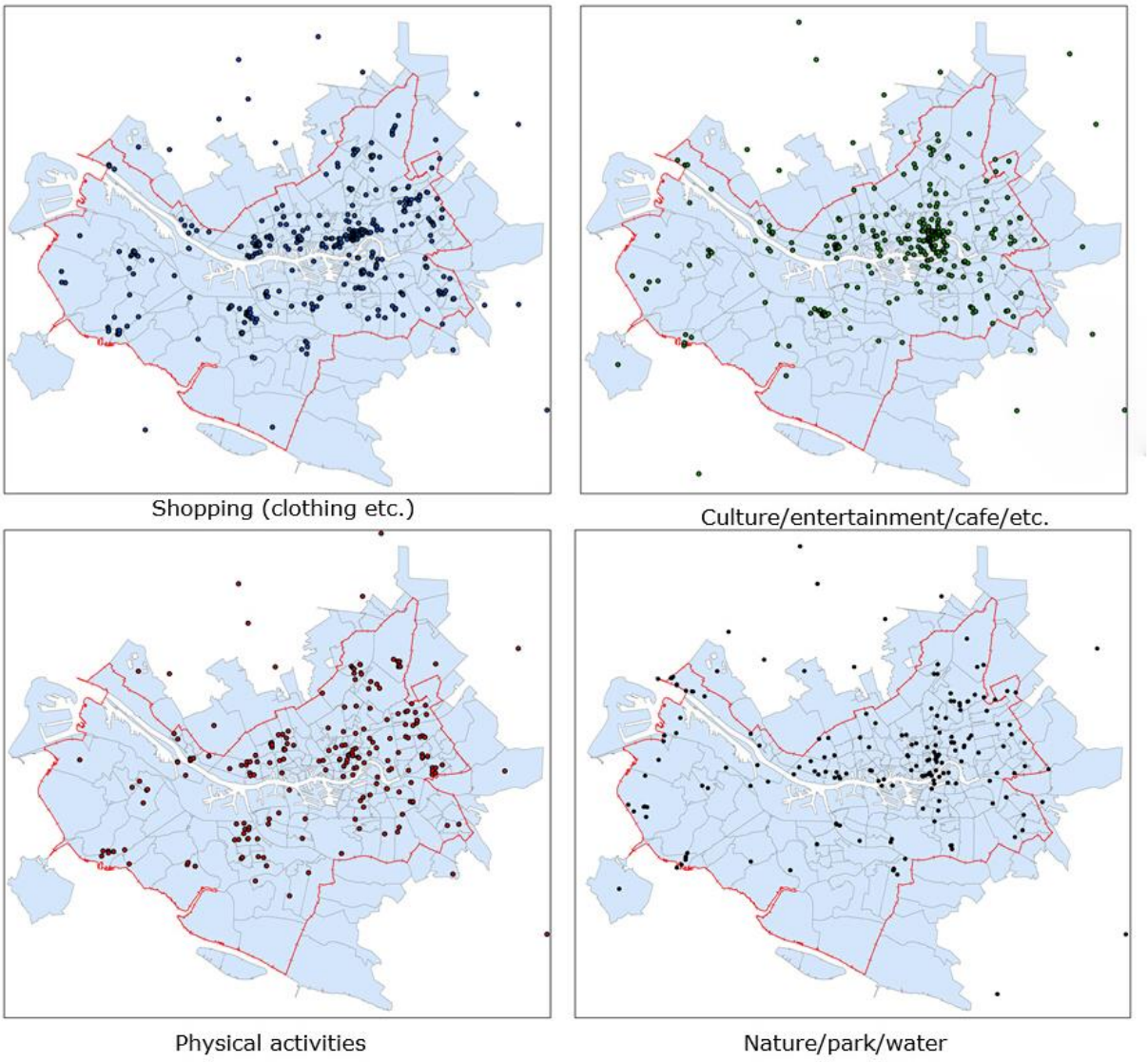

Figure 11: Distribution of locations of leisure activities.

Few conclusions could be made from the map above:

Firstly, it can easily find out that shopping has the largest amount of records in totally (721 records). And secondly is the culture and entertainment related activities (536 records). Both of these two kinds of leisure activities have a big range of possible destinations on the map. Physical activities and sports is the third category that it also has a wide range of destinations on the map, but the amount decreased (335 records). At last, the Nature/park/water has the minimal amount (306 records). This shows how popular each kind of leisure is among the respondents.

Secondly, turning back to the map, even though the shopping and entertainment have similar distributions maps, in detail, there could still find some differences among them. The figure below would show the differences in details.

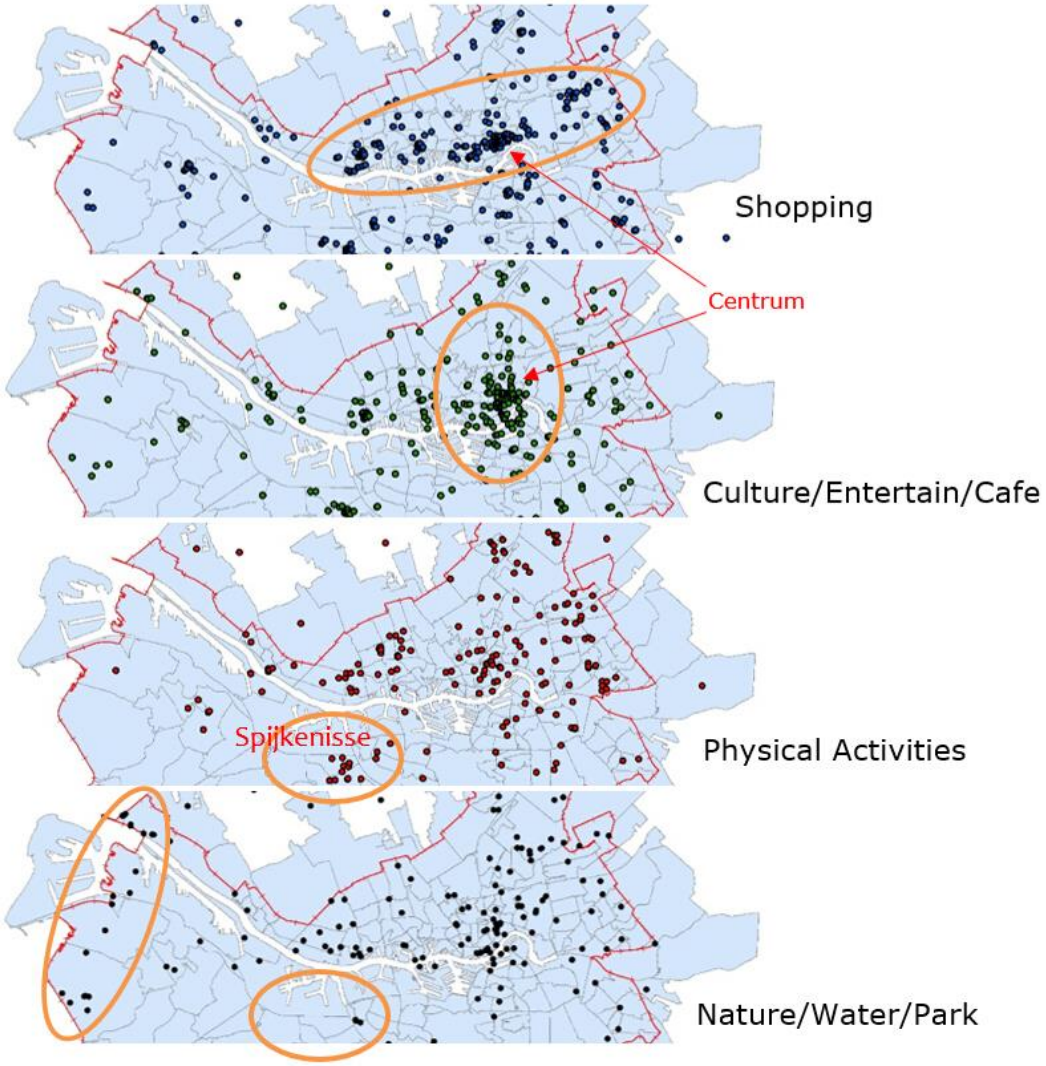

Figure 12: Comparison of distribution maps for different leisure activities

For the shopping and culture & entertainment, along the city center and river, there has an aggression of the destinations where people would go for leisure. But the destinations of these two kinds of leisure activities are different. While the leisure activities are more likely

to locate along the river, from the west to the ease, the destinations of culture & entertainment are more centralized because most of the destinations are more likely to locate around the Centrum.

Moreover, considering about the physical activities, it shows similar popular destinations on the map. However, the amount of the totally number of trips decreased a lot. When contrast with the nature related nature activities, the differences could be found on the distribution map. For the nature/water/park, it shows that few nature related leisure activities records could be found on the beach at the west of Rotterdam. But it is also reasonable that because of the beach, the Hook of Holland could easily became a popular destination for nature relax. However, nature related records show that there is a place where respondents would not go for leisure is Spijkenis, while for the previous three kind of leisure activities, Spijkenis is one of the dominant places for leisure purposed activities.

Kernel Density map

Moreover, the map below shows how frequently a destination would be arrived, by using kernel density analysis tool. Area with a shadow means the record density is more than 1.5. And the darker the scope, the higher the density it is.

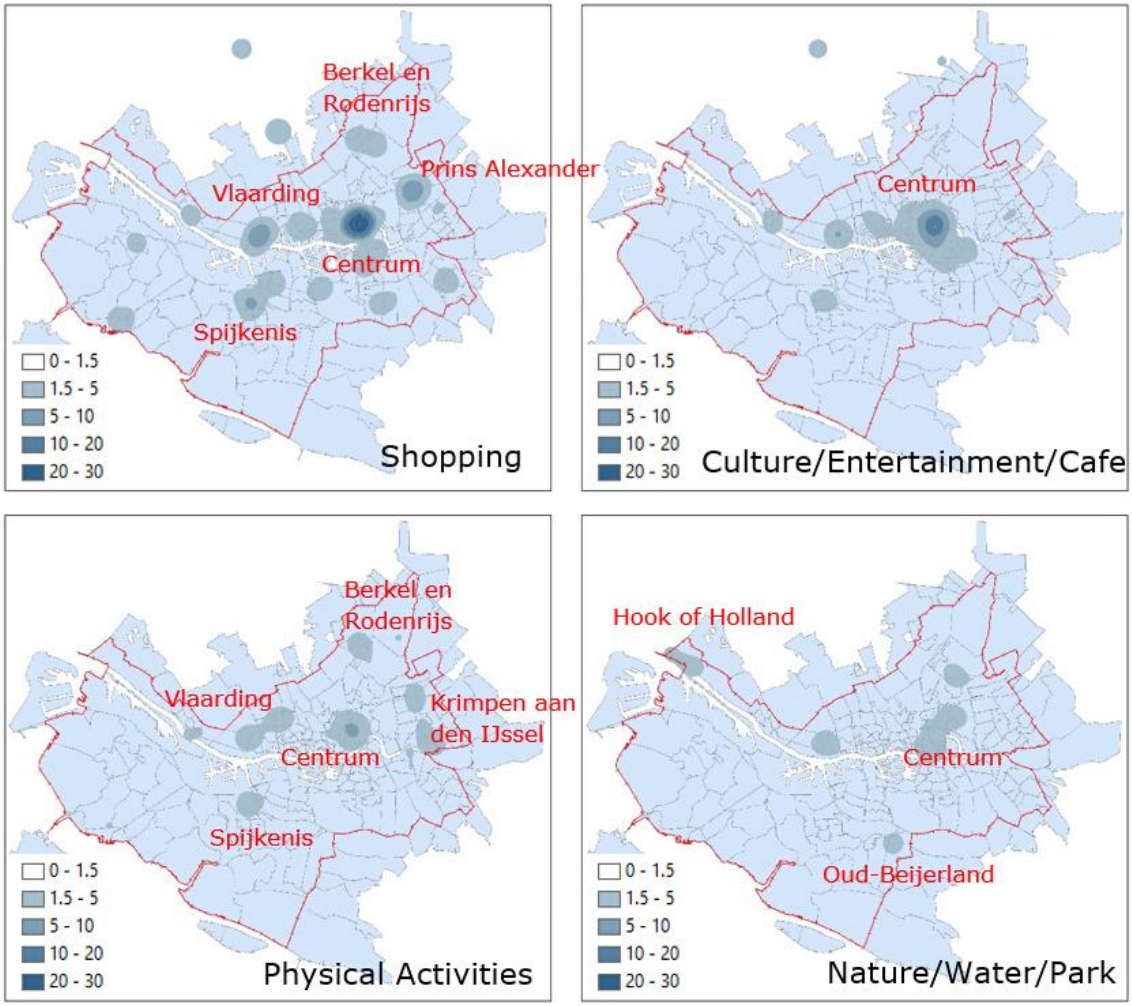

Figure 13: Kernel Density evaluation of each leisure activities

The density of each circle means how many destinations could be found within a circle of 2 kilometers. And the density has been classified into five categories, <1.5, 1.5~5, 5~10, 10-20, >20. Therefore, the darker area means that there is more records could been found around.

For the shopping activities, it has the darkest area on the map, followed by the culture and entertainment activities. Both of this two kind of activities have a "5~10" class area. However, the most popular area are both located at the Centrum. The map of shopping area shown there are other two places named Vlaarding and Berkel en Rodenrijs, respectively, where the density is more than 5. Moreover, for shopping, the density of the Centrum can reach ">20", while for the culture and entertainment, the highest density of the popular leisure places is only 10~20. More specifically, the density map of the culture & entertainment represent a much more centralized trend that only the Centrum could have a higher density than 1.5.

In addition, when make contrast between the physical activities and the nature/park/water, the physical activities are more popular than the nature activities, and also, the resulting dominant places are different. The map of physical activities shows that at the Centrum there could have more than 5 leisure destinations located around. However, the other places except the Centrum could not reach a density higher than 1.5. More specifically, the other place where could have a density higher than 1.5 are the Oud-Beijerland, Vlaarding, Berkel en Rodenrijs and Krimpen aan den Ijssel. Moreover, for the culture & nature related leisure activities, there has popular destination where only the people who want to experience nature leisure activities want to go, while the other three do not. That is beach at the west side of the river near the sea, called the Hook of Holland. Few records has been found around the beach.

Sum up, it can concluded that shopping activities still rank the first option for people to spend leisure time, and the locations of the popular places are relatively equilibrium located at every corner near the center. Once people want to do shopping, it could more easily for them to find a shop, supermarket or mall to buy something and do not have to travel a lot. And for the culture & entertainment related activities, the available options are too much centralized that most of the records are found just near the Centrum. People do not have a lot place to go if there are desires to experience culture, entertainment or even drink a cafe. For the physical activities, even though much less records could be found in contrast with the previous two kind of leisure activities, there are more popular places for physical activities than the culture & entertainment. Not only the Centrum could be a dominant place for sports, but also there are other six places where respondents went frequently. At last, for the nature/water/park, as it can regarded as special requirement from people, therefore, only four places could find a density higher than 1.5. Except for the Centrum, Hook of Holland became the most popular place, it is reasonable and acceptable for the residents living in the city.

Dominant Leisure places

As one of the objectives of this thesis is to find out if there are some dominant places for people to have leisure time, therefore, in this part, all the previous four Kernel

density maps would put together in order to find out if the dominant places exist and where they can spend at least 3 kinds of leisure activities.

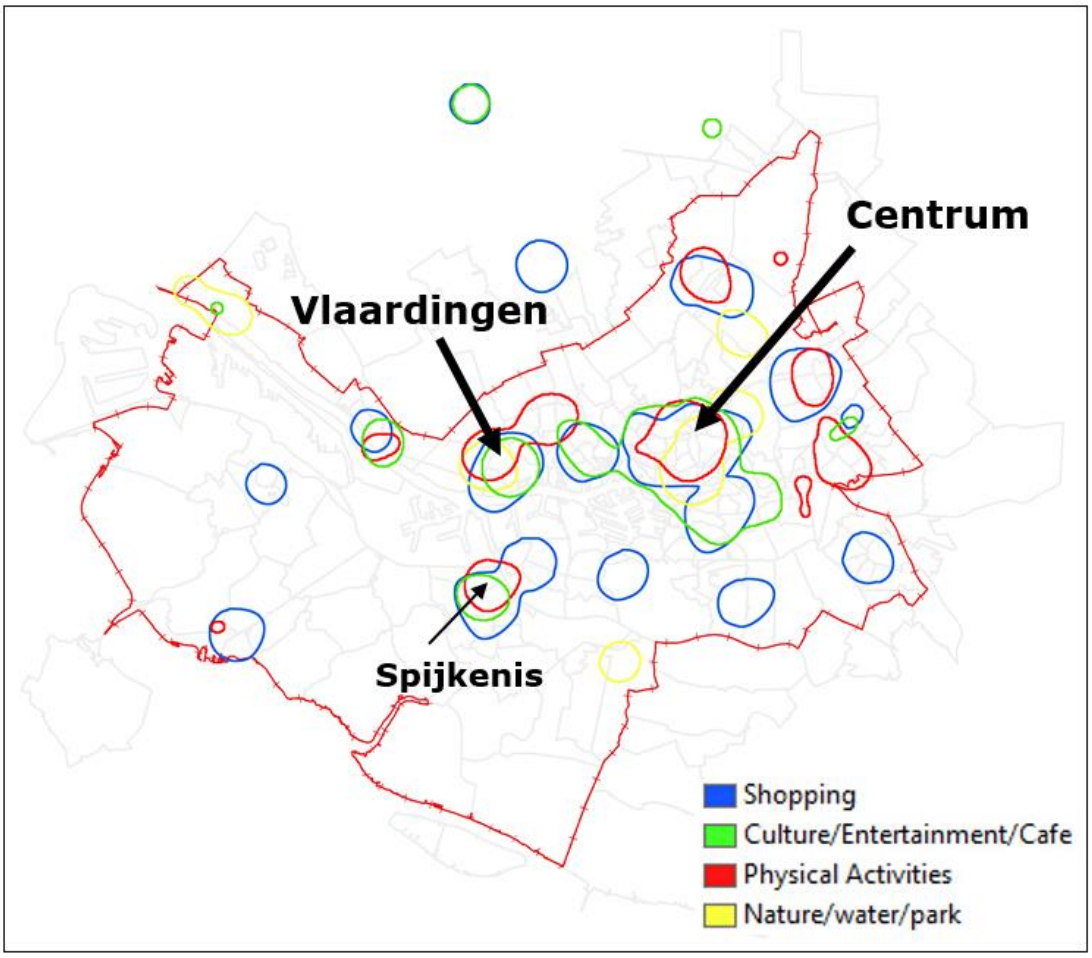

Figure 14: Dominant destinations for leisure activities

The map above shows that how the different kinds of leisure activities located together on the map. The blue circles means that in this area, the Kernel density of shopping activities is higher than 1.5, and moreover, the green area is indicated to the culture/entertainment activates, the red is physical activities, and the yellow is nature, water and park activities.

Therefore, if dominant leisure places are defined as the place where all the four leisure desires could be satisfied, then, the Vlaardingen and Centrum are the two places. These two places lie at the cross area of all the four leisure types, and Centrum has a bigger area than the Vlaardingen area. Moreover, at Spijkenis, there represent an overlap for the shopping, culture & entertainment, and physical activities. Spijkenis can be regarded as the third dominant leisure place at Rotterdam.

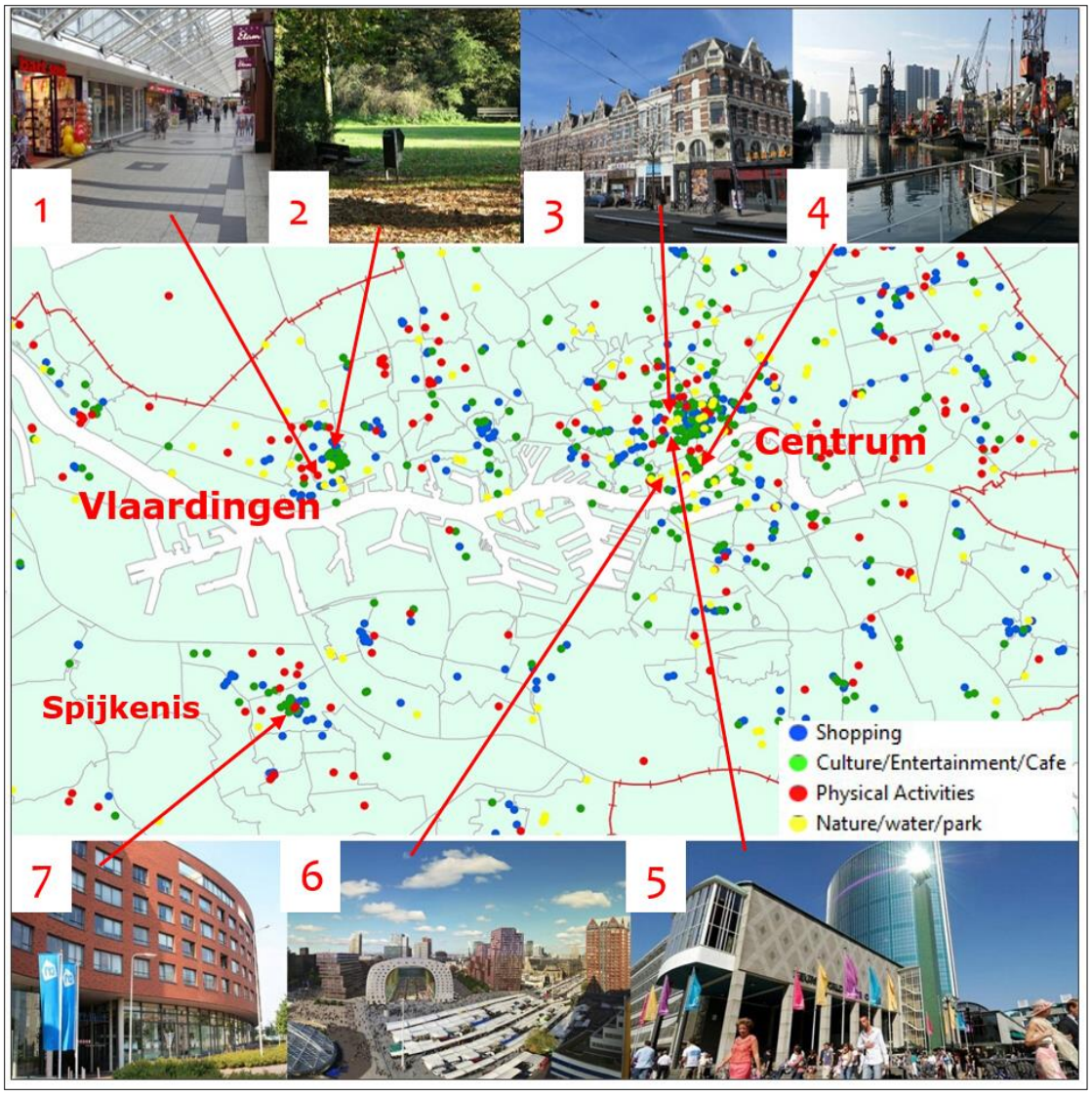

Figure 15: Possible leisure attraction at dominant leisure places

(1: Centrum Vlaardingen, 2:'t Hof park, 3: Shopping District West-Kruiskade, 4: Maritiem Museum Rotterdam, 5: Beurs World Trade Center Rotterdam, 6: Blaak Markt, 7: City Plaza Spijkenis)

The figure above shows the possible leisure attractions for Rotterdam people, other than the tourist people, as the tourist people are more expected to go for the shopping malls or museums. The most influential shopping mall are located at the Centrum. The Beurs World Trade Center, Shopping District West-Kruiskade and even the Blaak Markt. All of these places have a high reputation for both the residents and the tourists. There is a lot museums located at the Centrum, for instance the Maritiem Museum. Moreover, the reasons why Vlaardingen and Spijkenis became a popular leisure destinations is that both of these two areas have a city plaza or centrum mall. For the Spijkenis, it is the City Plaza, and for the Vlaardingen, it is the Centrum Vlaardingen. In addition, there is a big park named the 't Hof located at Vlaardingen. Possibility, it could be a suitable place for people to have physical activities and nature or entertainment related activities there.

Traveling map of the five areas with most respondents

While there are more than 900 people join the questionnaires, not all the questionnaires are fully completed. There is only 844 people who has more than one record with a postcode and x & y coordination in it. All these 844 people are coming from 151 post code areas (there are 213 postcode areas in Rotterdam totally), and the top five areas where have most completed questionnaires are the postcode zone: '3011', '3131', '2661', 2651', and '3181'.

Postcode	Location	Total number
3011	Stadsdriehoek	27
3131	Vlaardingen	25
2661	Bergschenhoek	24
2651	Berkel en Rodenrijs	23
3181	Rozenburg	21

Table 8: Top 5 postcode areas where have the most completed questionnaires.

The Map below shows the traveling records that come from the top five areas. Each area has been given a different color. However, here we don't take travelling route into consideration, and only take the start point (home) and the destinations into considerations. The x and y coordination of the start point is not shown, but the destinations are shown. Records from different areas are separated by using different colors. More specifically, three of the areas are located near the river, which are the Stadsdriehoek (the Centrum), Vlaardingen, and the Rozenburg, and the other two areas are Bergschenhoek, and Berkel en Rodenrijs, which are both located in the north-east of Rotterdam.

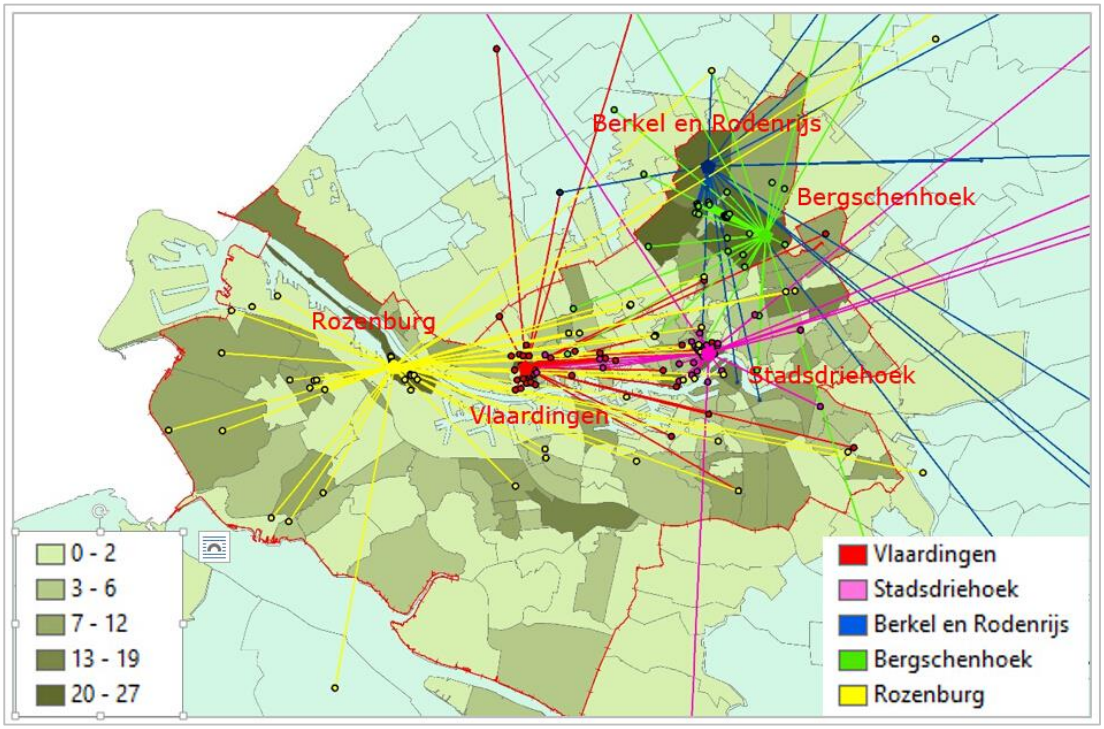

Figure 16: Leisure travelling map of the five areas with most completed records.

As it is shown on the map above, firstly, for the people living in Rozenburg, part of the people are prefer to have leisure activities just in Rozenburg, and the rest people still have the most frequently records travelling to the other places in Rotterdam. Among these people travelling outside the neighbourhood, most of them prefer to travel to the west of Rotterdam near the beach. Secondly, for the people who living in Vlaardingen and Bergschenhoek, they share the same feature that most of them do not travel a long distance from the start points. It means that people in these areas are more prefer to have leisure activities just around the neighbourhood. Thirdly, for people living at Stadsdriehoek, they have the most records that travel outside Rotterdam, and at the same time, there are a lot of records located near the Centrum, not far away from home. At last, how people live in Berkel en Rodenrijs acting for their leisure activities is not apparently, there are a few records between Berkel en Rodenrijs and Bergschenhoek, and also there are few records that travelling to some destinations outside Rotterdam.

4.3 Transportation Matters, or not

In order to analysis the connection between the leisure activities and the possible factors: transportation and weather, there should be an assumption that how transportations matters within the influencing system from the weather to the leisure activities. Firstly, it is possible that weather could apparently affect the transportations, and then affect the leisure activities, as the people are possibly to go different places for leisure by using different transportations. In this way, weather affect leisure activities by changing the transportations preferences first. The second possible situation is that weather will not affect the transportations a lot, and instead, weather will affect respondents' leisure activities directly.

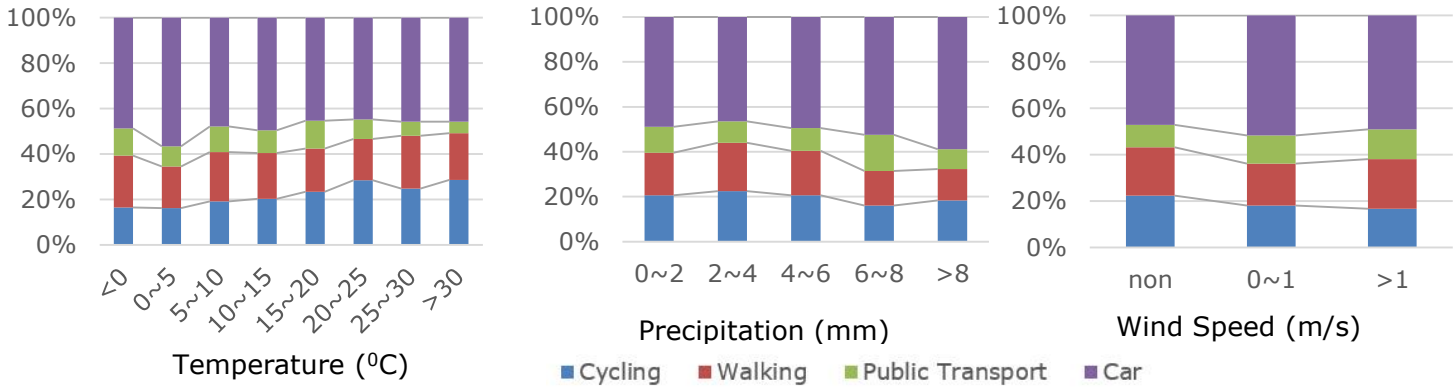

Table 9: Percentage of different transportations people use for leisure activities in different temperature, wind, and precipitation conditions*.

**percentage = leisure trips by using each transportations / totally amount of leisure trips*

Note that the data in the Table above is based on the people who already choose leisure as their trips motivations, therefore the results are different from the figures in paragraph 4.1. And then, from the Table above, it can conclude that, to some extent, weather's influences on people's preferences for transportations are not strong. The last option to

find a possible link is that when temperature raise, there are more people choose cycling as their first choice for leisure activities. However, for the other kinds of transportations and weathers, the link is not obvious and apparently.

Therefore, here we separate the weather conditions into two group, the temperature and the other two, as there is a relative apparently connection between the temperature and transportation (cycling). In the following content, three examples would be given, which is about the temperature and the precipitation. For the temperature, the aim is to find out what the influences would be while the temperature has already approved to have obvious influences on transportations. And in contrast, as the precipitation would not change the transportation a lot, it is also meaningful to find out whether the leisure activities will be influenced in a rainy day, and how the influences exist.

Temperature and Cycling

In Figure 10, it has shown that temperature has positive effects on people's preferences to choose cycling. However, what if the destinations and motive will not be changed in different temperature conditions?

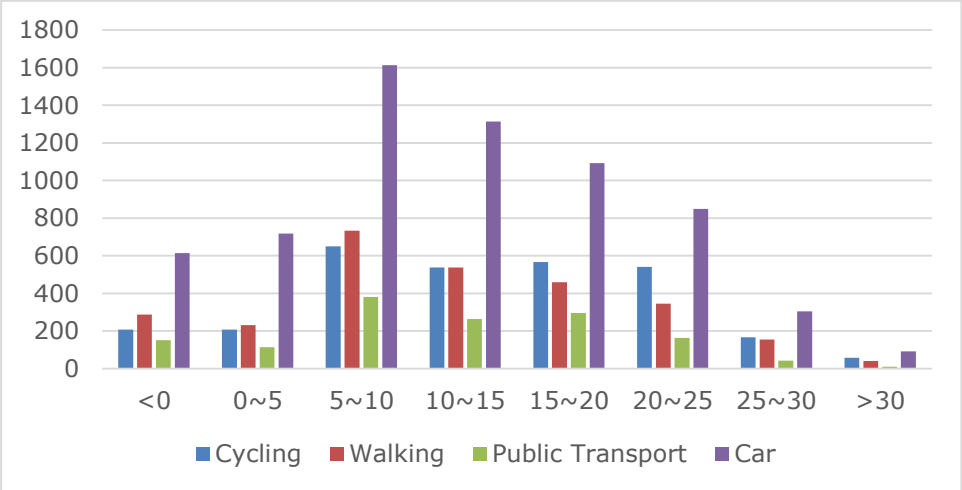

Table 10: Amount of leisure motivation trips under different temperature

The Table above illustrate how the temperature will change people's willing to use bikes in different temperatures, before 5~10 °C, there are few record about the leisure travel, then when the environment get warmer, more records could be found to go for leisure motivations. Meanwhile, after around 10 °C, and before around 25 °C, the number of people who went for leisure by using car, public transport and walking are all keep decreasing. However, in the same time, records that related to cycling do not decrease. Around 15 °C to 25 °C, the cycling records even raise a little bit. Therefore, it can conclude that, when the temperature is hotter than 5 °C, the temperature will have a positive effects on cycling. At the same time, the hotter temperature stop people from going somewhere for leisure by using walking, public transport and cars. In the other words, the hot day will not have negative effects on people's willing for leisure by using bikes.

Moreover, how the distribution of cycling-leisure destinations represent on the map is still needed to be discovered. The figure below shows how it changes in different temperatures.

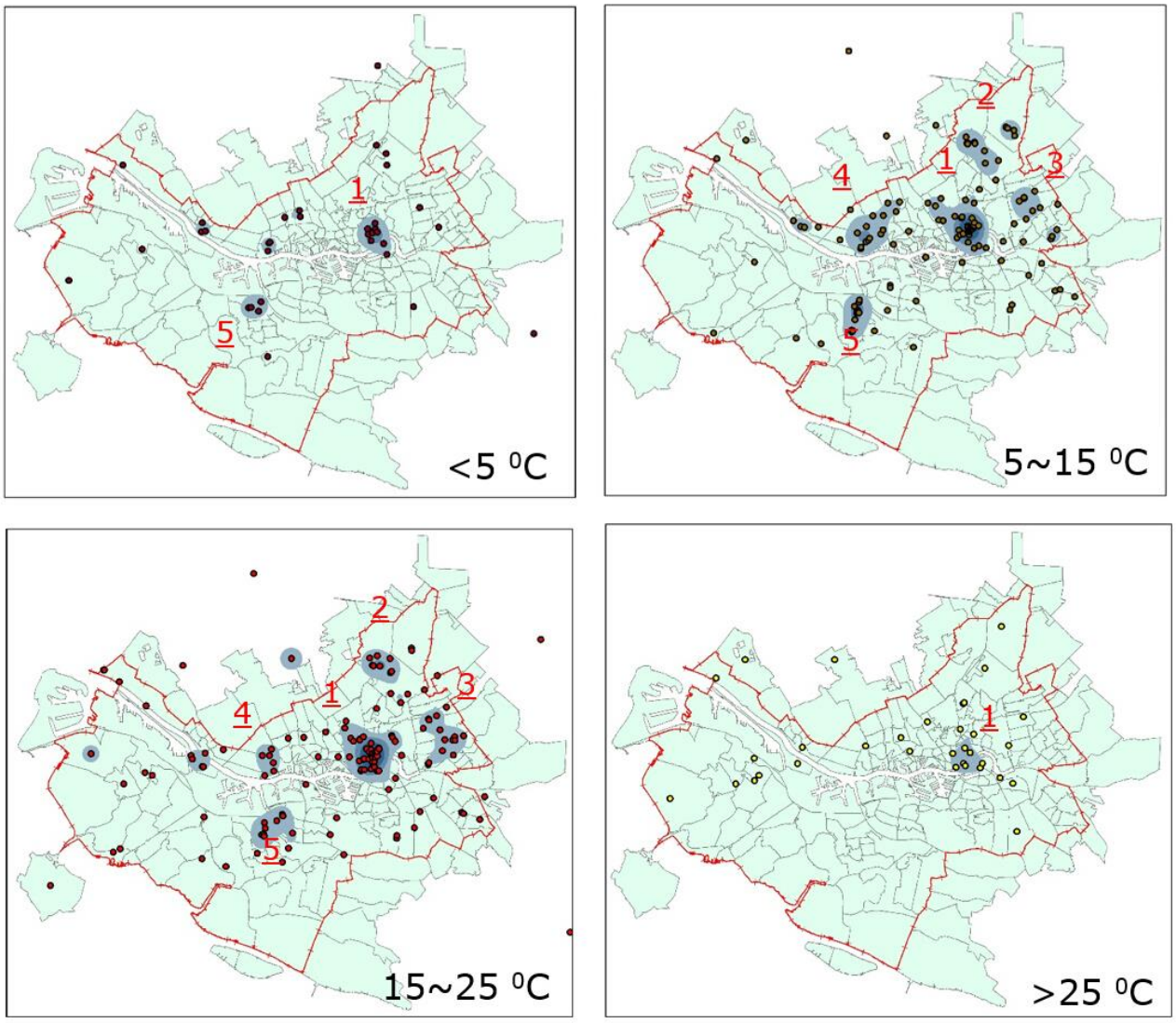

Figure 17: Destinations of cycling-leisure in different temperatures

(1, Centrum; 2, Berkel en Rodenrijs; 3, Prins Alexander; 4, Vlaardingen; 5, Oud-Beijerland)

The distributions of cycling destinations varies among different temperatures. When it is either too cold or too hot (<5 °C and >25 °C), the number of records are much less than the number of records of the usual temperature conditions (5~25 °C). However, when make a contrast between the maps of 5~15 °C and 15~25 °C, in fact, there is not much differences, both the map show a result of 5 popular leisure activities destinations.

Therefore, it can conclude that when the temperature changes, the destinations of cycling leisure trips do not change. In another word, the temperature have positive effects on people's preference to use bike for leisure trips when it is hotter than 5 °C, but it do not change the destinations of cycling among each temperature conditions. Considering about the map, when it get hotter, the 5 popular destinations never change, but when it get

hotter, there would be more people go to the 5 popular destinations. The reason is that more people would choose the cycling for leisure.

Sum up, the weather will have influences on people's leisure trips by changing people's preferences for transportations. The amount of people who chose specific transportations for leisure activities would change, but the destinations do not change.

Precipitation on weather exposed and weather sheltered transportations

Different with the situation of temperature, precipitation will not change people's preference to choose transportations. According to Table 11, for different rainy conditions, the percentage of each transportation is nearly the same. However, there is a trend that when the precipitations raise, less records could be found for all of the four transportations. Especially when the precipitation is more than 5 mm, limited records could be found. In conclusion, it means the precipitation will not change people's preferences for different kinds of transportations.

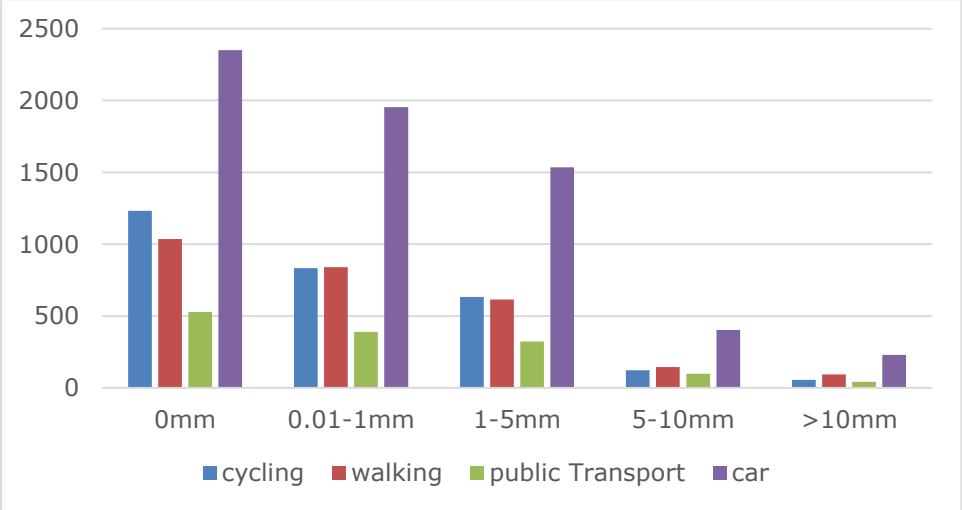

Table 11: Transportation use of leisure motivation records in different precipitations.

More specifically, all of the four kind of transportations trips would decrease when the precipitation raise. However, here we can separate the transportations into two categories, the weather exposed transportations and the weather sheltered. The first one are cycling and walking, which is thought to be more affected by the precipitations in the previous studies, and the second one is private car and public transport. While the precipitations would have negative for the totally number of trips for all kinds of transportation, how the precipitation would have influences on the weather exposed or weather sheltered transportation and how the destinations changes would be shown on the map below.

As the totally number of cycling and walking meet a great drop when the precipitation is more than 5 mm, therefore, for the map below, the records of "more than 1 mm" has been put into one category. Moreover, in this way, the totally number of records for the three categories, i.e. '0 mm', '0.01~1 mm' and '>1 mm' will not have a large differences. Only in this way, the contrast between each maps in the following figures would be much more meaningful.

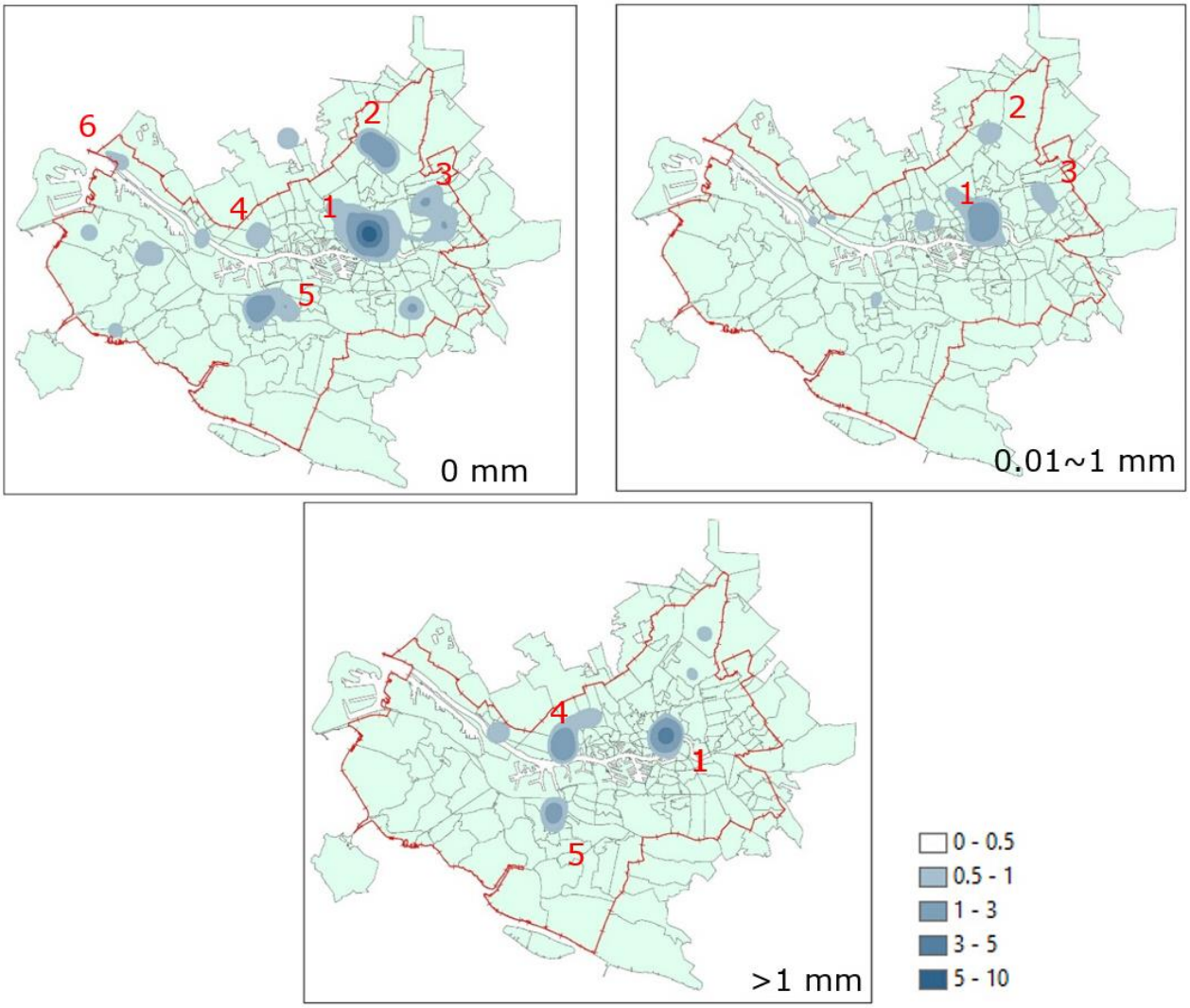

Figure 18: Kernel Density map of leisure activities by Walking and Cycling in different precipitation conditions. (1, Centrum; 2, Berkel en Rodenrijs; 3, Prins Alexander; 4, Vlaardingen; 5, Oud-Beijerland; 6, Hook of Holland)

For the map above, when the precipitation is '0 mm', there are the most travelling records, and the destinations are much centralized. A few popular destinations could be found, including the Centrum, Berkel en Rodenrijs, Prins Alexander, Vlaardingen, Oud-Beijerland, and the Hook of Holland. However, when it start to rain, and the precipitation is between 0.01 mm to 1 mm, people would more prefer to go for leisure at just three places, i.e. the Centrum, Berkel en Rodenrijs and Prins Alexander. Moreover, when the precipitation is more than 1 mm, another three high density areas appear on the maps, including the Centrum, Vlaardingen, and Oud-Beijerland.

In this way, it can conclude that even though the totally amount of the records in the three precipitation categories do not varies a lot (0mm, 0.01~1mm, >1mm), but the high density destination of the leisure activities would change a lot. If there is no rain, people would have a lot choices for leisure activities (6 high density areas). And when it starts to rain, the destinations would change at each precipitation level. The high density area of "0.01~1 mm" and ">1 mm" is not the same. In another word, even though precipitation will not have

influences on the totally number of trips by weather sheltered transportations, the destinations of different precipitations level do change a lot.

In contrast, how the weather sheltered transportations matter is still unknown. Therefore, the following figures are related to the public bus transportations and private car. As the totally amount of people who go for leisure by using the weather sheltered transportations in the three precipitation categories are almost the same, thus, the results could be meaningful to understand if the weather matters when the transportation and motivation is the same.

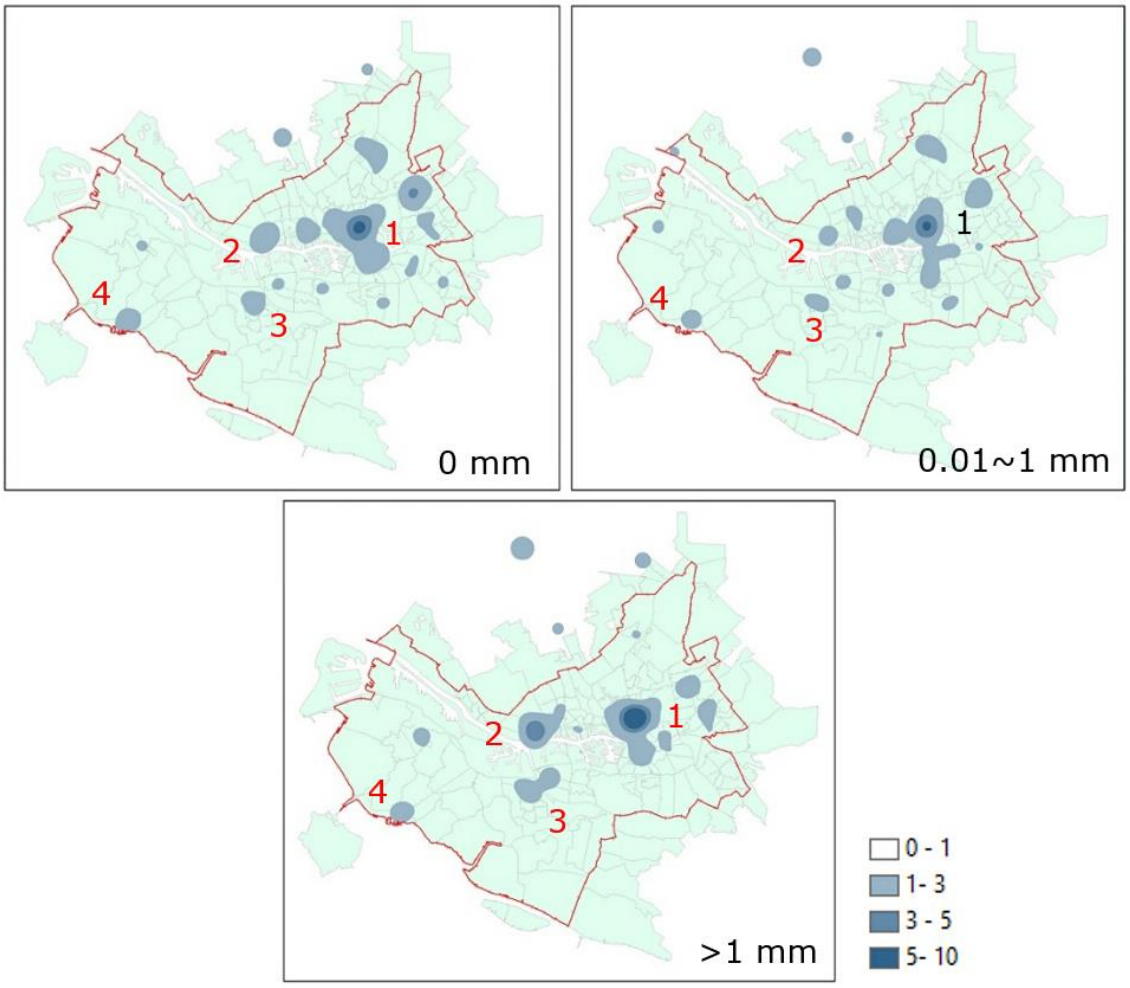

Figure 19: Kernel Density map of leisure activities by Public Bus Transportations and Private Car in different precipitation conditions. (1, Centrum; 2, Vlaardingen; 3, Spijkenis; 4, Hellevoetsluis)

From the figure above, it shows that when the precipitations change, the Kernel density map results into three similar maps. There are four places where people want to go for leisure activities mostly, including the Centrum, Vlaardingen, Spijkenis and Hellevoetsluis. However, both the locations of the high density area and how much the centralized it is will not be affected by the precipitations.

In summary, when considering how the transportations matter for people's leisure activities in different precipitation conditions, the transport situation should be separated

into the weather exposed transports and the weather sheltered transports. And also, how the transportations matter in different temperatures and precipitations is also not the same.

1). Temperature and walking & cycling

Among all the leisure activities records of which transportations are cycling and walking, temperature will have positive effects for the leisure when the temperature is less than 5 ^{o}C. Meanwhile, when the temperature is hotter than that, temperature will have negative effects to the totally amount of leisure activities. However, even though the totally amount of people who go for leisure by cycling and walking changes a lot in different temperature, the destinations do not change a lot. In this way, temperature affects people's preference for transportation, but do not affect their choices for leisure.

2). Precipitation and weather exposed transportations (walking & cycling)

The respondents is not sensitive to the precipitation when the precipitation is less than 5 mm, and in fact, the totally amount of leisure activities is nearly the same when precipitations are separated into "0mm", "0.01~1 mm" and ">1mm". However, as it is shown in the density map of each precipitation categories, the popular destinations of each precipitation conditions do change a lot. In another word, precipitation do not change people's preference for transportations, but change people's preference for leisure. And this is reasonable that people would more sensitive to the instant raining conditions when they are taking weather exposed transportations.

3). Precipitation and weather sheltered transportations (public transportations and car)

Contrast with the weather exposed transportations, the totally amount of leisure records are also not sensitive to the precipitations. But the difference is that the high density areas of each raining conditions are nearly the same. Therefore, it can conclude that precipitation will neither affect the people's preference for transportations nor affect their willing to take leisure activities. It is also easily to understand that when they are taking a bus or driving a private car, no matter what the rainy day it is, most people will still go to the places where they already planned to go.

4.4 Individual specific characteristic matters? Or not

As it is shown in Table 6, when considering about the individual and household specific characteristics, only the age, sex, income, and education index have an acceptable gap between the sample and the demographics. As for the ethnic and obesity, the gaps become unacceptable (while there are much more native Dutch people in the Sample, and the gap for the obese is unknown). Therefore, in this master thesis, only the age, sex, income and education would be taken into consideration. Only in this way, we can keep the Kernel density map meaningful enough as all these four factors in the sample rightly match the actual situation well.

		Motive			Leisure				
		leisure	not leisure	Total	Shopping	entertain etc.	physical activities	Nature Etc.	Total
age	<45	23.9%	76.1%	100%	35.8%	29.6%	18.7%	15.9%	100%
	>45	30.5%	69.5%	100%	36.5%	25.3%	15.7%	22.5%	100%
sex	male	28.9%	71.1%	100%	34.9%	29.7%	15.4%	19.9%	100%
	female	26.5%	73.5%	100%	38.3%	24.1%	18.3%	19.3%	100%
income	<2000	25.6%	74.4%	100%	39.8%	27.4%	12.1%	20.8%	100%
	2000-3000	30.9%	69.1%	100%	35.8%	23.4%	19.2%	21.6%	100%
	3000-4000	27.4%	72.6%	100%	35.1%	25.8%	16.6%	22.5%	100%
	>4000	26.8%	73.2%	100%	36.4%	32.3%	19.1%	12.3%	100%
education	lower	28.8%	71.2%	100%	38.6%	23.3%	17.9%	20.2%	100%
	middle	27.8%	72.2%	100%	36.6%	27.5%	16.2%	19.6%	100%
	higher	26.6%	73.4%	100%	35.4%	29.5%	16.7%	18.4%	100%

Table 12: Leisure activities composition regarding to individual characteristics.

The table above show that to some extent, people's preference for different kinds of activities would largely depends on the individual and household specific characteristics, especially for the age, sex, and income.

Firstly, for the age, people older than 45 years old are more likely to go leisure activities (+6.6%), and in detail, they are also more likely to go for nature/park/water leisure (+6.6%). Meanwhile, elderly people are less prefer to go for culture & entertainment related leisure activities (-4.3%).

Secondly, for the sex, it appears that male are more likely to go for culture & entertainment (+5.6%), and female are more likely to go shopping (+3.4%).

Thirdly, for the income, people whose income is between 2000 and 3000 are most likely to go for leisure (+5.3% in contrast with '<2000'), and people whose income is between 3000 and 4000 are mostly likely to go for nature/water (+10.2% in contrast with '>4000'). This is also reasonable that people with a relative high salary do have free time and are more willing to go for nature.

At last, the higher educated people have the most records for culture & entertainment related leisure activities (+6.2% in contrast with 'lower').

Therefore, to some extent, as the age, sex, income and educations matters for people's choices for leisure activities, how they distribute on the map is still unknown. The follow figure shows what the differences are.

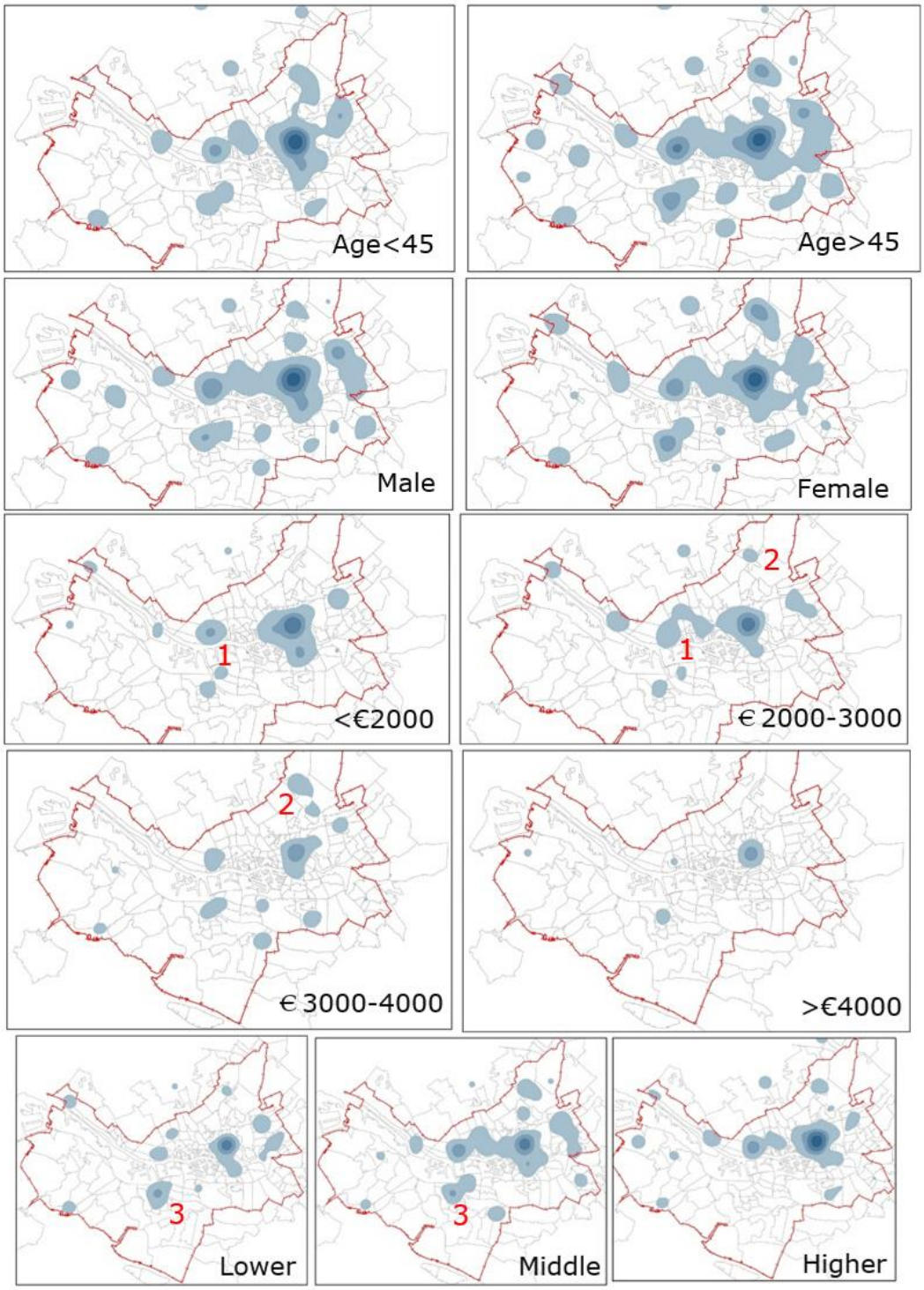

Figure 20: Kernel density map of leisure activities regarding to different age, sex, income, and education. (1, Schiedam; 2, Berkel en Rodenrijs; 3, Oud-Beijerland)

Considering about the map above, few conclusions could be made.

Firstly, for the age and sex, there could find limited differences between the '<45 years old' and '>45 years old', and also the male and female. Even though the percentage could be different, but the distributions are similar. It means that, to some extent, these two individual specific characteristic is not relevant to people's leisure behavior.

Secondly, considering about the income, the people whose income is lower than 2000 are more prefer to go to the Centrum and the Vlaardingen, and also the destinations are more centralized than the other map. Meanwhile, people whose income is from 3000 to 4000 are more likely to go to the north-ease of Rotterdam, i.e. Berkel en Rodenrijs. And people with an income '2000-3000' are also prefer to go to Schiedam, while the other people don't. People with an income more than 4000 have the minimal number of records. Therefore, it can conclude that, in fact, income could be an important factor that separate people and affect where they would go for leisure.

At last, destinations of people with different education are similar. The only difference is that for the people with a higher education, they are less likely to go to Oud-Beijerland, while the people with a 'lower' and 'middle' education would more likely to go.

In summary, for different age, sex, income, and education, these factors could have influences on people's preference for different leisure activities. However, considering about how these leisure activities distribute for different individual specific characteristic, only the income could be an apparently factors which is related to the leisure activities. The density map of people in different age, sex and education do not have big differences. These three factors can change people's preference for leisure, but cannot change the destinations of leisure trips.

5. Discussion and conclusion

Leisure can be considered a part of a high quality life for every person. In this thesis, we focused on how weather influences this particular aspect of our everyday life. Considering previous studies, it is established that transportation issues and specific individual characteristics are both relevant factors; therefore, these two factors are also assumed to be important in this thesis. An existing body of research related to this topic has been conducted around the world from Chicago, Vienna, Montreal, San Francisco, Gothenburg, Athens to Taiwan, Japan, etc. (see review: Dijst, Bocker et al. 2013), but little could be found regarding the same issue in the Netherlands. Therefore, by analyzing people's leisure-related behavior in Rotterdam, it can be an important and meaningful reference for the government or other agency to understand how the Dutch people are acting in different weather conditions. It can also help the government to improve the planning of people's leisure activities in this city. Where are the existing dominant leisure places? How are they located on the map? Are people in Rotterdam sensitive to different weather conditions? If there would be more public transportations (bus lines, cycling route, et al), could it be helpful for native people to enjoy leisure activities? More questions like these could be given answers in this thesis. And by solving these questions, it can help to get a clearer picture about the situation and facilitate the government in better policy making.

Lacking of previous studies and objectives of this thesis

When referring to previous studies, a large amount of related literature could be found, and those studies are focus on the relationship between the weather conditions, different leisure activities, and transportation and individual characteristics of people. In the review section, it is shown how existing literature has already focused on most of the connections between the leisure activities and possible variables (weather conditions, transportations, individual characteristics), but some areas are still lacking. Some of the connections are missing, and some of the connections could not result in clear positive or negative effects. This means that there are still some aspects that previous studies did not paid fully attentions to, and therefore, more studies are needed to get better understanding for the weather and leisure topics.

Firstly, considering the weather conditions, temperature has been paid the most attentions among the previous studies, while the precipitation and wind were less focused on. There is an explanation from Cool and Moons (2010) stating how temperature is expected to have direct influences on people and how it is more important in contrast with the precipitations and winds. Even though a few literature works could be found to discover the connection between the wind and people's leisure behavior (Thomas et al. 2013, Sabir et al. 2011, Cools et al. 2010), it is still not as prominent when compared with the previous two factors. Besides, it is harder to find literature related to wind conditions. Moreover, only a few research papers could do an analysis within considerations about all three weather conditions. Therefore, in order to have a comprehensive understanding about how leisure is effected by all possible weather conditions, it is needed to discuss the temperature, precipitation and winds at the same time.

Secondly, in previous studies, the distinction between different leisure activities is unclear. In fact, it is difficult to classify different leisure activities according to their actual purposes. However, according to the literature review, it is easier to find differences for different leisure activities under similar weather conditions. And surely, for different purpose, the behavior of people should not be the same. For example, Spinney and Millward (2011) concluded that influences from temperature would largely depend on what kind of activities people attend. Connolly gave a similar conclusion that time spend on different leisure activities would transfer under different weather conditions. In fact, when talking about leisure, few previous studies focus on the long distance travelling and some others pay attentions to the daily commuting. Therefore, there is a need to defined leisure activities according to the main purposes. In this thesis, we define eleven kinds of activities and four of them are leisure activities, i.e. shopping, culture/entertain/ cafe etc., physical activities, and nature/park/water. This could present a rough classification of the leisure activities and respondents defined each of their trip based on their own opinion.

Thirdly, how the weather affects residents' leisure behavior would depend on the research area, For example, how do people enjoy the recreation time in a hot day is quite different for a Swede and Japanese (Thorsson et al. 2007) and how the temperature affects the transportation of a leisure trip is also different between Europe and North America (Cools et al. 2010, Guo et al. 2007, Shih et al. 2011, Tang et al. 2012). More results like in the previous two examples could be found. Considering about the travel behavior in different weather, Dijst (2013) indicated that most of the studies have been conducted in Northwest Europe, North America and Australia, while other areas are under research. For the current study, there is a need to expand the research area, and to the writer's knowledge, there are few researches concerning similar topics in the Netherlands. More specifically, as Rotterdam is a modern city with all the possible leisure activities within it, it can be a good reference to discover how the weather affects people's leisure behavior in the Netherlands as a whole.

Fourth, as the individual characteristics could contribute to people's preference for leisure activities, it is reasonable to assume that the personal societal background can be an important factor. Personal perception and experience of weather could be different for people in different age, sex, ethnic, health, income statues and lifestyle groups. However, few studies could be found concerning these aspects. There are few conclusions about how obese people and elderly people are behaving, but as the review written by Böcker, Dijst et al. (2013), the societal factor still needs to be studied.

At last, concerning the geographical analysis methods, Kernel Density Evaluation has been utilized in other research fields like crime, health, inclement weather, etc. A few literature works are focusing on leisure activities. Wu and CAI (2006) analyzed spatial modeling of people's leisure activities, and gave three possible factors, i.e. demand of people, facilities of the destinations and the available transportations. However, the first step of the modeling should be mapping the locations of leisure activities and find out if dominant destinations exist. And then, that would be easier to classify the activities and find the reasons. Kernel Density Evaluation is the suitable analytic tool and therefore it is needed to be used for this research about leisure activity.

Considering the lack of previous studies and the main topic how leisure activities are affected by different weather conditions (together with the transportations and individual specific characteristics), to this end, the following research questions were formulated.

1) To what extent does weather influence leisure activities (separate the weather into temperature, precipitation and wind)?

2) To what extent do the destinations of leisure activities have a clustering effect and if yes, are there some dominant destinations for leisure activities?

3) Whether the mode of transportations matters and how?

4) Whether the individual characteristics of the people matter and how?

There are two steps to analyze the data in order to get the answers. The first step is doing statistical analysis. It considered both the total amount and the percentage of each leisure activity under different weather situations. It gave an overview to what extent the weather affects the leisure activities. Transportations issues and individual specific characteristics have also been analyzed in this way. The second step is using the Kernel Density Evaluation to visualize how the locations of leisure activities are distributed on the map. Dominant places have been found, and there have been some comparisons for different weather or transportations and individual characteristic background.

Results

1) To what extent weather will have influences to leisure activities

Firstly, for the temperature most records for all the leisure activities were around 5~10 °C. Shopping was always the first option for people to have leisure. When it is colder than 15 °C, nature is people's last option, while when it is hotter than 15 °C, physical activities is the last option. Moreover, temperature would have positive effects on people's preference for shopping, nature related activities and culture & entertainment related activities. When it is hotter than 15 °C, temperature represents a negative effect to physical activities. Secondly, precipitations have negative effects to all leisure activities and in fact people are more sensitive to the hourly precipitations (instant precipitation). However, in contrast with the other three leisure activities, culture & entertainment is the least sensitive activity. And when the precipitation is more than 5 mm, there could be hardly any leisure activities to find. Thirdly, for the wind, there is a threshold for wind speed that can be tolerated by people. The most suitable wind speed for leisure activities is around 2-4 m/s and all the four kinds of leisure activities could find the most percentage for all the recorded activities around this wind speed. When the wind speed is higher than the threshold, clear negative effects could be found to all types of leisure activities.

Finally, few contrasts could be found when comparing to previous studies. In Sydney, Currie and Develin (2002) found that participants prefer a dry and not windy day to do exercise, while in Rotterdam, the most suitable weather was found to be warm, with no precipitations and a 2-4 m/s wind. Similar positive effects from the temperature could be found in Chicago, Vienna, Montreal, San Francisco, Athens, Japans and Taiwan, etc.

(Lindsey, et al. 2006, also see review: Dijst, Böcker, et al. 2013). More specifically, as the temperature has positive effects on shopping, culture & entertainment, and nature related activities, it has negative effects to physical activities. This is similar to the finding of Thompson et al. (1993) who shows how attendance of physical activities declines while the mean of temperature increase. At the same time, Bergstralh et al. (1990), Burdette et al. (2004), Levin et al. (1999), Constantinos et al. (2004), Plasqui et al. (2004), Ross et al. (1985) found different positive effects of the temperature to physical activities. Similar negative effects have been found in both this thesis and the previous studies. Guo et al. (2007), Hofmann et al. (2005), Tang (2012) found a decline of the number of people who are willing to have leisure activities. Spinney et al. (2011) indicated that the influences depend on what kind of leisure activities they are. More precipitation would contribute to more relaxing, socializing activities, and hobbies. At the same time, a decrease in precipitation will increase the number of people who do outdoor sports and other leisure activities. This is not indicated in this thesis. At last, the threshold of wind speed is a consensus of previous studies. Since Sabir et al. (2011) and Böcker (2013) both indicated that there is a threshold of wind speeds, it is expected to find similar wind speeds in most leisure records. For the finding of Sabir et al. (2011), the threshold wind speed is 4 Beaufort, and for this thesis, the threshold is around 2~4 m/s. According to Cools et al. (2010) one reason people are less likely to attend the leisure trips during a windy weather is that it could cause delay in arriving and make leisure activities more risky.

2) *To what extent do the destinations of leisure activities have a clustering effect and if yes, are there some dominant destinations for leisure activities?*

In Rotterdam, there are distinct areas when mapping different leisure activities during different weather conditions. A few popular leisure activities destinations have been found, i.e. the Centrum, Vlaarding, Berkel en Rodenrijs, Spijkenis, Oud-Beijerland, Krimpen aan den Ijssel, Bergschenhoek, Rozenburg, and the Hook of Holland. Depending on different weather conditions, the hotspots of preferred leisure locations vary. More specifically, according to the map of dominant destinations for leisure activities, the Centrum and Vlaardingen is the place where all the four kinds of leisure activities could be found. For the nature/park/water activities, the Centrum and Oud-Beijerland were found to be popular. However, there were also some people who went to the beach to have leisure time. For the culture & entertainments related activities, the destinations of records are much more centralized compared to the other three activities. Only the Centrum could be found as a popular destination. The places where people would like to go for physical activities are similar to results for the shopping areas, but the total number is significantly lower.

In addition, considering the five areas where have the most records, people living in the center (Stadsdriehoek) are more prefer go outside Rotterdam to have leisure time than the other four area. In contrast, people living in Rozenbur, are more likely to go to the beach or other destinations that located far away from their home. It could be because of that Rozenburg is not a popular leisure activities destinations in contrast with the other four places.

Butler et al. (1986) indicated two kinds of factors that are related to people's destination choices. The first is about the spatial-economic factors which are related to distance, accessibility, transportation costs and physical attributes of destinations. The second is about the natural and environmental variables. Moreover, Wu et al. (2006), Novak et al. (2007) and Böcker et al. (2013) indicate that the physical attributes of the destinations matters when people spend leisure times. Therefore, it is easy to explain why those places could be the dominant destinations for leisure. It is not the reasons of the weather or environment, it is because of the attractions of these places. There are some museums, shopping malls, shopping districts and open markets at the Centrum which make it the dominant place for leisure activities. The city Centrum is followed by Centrum Vlaardingen and the famous 't Hof Park, which are also dominant places for leisure. Spijkenis is famous for the City Plaza and Hook of Holland is famous for the beach. Therefore, in Rotterdam, the preferred location for people who want to go for leisure activities largely depends on the accessibility and physical attributes of the destinations.

3) Whether the transportations matters and how

Considering transportation, there are three ways how the weather could change people's leisure activities. Firstly, the weather can change people's preference for transportation, but the destination of the transportation does not change in different weather conditions. For instance, while temperatures can have positive effects on people by making them use bicycles for commuting, but it is shown that in different temperatures, the destinations does not change.

Secondly, in different precipitation conditions, ('0 mm', '0.01-1 mm' and '>1 mm') the amount of participation of leisure by using walking and cycling does not change significantly, but when the rainfall increases, less distant leisure destinations have been recorded to be more popular. Between '0.01-1 mm' and '>1 mm' of precipitation, the Centrum is the most common popular destination. This means that people are more sensitive to the precipitation when they have to decide where to spend leisure time by bike or walk.

Thirdly, precipitation will neither change the totally amount of bus taking and private driving records, nor the destinations where people want to go for leisure. It means that, when people's major modes of transportation are public bus or private car, they would be relatively careless about what the weather conditions is. If they prefer a place for leisure at the sunny day, they would also prefer to go there at a rainy day. In another words, the precipitations situations cannot prevent people from doing what they want.

4) Whether the individual characteristic matters.

How individual and household specific characteristics affect the leisure activities is somehow similar to the transportation. In one aspect, the different social background could change people's preference for different leisure activities. For instance, elderly people (>45 years) are found to have more leisure time for nature, and people with income between 2000 and 3000 are found to have more leisure time than other people. Also, people with the highest income (>4000 per month) have been found to have more

entertainment/culture time than the others. Moreover, higher educated people are more likely to go for culture and entertainment related activities.

However, in other aspects, different age, sex, income and education do not affect people's destination choices, especially for the age and sex. Different income changes the amount of people to have leisure time, but do not affect where to have leisure activities. However, the education level does affect the destination choice. Higher educated people are less likely to go to the south of Rotterdam to have leisure time. No records have been found in Oud-Beijerland for higher educated people seeking leisure.

Few previous studies have similar results to the conclusions above. Sun et al. (2001) has concluded that weather will have influences to what the elderly do for their leisure time, but where they were going has not been affected. Therefore, as the results of Questions 3) show that weather conditions do not change the dominant places, when regarding to the individual characteristics, it shows similar results, i.e. where the people could have leisure activities is more important than what the weather is.

Policy Recommendations

The previous conclusions represent a diversity among the people who seek leisure activities in different weather conditions across Rotterdam. Based on these conclusions there is room for recommendations for policy making.

Firstly, when comparing how the destinations of different leisure activities distributed on the map, it represents a problem that the government should pay more attentions to. While the shopping destinations are equally distributed on the map, the destinations of the culture/entertainment/café locations are more centralized than the others. Furthermore, most of the popular places for physical activities are located in just five parks in Rotterdam. Therefore, since culture and entertainment is equally important as shopping, the government should make efforts to build more entertainment or culture places at other places in Rotterdam. Otherwise people who want entertainment have to travel longer from the peripheries of Rotterdam which is not convenient and economical. Regarding the physical activities, more parks are needed for the population of Rotterdam.

Secondly, considering how the mode of transportation matters when it comes to the weather and the leisure activities, there is a big difference for the people who use cycling or walking and those people who use public transportation or a private car. Palomares (1964) indicated that planning should not only take advantage of weather to promote some recreation activities in ideal weather and climate conditions, but also promote programs to prevent the people from being exposed to adverse microclimate and micro weather conditions. Martin et al. (2005) also indicated that people always seek to settle in a place where offer the most great comfortable feeling and enjoy the time without worry of the weather. Therefore, in order to provide the people with the option to enjoy leisure activities in some adverse weather conditions, the government could either build more weather sheltered facilities for people who bike or walk, or reduce the bus price on a day with heavy rain. All possible policies are aiming to make the people have safer and more economical ways for commuting during bad weather condition.

Thirdly, considering about the map of dominant destinations, it can be seen that Hook of Holland is the only popular destination in Rotterdam where people can frequently go for leisure along the beach. However, as a modern city near the sea, the government could make an analysis for the business opportunities of a second "Hook of Holland". We strongly recommend the government to do a feasibility study on the beach scene because it could possibly be a good way to develop local businesses and contribute the economics.

Limitation and Suggestions

Contrasting with other literature, the advantage of this thesis is that the data base is sufficient and reliable to explain some phenomena. Moreover, as the motivation in the database is classified into 11 kinds of activities (4 of those are leisure related activities), this matches the concept model and previous literature quite well. Therefore, together with the weather, transportation and individual characteristics, the leisure activities could also be easily defined. And in fact, with these 13752 trips, there are still more opportunities to explore other aspects about the leisure activities. The biggest limitation of this thesis is that because of the design of the research schedule, there was no opportunity to have a field trip to Rotterdam. In fact, the field trip should be regarded as the most important step in a geography related research program.

Moreover, tracking the persons' route for each trip was not fully done in this thesis. It is meaningful to make a better visualization process to find out how the locations distributed and what the connection is between the starting places and the destinations. In this thesis, the route is unclear and what we can do is only analyze the destinations.

For the individual specific characteristics, sufficient data can explain a phenomenon but quantitative study is not the best way to answer the questions related to people. As the policy recommendations are aiming to serve the native people, there is a need to discover how the residents think about the situation. What they really need from the policy is important. Therefore, qualitative study is needed when concerning about the difference between people in different societal background.

For future research, firstly, scholars should expand the research areas around the world. As the native Dutch people get used cycling in a rainy and windy day, they would be less influenced by precipitations. However, this logic is possibly not reasonable at other places. Therefore, there should be a larger range of research areas. As Dijst (2013) indicated, most of the travel behavior studies are conducted in the rich countries in Northwest Europe, North America and Australia. Therefore, scholars in the other countries could also start researches in this field.

Secondly, as the scale of this research is a city, future research could zoom in to find out more details about how the leisure activities have been influenced within a neighbourhood. As Butler (1986) indicated few factors that can contribute to a dominant places for leisure activities and the physical attributes are approved to be more important, then it is meaningful to discover the features of these dominant places. It will help to understand why these places would be popular for people to spend leisure times while the other places don't. If a few shopping malls are more attractive for people to do shopping, do they share

the same features that make them better than the others? And moreover, discovering how the sales of different shops have been influenced by weather is more useful to analyze in a business model, and it could provide suggestions for the planning of future chain stores. Also, the kernel density evaluation is good for optimal locations analysis.

Thirdly, as the individual characteristics are less focused by previous studies, there is a need to continue researches in this field. More specifically, as it is proved that elderly have more leisure time than people in other age groups, scholars should do researches focus on this group of people. What kind of leisure activities do they prefer and how to make a better leisure environment for them are the questions needed to be answered.

At last, this thesis could just focus on the neighbourhood but does not have more details for the actual name of the destination. For future research, field trips are needed and also, the researcher should have a better design for the research schedule to arrange a time for a field trip.

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