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Mobility and Sustainabilities in rural areas – A study based on GPS dataset

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Mobility and Sustainabilities in rural areas – a study based on GPS dataset

Abstract

This research study is an overview of the field of rurality, sustainable mobility and includes an analysis of a few tracks from two different communes of rural France to study the influence of the size of a territory on the mobility behaviour of its people. The different definition of the term 'rurality', the various mobility paradigms are discussed and the various aspects of mobility are studied. Sustainability of rural areas and the need for mobility in rural areas is studied. Rural travel trends, the different characteristics of mobility in rural France are studied with the help of GPS datasets of volunteers from two different types of communes in rural France (namely CCTNO and CCB) and the relationship between the size of a territory and the mobility demand or pattern is analysed. The study suggests a methodology for the analysis of travel using GPS dataset for similar tracks.

Keywords: Rurality, mobility, GPS, sustainable mobility

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CHAPTER 1

A. GENERAL INTRODUCTION

1.1 INTRODUCTION

The oldest urban communities known in history began approximately 6000 years ago from the development of the earliest cities in Mesopotamia and Egypt until the 18th century. An equilibrium existed between the vast majority of the population who engaged in subsistence agriculture in a rural context, and small centres of populations in the towns where economic activity consisted primarily of trade at markets and manufactures on a small scale. Due to the primitive and relatively stagnant state of agriculture throughout this period the ratio of rural to urban population remained at a fixed equilibrium.

With the onset of the agricultural and industrial revolution in the late 18th century this relationship was finally broken and an unprecedented growth in urban population took place over the course of the 19th century, both through continued migration from the countryside and due to the tremendous demographic expansion that occurred at that time. Less than 3% of the world's population lived in urban areas around 1800 (Clark, 1998). In England, the urban population jumped from 17% in 1801 to 72% in 1891. For other countries, the figure was: 37% in France, 41% in Prussia and 28% in the United States (Watson, 1993).

Urbanization rapidly spread across the Western world and, since the 1950s, it has begun to take hold in the developing world as well. In 1960, nearly all less urbanized regions of the world had low rates of rural out-migration of under 1 % annually and high rates of urban immigration of 1.5% to 3.2% annually (Lowry, 1990).

At the turn of the 20th century, just 15% of the world population lived in cities (Annez and Buckley, 2007). The year 2007 witnessed the turning point when more than 50% of the world population were living in cities, for the first time in human history (The United Nations). Today, 54 per cent of the world's population lives in urban areas, a proportion that is expected to increase to 66 per cent by 2050. The world's urban population is expected to surpass six billion by 2045 (United Nations DESA Report, 2014).

region /country	% urban 2015	% urban 2025 (Projected)
World	54.0%	58.2%
Africa	40.4%	44.9%
Eastern Africa	25.6%	30.3%
Burundi	12.1%	15.4%
Comoros	28.3%	30.1%
Djibouti	77.3%	78.5%
Eritrea	22.6%	27.5%
Ethiopia	19.5%	24.2%
Kenya	25.6%	30.3%
Madagascar	35.1%	41.4%
Malawi	16.3%	18.7%
Mauritius	39.7%	39.4%
Mayotte	47.0%	45.0%
Mozambique	32.2%	35.8%
Rwanda	28.8%	37.9%
Réunion	95.0%	95.9%
Seychelles	53.9%	57.1%
Somalia	39.6%	44.6%
South Sudan	18.8%	21.6%
Tanzania, Utd. Rep. of	31.6%	38.6%
Uganda	16.1%	19.9%
Zambia	40.9%	45.7%
Zimbabwe	32.4%	32.6%
Middle Africa	44.0%	49.0%

region /country	% urban 2015	% urban 2025 (Projected)
Angola	44.1%	51.3%
Cameroon	54.4%	59.6%
Central African Republic	40.0%	43.8%
Chad	22.5%	24.7%
Congo	65.4%	69.4%
Congo, Dem. Rep. of the	42.5%	47.8%
Equatorial Guinea	39.9%	42.3%
Gabon	87.2%	88.5%
Sao Tome and Principe	65.1%	69.5%
Northern Africa	51.6%	54.3%
Algeria	70.7%	75.6%
Egypt	43.1%	45.0%
Libya	78.6%	80.7%
Morocco	60.6%	65.2%
Sudan	33.8%	36.7%
Tunisia	66.8%	69.2%
Southern Africa	61.6%	66.1%
Botswana	57.4%	60.5%
Lesotho	27.3%	32.8%
Namibia	46.7%	55.4%
South Africa	64.8%	69.4%
Swaziland	21.3%	22.1%
Western Africa	45.1%	51.4%
Benin	44.0%	48.7%
Burkina Faso	29.9%	37.7%

region /country	% urban 2015	% urban 2025 (Projected)
Cabo Verde	65.5%	71.0%
Côte d'Ivoire	54.2%	60.5%
Gambia	59.6%	64.4%
Ghana	54.0%	60.0%
Guinea	37.2%	42.4%
Guinea-Bissau	49.3%	56.0%
Liberia	49.7%	53.9%
Mali	39.9%	47.1%
Mauritania	59.9%	65.0%
Niger	18.7%	22.2%
Nigeria	47.8%	55.3%
Saint Helena	39.5%	40.6%
Senegal	43.7%	47.8%
Sierra Leone	39.9%	44.2%
Togo	40.0%	45.1%
Asia	48.2%	53.9%
Eastern Asia	60.0%	68.6%
China	55.6%	65.4%
China, Hong Kong SAR	100.0%	100.0%
China, Macao SAR	100.0%	100.0%
Japan	93.5%	96.3%
Korea, DPR of	60.9%	63.2%
Korea, Rep. of	82.5%	83.8%
Mongolia	72.0%	78.4%

region /country	% urban 2015	% urban 2025 (Projected)
Taiwan	76.9%	80.4%
South-central Asia	35.0%	39.6%
Afghanistan	26.7%	31.4%
Bangladesh	34.3%	41.6%
Bhutan	38.6%	45.3%
India	32.7%	37.0%
Iran (Islamic Rep. of)	73.4%	77.8%
Kazakhstan	53.2%	54.3%
Kyrgyzstan	35.7%	38.1%
Maldives	45.5%	53.7%
Nepal	18.6%	22.7%
Pakistan	38.8%	43.8%
Sri Lanka	18.4%	19.6%
Tajikistan	26.8%	28.7%
Turkmenistan	50.0%	54.1%
Uzbekistan	36.4%	38.7%
South-eastern Asia	47.6%	53.3%
Brunei Darussalam	77.2%	79.7%
Cambodia	20.7%	23.6%
Indonesia	53.7%	60.3%
Lao PDR	38.6%	47.7%
Malaysia	74.7%	80.1%
Myanmar	34.1%	39.8%
Philippines	44.4%	44.9%
Singapore	100.0%	100.0%

region /country	% urban 2015	% urban 2025 (Projected)
Thailand	50.4%	60.3%
Timor-Leste	32.8%	38.6%
Viet Nam	33.6%	39.9%
Western Asia	69.9%	72.8%
Armenia	62.7%	62.6%
Azerbaijan	54.6%	57.8%
Bahrain	88.8%	89.5%
Cyprus	66.9%	66.8%
Georgia	53.6%	56.1%
Iraq	69.5%	71.2%
Israel	92.1%	92.8%
Jordan	83.7%	85.7%
Kuwait	98.3%	98.5%
Lebanon	87.8%	89.0%
Palestine, State of	75.3%	77.6%
Oman	77.6%	81.4%
Qatar	99.2%	99.7%
Saudi Arabia	83.1%	85.0%
Syrian Arab Republic	57.7%	61.8%
Turkey	73.4%	77.7%
United Arab Emirates	85.5%	87.7%
Yemen	34.6%	40.4%
Europe	73.6%	75.8%
Eastern Europe	69.4%	71.0%

region /country	% urban 2015	% urban 2025 (Projected)
Belarus	76.7%	80.0%
Bulgaria	73.9%	77.0%
Czech Republic	73.0%	73.5%
Hungary	71.2%	75.3%
Poland	60.5%	61.4%
Moldova, Rep. of	45.0%	47.0%
Romania	54.6%	57.0%
Russian Federation	74.0%	75.3%
Slovakia	53.6%	53.6%
Ukraine	69.7%	72.1%
Northern Europe	81.2%	83.3%
Channel Islands	31.5%	33.0%
Denmark	87.7%	89.2%
Estonia	67.5%	67.5%
Faroe Islands	42.0%	44.5%
Finland	84.2%	85.6%
Iceland	94.1%	94.9%
Ireland	63.2%	66.4%
Isle of Man	52.2%	53.5%
Latvia	67.4%	67.9%
Lithuania	66.5%	67.3%
Norway	80.5%	82.9%
Sweden	85.8%	87.3%
United Kingdom	82.6%	84.8%
Southern Europe	70.1%	72.6%

region /country	% urban 2015	% urban 2025 (Projected)
Albania	57.4%	65.7%
Andorra	85.1%	81.1%
Bosnia and Herzegovina	39.8%	42.5%
Croatia	59.0%	62.6%
Gibraltar	100.0%	100.0%
Greece	78.0%	80.9%
Holy See	100.0%	100.0%
Italy	69.0%	70.9%
Macedonia	57.1%	59.2%
Malta	95.4%	96.3%
Montenegro	64.0%	66.2%
Portugal	63.5%	68.5%
San Marino	94.2%	94.5%
Serbia	55.6%	57.4%
Slovenia	49.6%	50.5%
Spain	79.6%	81.7%
Western Europe	78.9%	81.1%
Austria	66.0%	67.2%
Belgium	97.9%	98.2%
France	79.5%	81.7%
Germany	75.3%	77.5%
Liechtenstein	14.3%	14.7%
Luxembourg	90.2%	92.3%
Monaco	100.0%	100.0%
Netherlands	90.5%	94.2%

region /country	% urban 2015	% urban 2025 (Projected)
Switzerland	73.9%	75.1%
Americas	80.5%	82.6%
Northern America	81.6%	83.4%
Bermuda	100.0%	100.0%
Canada	81.8%	83.6%
Greenland	86.4%	89.4%
Saint Pierre and Miquelon	90.4%	91.2%
United States of America	81.6%	83.3%
Caribbean	70.4%	74.7%
Anguilla	100.0%	100.0%
Antigua and Barbuda	23.8%	21.4%
Aruba	41.5%	40.5%
Bahamas	82.9%	83.8%
Barbados	31.5%	31.7%
British Virgin Islands	46.2%	49.4%
Caribbean Netherlands	74.7%	75.4%
Cayman Islands	100.0%	100.0%
Cuba	77.1%	78.4%
Curaçao	89.3%	88.8%
Dominica	69.5%	72.2%
Dominican Republic	79.0%	85.4%
Grenada	35.6%	36.5%
Guadeloupe	98.4%	98.5%
Haiti	58.6%	67.5%

region /country	% urban 2015	% urban 2025 (Projected)
Jamaica	54.8%	57.7%
Martinique	88.9%	89.1%
Montserrat	9.0%	9.3%
Puerto Rico	93.6%	93.5%
Saint Kitts and Nevis	32.0%	34.0%
Saint Lucia	18.5%	19.3%
Saint Vincent & the Gr.	50.6%	54.0%
Sint Maarten (Dutch part)	100.0%	100.0%
Trinidad and Tobago	8.4%	8.0%
Turks and Caicos Islands	92.2%	94.5%
US Virgin Islands	95.3%	96.3%
Central America	73.8%	76.5%
Belize	44.0%	43.8%
Costa Rica	76.8%	83.3%
El Salvador	66.7%	71.0%
Guatemala	51.6%	56.2%
Honduras	54.7%	60.2%
Mexico	79.2%	81.8%
Nicaragua	58.8%	62.3%
Panama	66.6%	69.7%
South America	83.3%	85.2%
Argentina	91.8%	93.0%
Bolivia	68.5%	72.2%
Brazil	85.7%	87.8%
Chile	89.5%	90.9%

region /country	% urban 2015	% urban 2025 (Projected)
Colombia	76.4%	79.0%
Ecuador	63.7%	66.4%
Falkland Islands	76.3%	80.1%
French Guiana	84.4%	86.5%
Guyana	28.6%	30.3%
Paraguay	59.7%	62.6%
Peru	78.6%	81.4%
Suriname	66.0%	66.4%
Uruguay	95.3%	96.5%
Venezuela	89.0%	89.6%
Oceania	70.8%	71.1%
Australia/New Zealand	88.9%	90.1%
Australia	89.4%	90.6%
New Zealand	86.3%	86.9%
Melanesia	19.3%	20.2%
Fiji	53.7%	57.3%
New Caledonia	70.2%	74.7%
Papua New Guinea	13.0%	13.9%
Solomon Islands	22.3%	26.6%
Vanuatu	26.1%	29.3%
Micronesia	66.8%	67.8%
Guam	94.5%	95.2%
Kiribati	44.3%	46.3%
Marshall Islands	72.7%	75.1%

region /country	% urban 2015	% urban 2025 (Projected)
Micronesia, FS of	22.4%	23.5%
Nauru	100.0%	100.0%
Northern Mariana Islands	89.2%	89.2%
Palau	87.1%	90.9%
Polynesia	42.5%	42.8%
American Samoa	87.2%	87.1%
Cook Islands	74.5%	76.9%
French Polynesia	55.9%	55.9%
Niue	42.6%	49.2%
Samoa	19.1%	18.5%
Tokelau	-	-
Tonga	23.7%	25.0%
Tuvalu	59.7%	

Table 1.1. Urbanization report of countries for the years 2015 and 2025

While the world is busy looking at the sustainable development of megacities and smart cities, we should also keep in mind that rural populations are expected to decrease as urban populations continue to grow. The rural population of the world has grown slowly since 1950 and it is expected to reach its peak around 2020. The global rural population is now close to 3.4 billion and is expected to decline to 3.1 billion by 2050. While Africa and Asia are urbanizing rapidly, the regions are still home to nearly 90 per cent of the world's rural population. India has the largest rural population with 857 million, followed by China with 635 million (UN).

Why does rural become important in this age? Has it not been important previously or rather more important than the cities? The following discussion is a testimony to the rurality. Rural populations represent 70 per cent of the world's poor and 72 per cent of the population of the least developed countries. Rural agriculture uses more than one-third of the earth's land and employs more than 40% of the population, a figure that approaches 75% in developing countries (Gustavo and Libor,

2008). As a result, rural demographic change is of vital importance. Rural populations do not follow the exact same dynamics as urban populations as usually the underlying demographic determinants [such as total fertility rate, access to health services, including reproductive health services that are less accessible in rural areas; and education levels, which have consistently been found to be negatively correlated with fertility (Scholnik and Chackiel, 2004) tend to be lower in rural areas] are different between these population groups. Rural/urban inequalities are a major obstacle to sustainable development. Intergovernmental Panel on Climate Change(1995): "There is a discernible human influence on global climate"

Rural areas comprise human settlements of less than 10,000 people and the rural space is dominated by farms, forests, water, mountains and/or desert. Typically, rural people depend on agriculture for their livelihoods as farmers, nomadic herders, or fishermen; they deal with animal production, transformation and marketing of food and non-food agricultural products and services. Rural communities are diverse culturally, socially and economically. Their labour is cheap because gainful employment options are limited. Usually rural people lack access to adequate basic social services because they lack a political voice and rural areas have a low national priority (UNESCO).

Rural people are an overlooked majority of the world's poor population because of the prevailing western and industrial models of development that give more priority to the urban industrial and services sectors as the engine of national economic development. Rural people are an overlooked majority of the world's poor population because of the prevailing western and industrial models of development that give more priority to the urban industrial and services sectors as the engine of national economic development.

Rural people cannot be assumed to be a homogenous group. "Rural is plural", meaning that there is a wide variation in the needs of different groups throughout the world. Research points out a large degree of heterogeneity both within and across countries in terms of access by rural households to essential assets and services, including education (FAO, 2007). Sustainable development of a country or a region encompass the growth of both the urban and the rural areas. Urban and rural areas co-exist, this being the reason behind the very discipline called "Regional Planning". Without inclusive planning, it is impossible for any nation to develop further.

The relationship between urban and rural areas is changing in countries all over the world. While some of the issues like changing agricultural systems are universal, other aspects of the process are specific to certain countries or regions. Urban and rural land uses in these countries are no longer mutually exclusive, but rather exist on a continuum of community types that are increasingly interconnected. Migration and settlement patterns are changing as new forms of urban, suburban and exurban development alter patterns of community development. The population is increasingly

decentralized as suburbanization is being replaced by exurban development, characterized by low-density growth where households with fewer people are living on larger pieces of land further from urban centres (Herbers, 1986). Rural-urban linkages are important for poverty alleviation and sustainable rural development and urbanization. Strong linkages can improve the living conditions and employment opportunities of both rural and urban populations. Domestic trade and the adequacy and efficiency of infrastructure are the backbone of mutually beneficial rural-urban relationships and of the success of the relationship between urban and rural areas (Tacoli, 1998; Tacoli, 1998; Tacoli, 2003; Rosenthal, 2000).

At a general level, agriculture remains the predominant economic activity in the poorest countries of the world. The poorest countries are mostly rural, most of the economically active population is engaged in farming, and agriculture is a sizeable share of the economy. At the other end of the spectrum, the richest countries are mostly urban, only a very small part of the active population is employed in farming, and agriculture contributes relatively little to the overall economy. Investment in rural roads has been a major concern of donor agencies and developing country governments. The importance of transport services in the provision of rural accessibility has largely been ignored until relatively recently. Accessibility should be thought of not just in terms of access to roads but also in terms of mobility or access to vehicles. Without mobility rural communities are isolated, which perpetuates the deprivation trap by denying them access to their most basic needs. Isolation will slow down the diffusion of new technologies and techniques, increase marketing and production costs and limit access to education and health facilities (Ellis, 1997).

Rural–urban linkages play a crucial role in the generation of income, employment and wealth. Yet, for various reasons the importance of such linkages is not recognized and thus ignored in national economic and trade policies (Akkoyunlu, 2013). Douglass (1998) constructed a template for research on rural–urban relations that can aid efforts to formulate a better plan for sustainable development.

Mobility is almost universally acknowledged to be one of the most important prerequisites to achieving improved standards of living. Enhanced personal mobility increases access to essential services as well as to services that serve to make life more enjoyable. It increases the choices open to individuals about where they live and the lifestyles they can enjoy there. It increases the range of careers that individuals can choose and the working environment in which they can pursue these chosen careers. Enhanced goods mobility provides consumers with a greatly widened range of products and services at more affordable prices. It does this by enabling people to market the products they grow or manufacture over a much wider geographic area and by reducing the cost of inputs they must use. This reaffirms the need for mobility in the rural areas.

So what is the need for this topic “Mobility and sustainabilities in rural areas”?

1. Private households make the second biggest contribution to greenhouse gases, fourth biggest to acid rain and the largest to black smoke(carcinogenic)
2. The countryside and the city are interconnected, not only in transport but in the economic patterns of production and consumption. Current rate of emissions associated with transport is not sustainable
3. Conflict between individual who wishes to travel further and the ability of the environment to cope with the by-products of travel
4. Current levels of mobility are increasing so it is necessary to reduce distances travelled, use less energy intensive modes and/or have more efficient, cleaner, vehicle technology if the impact is to be stabilised or reduced (Royal Commission on Environmental Pollution)

In an important intervention, Gustafson (2001) criticises the idea that place attachment and mobility are contradictory or mutual exclusive phenomena, suggesting that as well as providing freedoms and new opportunities, mobility can be associated with loss and up rootedness. Similarly, place attachment may signify 'roots, insecurity, and sense of place, but it may also...represent impoverishment and narrow-mindedness'(Fielding, 1992).

The first part of this research study drives us to understand the notion of “rurality” as defined by different countries and institutions of the world, the understanding of the very word ‘mobility’ with its different interpretations, distinct mobility paradigms and the reasons why rural citizens move in and out of their villages and towns i.e, what motivates them towards mobility?

The second part of this research is directed towards the study of mobility needs, mobility patterns and the habits of the citizens of France. This instils a research question in our minds – **“How does the size of a rural territory in France influence the mobility of its people?”** This will be possible through extensive literature review and case studies from across the world and the use of GPS dataset for understanding the travel patterns of citizens in the developed country France and to make proposals from the results obtained and further a general methodology for the analysis of similar tracks has been proposed.

CHAPTER 2

B. LITERATURE REVIEW

2.1. Rurality, rural people and the rural environment

The field of rural studies has for decades been characterised by never-ending debates on how to define 'rurality'. Rurality is a multifaceted concept that has no universal consensus. Defining rurality can be an elusive task and it frequently relies on stereotypes and personal experiences. In this study, an attempt is made to blend the various definitions of rural area across the globe and to understand as clearly as possible, the basic theories of rurality.

The etymology of the word 'rural' goes back to the 15th century - from old French 'rural' (14th century.), from Latin 'ruralis' "of the countryside," from 'rus' (genitive ruris) "open land, country," from PIE *reue- (1) "to open; space". One of the simplest, but clearest definition of rurality is that one that expresses rurality as "a condition of place-based homeliness shared by people with common ancestry or heritage and who inhabit traditional, culturally defined areas or places statutorily recognized to be rural" (Chigbu, 2013: p. 815). According to a study by Hart et al., the term suggests different opinions like pastoral landscapes, unique demographic structures and settlement patterns, isolation, low population density, extractive economic activities, and distinct sociocultural milieus. But these aspects of rurality fail to completely define "rural." For example, rural cultures can exist in urban places (Larson and Hart, 2003). Only a small fraction of the rural population is involved in farming, and towns range from tens of thousands to a handful of residents. The proximity of rural areas to urban cores and services may range from a few miles to hundreds of miles. Generations of rural sociologists, planners, demographers, and geographers have struggled with these concepts (Miller and Luloff, 1981). Proximity of the rural to the urban (in terms of time and distance) becomes inevitable for the market of local (especially perishable) goods.

The FAO's Rural Institutions and Participation Service (SDAR) in the Rural Development Division defines rural people as those living in settlements with an average of less than 10,000 inhabitants and located in areas where the dominant features are farms, forests, bodies of water, mountains and/or deserts.

Most rural dwellers work in agriculture, often for low rates of compensation. They face high transaction costs and have little political clout. The government services to which they have access are generally inappropriate and of poor quality. Rural people are generally farmers, stockbreeders, fishermen and, in some cases, nomads (FAO/UNESCO-IIEP, 2007b, p. 15).

The rural environment may be defined in a number of ways. Interestingly, no definition is universally accepted. These differences of definition are found both among the developed and developing countries (UNESCO- IIEP, 2007).

A first classification based on categories of municipalities given by UNESCO (IIEP, 2007) is as follows:

"Municipalities are classified by many countries according to categories ranked by size: a) those with less than 1,000 inhabitants, b) those with 1,001 to 5,000 inhabitants, and so on. This cannot be the only criterion used, however, as some small municipalities belong to very large and heavily populated urban areas. The size criterion is therefore combined with one based on the type of settlement and, as a result, an urban unit is defined in terms of continuity of built-up areas and the size of the population. Such an urban unit is made up of 'population clusters' (IIEP, 2007).

One possible definition of a 'population cluster' is a set of dwellings with at least 50 inhabitants, such that no dwelling is more than 200 metres from the next. If this definition is adopted, a municipality may be called rural when it does not belong to an urban unit and when its clustered population is less than 2,000 (IIEP, 2007).

Another kind of classification that can be used to depict the rural environment is analysis by type of monetary movement. For example, rural municipalities whose primary activities are farming-related may be distinguished from municipalities with similar characteristics but whose economic activities are in manufacturing or services.

Some developing countries select a third type of classification, combining the previous classification by type of activity with one based on criteria related to infrastructure or accessibility. In Lao PDR, for example, an urban area is defined as meeting three of the five following conditions:

1. The availability of a market in the village;
2. The availability of an access road for motor vehicles;
3. The location of the village near the district or provincial capital;
4. The presence of electric power in the majority of homes or households in the village; and
5. The availability of running water in the majority of homes or households.

This type of definition is sometimes combined with the notion of poverty. In Lao PDR, districts are also defined as poor or extremely poor on the basis of criteria related to resources and available infrastructure. It is helpful, however, to distinguish clearly between these two approaches, even if they often overlap. Extreme poverty is very often linked to a situation of rurality and geographical isolation.

A fourth type of classification is used in countries with highly detailed information for their entire territory, notably on the basis of very thorough censuses. On this basis, they can identify rural areas with great precision according to population density. England and Wales, for example, use information based on the smallest unit for which statistical data are available: one hectare, i.e. 100 metres by 100 metres. There are 35 million such units in England and Wales combined. The population density in this unit is calculated. However, in order to distinguish between high density in a village and in a major city, densities are calculated for increasingly large areas with a view to characterizing the initial unit. Thus, if population density decreases very rapidly when the area considered is enlarged, the initial unit is probably the centre of a village; if it decreases only slowly or not at all, the initial unit is probably the centre of a city.

On the basis of these principles, 'density profiles' and various criteria relating to the values of these densities are determined, allowing a highly accurate description of the characteristics of each unit.

Once each basic unit has been described, it is necessary to establish rules for defining groupings of such units (electoral divisions, districts, etc.). An administrative unit is thus described according to the weighted proportions of its constituent basic units. By combining types of units and population dispersion, we obtain five broad categories of administrative divisions:

1. urban (population cluster greater than 10,000);
2. town with only slightly dispersed housing;
3. slightly dispersed village/hamlet;
4. town with dispersed housing; and
5. dispersed village/ hamlet.

The point of this classification is to be able to group the basic units together in the ways most relevant to the various types of analysis, as well as to identify locations where the population is highly dispersed and where provisions of social services, particularly education, is difficult and costly. This allows better targeting of the operational areas and cost of a 'rural' policy, especially where education is concerned."

In Canada, six alternate definitions of rural areas is available for the purpose of national level analyses. Each definition emphasizes different geographic criteria such as population size, population density, labour market context or settlement context and has different associated thresholds. These definitions are tabulated as given below in Table 2.1:

Table 2.1: Alternative Definitions of Rural areas in Canada

Definition	Main criteria, thresholds and building blocks
Census "rural areas"	**Population size**: Population living *outside* places of 1,000 people or more; *OR* **Population density:** Population living *outside* places with densities of 400 or more people per square kilometre. **Building blocks:** EAs
"Rural and small town" (RST **Metropolitan area and census agglomeration Influenced Zones (MIZ)**	**Labour market context**: Population living *outside* the commuting zone of larger urban centres (of 10,000 or more). **Population size/density**: Urban areas with populations less than 10,000 are included in RST together with rural areas if they are outside the main commuting zones of larger urban centres **Labour market context:** MIZ disaggregates the RST population into four sub-groups based on the size of commuting flows to *any* larger urban centre (of 10,000 or more) **Building blocks**: CSDs (for RST and MIZ)
Definition	**Main criteria, thresholds and building blocks**
OECD "rural communities"	**Population density**: Population in communities with densities less than 150 people per square kilometre.
OECD "predominantly rural regions"	**Settlement context**: Population in regions where more than 50 percent of the people live in an OECD "rural community." **Building blocks**: CDs
"Non-metropolitan regions" (Ehrensaft's "Beale codes")	**Settlement context**: Population living outside of regions with major urban settlements of 50,000 or more people. Non-metropolitan regions are

	subdivided into three groups based on settlement type, and a fourth based on location in the North. The groups based on settlement type are further divided into “metropolitan adjacent” and “not adjacent” categories. **Population size**: Non-metropolitan regions include urban settlements with populations of less than 50,000 people and areas with no urban settlements (where “urban settlements” are defined as places with a population of 2,500 or more). **Building blocks**: CDs
“Rural” postal codes	**Rural route delivery area**: Areas serviced by rural route mail delivery from a post office or postal station. “0” in the second position of a postal code denotes a “rural” postal code (also referred to as a “rural” forward sortation area (rural FSA)). **Building blocks**: Canada Post geography.

Sources: Statistics Canada (1999a); Mendleson and Bollman (1998); McNiven, Puderer and Janes (2000); OECD (1994); Ehrensaft (1990); Ehrensaft and Beeman (1992); Statistics Canada (1999b).

According to the European Union, there is a fifth classification which is sometimes used:

1. areas dominated by a major city;
2. areas formed of multiple nuclei with high urban and rural population density (but what exactly is meant by high urban and rural population density?);
3. networks of small towns; and
4. remote rural areas.

France has defined an aggregate called a 'predominantly rural area' that is of considerable size, representing 18 percent of the country's population and 58.9 per cent of its land area (Sauvageot, 2007). But what is a 'predominantly rural area'?

For the purpose of clarity, a series of definitions is proposed by Sauvegeot -“To give a negative definition, a predominantly rural area can be considered as a space that is not predominantly urban. A 'predominantly urban area' is an urban centre, an urban periphery or a multipolar municipality:

An 'urban centre' is an urban unit offering more than 5,000 jobs. An urban unit is an aggregate composed of municipalities linked by their built-up areas, the whole forming a population cluster of at least 2,000 inhabitants. A population cluster is a group of dwellings in which no one dwelling is further than 200 metres from the next.

An 'urban periphery' is an aggregate made up of municipalities (or small clusters) in which at least 40 per cent of the employed resident population works in the urban area;

An 'urban area' is a group of touching municipalities, without pockets of clear land, made up of an urban centre and its periphery; and

A 'multipolar municipality' is a rural municipality or an urban unit not located in an urban area, in which at least 40 per cent of the employed resident population works in several nearby urban area, but where this percentage is not reached with respect to any one of these urban areas.

For the sake of precision, this complexity of definition is necessary. Finally, a great deal of statistical information on the population and working population are used at the local level, but most countries are far from possessing data at this level.”

United Nations Department of Economic and Social affairs gives a detailed report of rural criteria as follows: Because of national differences in the characteristics that distinguish urban from rural areas, the distinction between the urban and the rural population is not yet amenable to a single definition that would be applicable to all countries or, for the most part, even to the countries within a region. Where there are no regional recommendations on the matter, countries must establish their own definitions in accordance with their own needs.

The customary distinction between urban and rural areas within a nation has been based on the assumption that urban areas provide a way of life which is different and usually a higher standard of living than are found in rural areas. In many industrialized countries, this distinction has become obscure and the chief distinction between urban and rural areas in terms of the circumstances of living tends to be a matter of the degree of concentration of population. Although the differences between urban and rural ways of life and standards of living remain significant in developing countries, rapid urbanization in these countries has created a great need for information related to different sizes of urban areas (UN Statistics).

Hence, although the traditional urban-rural dichotomy is still needed, classification by size of locality can usefully supplement the dichotomy or even replace it where the major concern is with characteristics related only to density along the continuum from the most sparsely settled areas to the most densely built-up localities.

Density of settlement may not, however, be a sufficient criterion in many countries, particularly where there are large localities that are still characterized by a truly rural way of life. Such countries will find it necessary to use additional criteria in developing classifications that are more distinctive than a simple urban rural differentiation. Some of the additional criteria that may be useful are the percentage of the economi-cally active population employed in agriculture, the general availability of electricity and/or piped water in living quarters and the ease of access to medical care, schools and recreation facilities. For certain countries where the facilities noted above are available in some areas that are still rural since agriculture is the predominant source of employment, it might be advisable to adopt different criteria in different parts of the country. Care must be taken, however, to ensure that the definition used does not become too complicated for application to the census and for comprehension by the users of the census results.

Even in the industrialized countries, it may be consid-ered appropriate to distinguish between agricultural localities, market towns, industrial centres, service centres and so forth, within size-categories of localities.

Even where size is not used as a criterion, the locality is the most appropriate unit or classification for national purposes as well as for international comparability. If it is not possible to use the locality, the smallest administrative unit of the country should be used.

Some of the information required for classification may be provided by the census results themselves, while other information may be obtained from external sources. The use of information provided by the census (as, for example, the size-class of the locality or the percentage of the population em-ployed in agriculture), whether alone or in conjunction with information from other sources, means that the classification will not be available until the relevant census results have been tabulated. If, however, the census plans call for the investiga-tion of a smaller number of topics in rural areas than in urban areas or for a greater use of sampling in rural areas, the classifi-cation must be available before the enumeration takes place. In these cases, reliance must be placed on external sources of information, even if only to bring up to date any urban-rural classification that was prepared at an earlier date. Urban/rural is a derived topic of high priority in a vital statistics system which is based on geographic information obtained from place of occurrence and place of usual residence. Because of national differences in the characteristics which distinguish urban from rural areas, the

distinction between urban and rural population is not amenable to a single definition applicable to all countries. For this reason, each country should decide which areas are to be classified as urban and which as rural, in accordance with their own circumstances (UN - Principles and Recommendations for a Vital Statistics System).

These diverse classification schemes also reveal the difficulty with the different approaches to defining rural and urban areas and the relationships between them. Definitions based on the criterion of physical clustering of a settlement (population density and/or land use) do not capture more complex relationships within the territory considered, whereas a more functional approach to rural/ urban differences might do so. To capture these linkages properly, however, a great deal of information is required.

Europe's rural areas are diverse in terms of many physical, socio-economic, environmental and institutional factors. This diversity is one of Europe's greatest resources but nevertheless it creates challenges for many Member States on how to accurately define rural areas.

The OECD regional typology is based on three criteria. The first criterion identifies rural communities according to population density. A community is defined as rural if its population density is below 150 inhabitants per square kilometre (500 inhabitants for Japan and Korea to account for the fact that the national population density exceeds 300 inhabitants per square kilometre). The second criterion classifies regions according to the percentage of population living in rural communities.

Thus, a TL3 region is classified as:

- Predominantly rural (rural or PR), if more than 50% of its population lives in rural communities.
- Predominantly urban (urban or PU), if less than 15% of the population lives in rural communities.
- Intermediate (IN), if the share of population living in rural communities is between 15% and 50%.

The third criterion is based on the size of the urban centres. Accordingly:

● A region that would be classified as rural on the basis of the general rule is classified as intermediate if it has a urban centre of more than 200 000 inhabitants (500 000 for Japan) representing no less than 25% of the regional population.

● A region that would be classified as intermediate on the basis of the general rule is

classified as predominantly urban if it has an urban centre of more than 500 000 inhabitants (1 million for Japan) representing no less than 25% of the regional population. Rural communes are the communes with population density below 150 inhabitants / Km^2.

The OECD definition of rural areas was only taken up by a minority of national and regional Rural Development Programs for the period 2007-2013. Member States or regions use a wide variety of territorial definition to target their rural areas. Several reasons were provided in order to justify the choice of an alternative (to the OECD) definition of rural areas. These include the “limited” (in several cases) ability of the OECD definition to portray the socio-geographical needs of the country or regional heterogeneity, the desire for a more relevant (nationally) distinction between rural and urban areas, a commitment to earlier national definitions, and the desire to utilize a more policy-priorities-driven tool for the identification of area-specific development needs (EPRS Library).

As rather expected, the modification of the OECD definition and the use of alternative definitions of rural areas have resulted into the rather significant increase of the proportion of national territory and population classified as rural.

The classic texts of Pahl (1966) and Newby (1980) represent only two examples in the plethora of works disputing the relevance of the concept of rurality. The latter's conclusion, published in 1980, was and still is illustrative in its definitive judgement: the rural 'has no sociological meaning [...] no sociological definition of rural is acceptable' (Newby, 1980).

The debate still goes on. In the 1990s, however, the discussion on how to understand rurality gained new momentum as several contributions, inspired by the 'cultural turn' within the social sciences, proposed to conceive of 'rurality' as subjective and socially constructed phenomena, located in people's minds, rather than as a material and objective reality (Phillips, 1998; Cloke, 1997; Halfacree, 1993; Murdoch & Pratt, 1993; Mormont, 1990). For example, Mormont (1990) concludes that 'rurality is not a thing or a territorial unit, but derives from the social production of meaning'. Halfacree (1993) in a similar tone defines 'the rural in terms of disembodied cognitive structures-which we use as rules and resources in order to make sense of our everyday world'. Thus, the research focus seems to have shifted towards the processes underlying actors' constructions of the rural and the outcome of these processes. Rather than asking what rurality 'is' the pivotal question has become how actors do socially construct their rurality.

The distinction between concrete and abstract characteristics of rurality, which is emphasised by Halfacree (1995), seems useful when examining lay people's conceptualisations of rurality. By and large, these seem to mirror the scholarly accounts of rurality. On the one hand, people seem to define

the rural in terms of a set of objective criteria. These primarily include landscape features (wilderness or farm land, not built-up land), demographic structure (sparsely populated), and occupational structure (agriculture) (Almas, 1995; Jones, 1995; Hoggart et al, 1995; Pahl, 1966). This list of rural indicators may vary from person to person and from society to society, as emphasised by Hoggart et al (1995) in their description of the many forms of rurality within Europe. However, these authors claim that open landscape and a sparse settlement structure seem to be accepted by most actors as generic characteristics of rurality.

At the same time lay people, just as much as scholars, conceive of the rural in terms of abstract social characteristics, to which they ascribe normative values. A review of previous empirical studies suggests a rather coherent structure of these characteristics. Nature/natural seems the most prominent feature of rurality (Halfacree, 1995; Bell, 1992). Rural life is conceived as more 'natural' than life in the cities. Bell (1992) even argues that this feature of rurality serves as the moral foundation for rural residents. Secondly, rural life is conceptualised in terms of the social fabric of the rural (Almas, 1995; Halfacree, 1995; Bell, 1992). The feeling of community is stronger and people seem to be closer to each other, partly due to the transparency of rural life that ensures that 'everyone knows everyone'. Thus, people care for each other and are more willing to engage in others' life. Furthermore, this 'community spirit' facilitates collective action. When the community faces a challenge, everyone gives his/her contribution.

One final point must be noted about the rural livelihood conditions. For large countries especially, there is a great deal of regional variation such that several “worlds” exist within a single country. Within India, for example, Uttar Pradesh may be classified as an agriculture-based state using the criteria descried above, whereas Tamil Nadu may be considered an urbanized state. Similar degrees of regional variation can be found in other large countries such as Mexico or China (Ibid., 33). Thus we can say that the idea of rurality is vast and endless.

2.2. Relationship between accessibility, mobility and rural development

Investment in rural roads has been a major concern of donor agencies and developing country governments. This process has been well documented, as have the problems associated with the subsequent neglect of this network. However, the importance of transport services in the provision of rural accessibility has largely been ignored until relatively recently (Ellis, 1996).

Firstly, the efficient supply of rural transport services is essential to accessibility and the promotion of economic growth. Secondly, the current emphasis on roads fails to address the problem of rural mobility. An effective rural transport policy needs to take an integrated approach where roads are considered in conjunction with vehicle services and the location of essential facilities and services.

Thirdly, that the market has an important role to play in the provision of rural transport services. Excessive regulation can lead to inefficiencies in transport operations (Ellis, 1997).

Transport is looked at as a basic need. Poor accessibility in the rural areas of developing countries perpetuates the deprivation trap by denying communities access to their most basic needs. Chambers (1983) lists isolation as one of the five factors (isolation, powerlessness, vulnerability, poverty and physical weakness) which contribute to the deprivation trap. Isolation through poor accessibility will slow down the diffusion of new technologies and techniques, increase marketing and production costs and limit access to education and health facilities according to him.

In the past the exact nature of rural people's transport needs were not fully understood and, as a result, transport interventions were mainly in the form of new road building. There is now considerable doubt as to whether new road building necessarily stimulates economic growth and, if it does, do the benefits "trickle down" to the poorest members of the community (Ellis, 1996). So some transport planners are currently adopting a basic needs approach for the development and the provision of transport services. Priority is given to giving access to essential social and economic goods and services. In order to plan accessibility to respond to people's needs it is important to define what actually constitutes basic needs. At the lowest level of basic needs there are three requirements - food, clothing and shelter. For the purposes of transport planning this definition has to be expanded in order to encompass all the transport elements required to satisfy needs. Howe (1983) lists core level local movement requirements as:

(i) Health

(ii) Education

(iii) Markets

(iv) Water

(v) Firewood

(vi)Other subsistence tasks (principally farming)

These six core level local movement requirements represent the first and most important level of accessibility in the rural context. The next level of level of accessibility is to wider needs through access to major centres of activity, and personal movement or travel for non-essential purposes. Satisfying basic transport needs in rural areas, particularly in many Sub Saharan African countries, represent a significant time, energy and cost burden on households. The time spent on subsistence transport tasks alone can reach up to 40 hours per household per week. In addition, the formal roads

network, and the conventional transport services that operate on them, fail to address the fundamental transport needs of rural people.

"Most rural transport is conducted on an informal path and track network which links villages, farms, and sources of water and firewood. Women incur most of this burden, particularly with regard to the collection of water and firewood. Poor accessibility also limits access to other vital services such as markets, schools and health facilities, thereby limiting people's productive potential"(Ellis, 1997). It is also documented that many Sub Saharan African countries make very little use of low cost transport aids (e.g. animals, wheelbarrows, bicycles etc.) to ease this burden. In many rural areas there are no alternatives to headloading, an activity that is mainly conducted by women. In contrast Asian countries have higher levels of both motorised and non-motorise vehicle ownership and greater levels of vehicle diversity. The efficiency, cost and reliability of rural transport services is therefore influenced by the insufficient supply of motorised as well as non-motorised vehicle service.

If transport planners aim to improve access and the ability of rural people to satisfy their basic needs then a more integrated approach has to be adopted. Equal weight must be given to infrastructure paths, tracks and roads), appropriate modes of transport and the improved location of facilities. In order to establish whether accessibility planning has been successful it is necessary to set targets to measure the degree of success in providing basic needs. Howe (1981) states that basic needs targets should be based on outputs rather than inputs. For example, in the education field the number of years of schooling might be used as an input target whereas a typical output target would be based on measured abilities developed by schooling (e.g. success in examinations). In the transport field an input target is the number of kilometres of road built whereas an output target tight be a quantified measure of mobility. In some cases there are known relationships between inputs and outputs as is the case with vaccination programmed.

Regardless of the troubles in setting output targets for rural accessibility there are a number that could be used. For example, all households should be within x km and y minutes from a water source, market or school; all markets connected by a route which is open at least 360 days a year; or all households within x km from anon-motorised transport service. The Pilot Integrated Transport Project in Malawi used these sort of targets to represent the ambitions of the project in providing access to various basic needs. For example, the targets included (a) to have access to water supplies within five minutes; (b) access to health facilities within 30 minutes; and (c) access to grinding mills within 60 minutes.

Creightney (1993) defines accessibility as "the ability or ease of reaching various destinations or places offering opportunities for a desired activity". The elements of accessibility therefore includes

the infrastructure and the means to use it. With respect to accessibility in the rural areas, the infrastructure will be feeder roads, tracks and paths, and the vehicles (motorised or non-motorised) will provide the mobility. If increased access to roads is provided but there is no provision for vehicle services and hence mobility, then there has been no improvement in accessibility according to Creightney's definition.

Reducing the time and effort involved in reaching essential services is not only a case of providing infrastructure and transport services but also relocating services. By bringing services closer to people or making services mobile, the need for travel is reduced. Jones (1981) adds a further component to accessibility, that of time i.e. the time at which the individual is able to participate and the time at which the facility is available. Particular interventions are likely to suit access to certain facilities and services better than others. For example, access to water, firewood, health and educational facilities can be most improved through the more appropriate location of these services. Crop marketing can be improved through low cost means of transport, conventional transport services and/or the provision of roads. A combination of roads and conventional transport services is the most sensible approach to be taken for improving access to markets and employment activities.

Let us first understand the distinction between accessibility and mobility which is a critical aspect in creating a sound and sustainable transportation policy. The SUSTRAN (Sustainable Transportation) website of the Global Development Research Center provides valuable data in this regard. The main points are listed below.

"'Traffic': in this perspective vehicle movement and speed are beneficial; congestion or inadequate roads are seen as the problem. The old roads-focussed approaches in rural transport could be seen as analogous to a traffic focus.

'Mobility': in this perspective it is the efficient movement of people and goods that is seen as beneficial or as they key aim of policy. This is much wiser than a traffic focus because at least it helps move attention to more efficient ways of moving people and goods. This would put a high priority on collective modes of transport (e.g. buses, rail).

Mobilities research encompasses not only corporeal travel of people and the physical movement of objects, but also imaginative travel, virtual travel and communicative travel (Urry, 2007), enabling and coercing (some) people to live more 'mobile lives' (Elliott and Urry, 2010). Mobility (being mobile) is defined as the ease or the difficulty with which people and goods move from one point to another (the origin and destination). Mobility is associated with the transport infrastructures as well as the means of travel and transport. There are 4 interpretations of mobility according to Urry:

1. That which is capable of movement
2. A ‘mob’
3. Social mobility(vertical hierarchy of socio-economic class)
4. Migration/ semi-permanent geographical movement

'Accessibility' or an 'access focus': In this perspective it is the ability to REACH opportunities that is beneficial, not movement itself. In remote rural contexts gaining access to services, goods and contacts will often require a lot of mobility. However, in many urban contexts accessibility might involve very short trips. And in places like suburban USA policy to enhance accessibility might actually require that we reduce traffic or even reduce the need to travel (or reduce mobility).

The different features of traffic, mobility and access are tabulated in the table 2.2 given below:

Table 2.2. Comparing transportation measurements

	TRAFFIC	**MOBILITY**	**ACCESS**
Definition of Transportation	Vehicle travel.	Person and goods movement.	Ability to obtain goods, services and activities
Unit of measure	Vehicle-miles and vehicle trips	Person-miles, person-trips and ton-miles.	Trips
Modes considered	Automobile and truck.	Automobile, truck and public transit.	All modes, including mobility substitutes such as telecommuting
Common performance indicators	Vehicle traffic volumes and speeds, roadway Level of Service, costs per vehicle mile, parking convenience	Person-trip volumes and speeds, road and transit Level of Service, cost per person trip, Travel convenience.	Multi-modal Level of Service, land use accessibility, generalized cost to reach activities.
Assumptions concerning what benefits consumers	Maximum vehicle mileage and speed,	Maximum personal travel and goods movement.	Maximum transport options, convenience,

	convenient parking, low vehicle costs		land use accessibility, cost efficiency
Consideration of land use	Favours low-density, urban fringe development patterns.	Favours some land use clustering, to accommodate transit.	Favours land use clustering, mix and connectivity.
Favored transport improvement strategies	Increased road and parking capacity, speed and safety	Increased transport system capacity, speeds and safety.	Improved mobility, mobility substitutes and land use accessibility.

Source: Todd Litman, 2003-2011

In the rural transport context, an example would be non-transport interventions such as efforts to bring water supply and fuel supply to houses (instead of forcing people - especially women - to walk long distances for them). This is an excellent example of an effort to increase accessibility of services without the need to increase mobility.

With an accessibility perspective, both traffic and mobility are obviously still important. But they are seen as 'means' not 'ends in themselves'. Other ways to enhance accessibility would include planning for proximity, improved communications systems, bringing services closer, etc."(Paul Barter)

According to Todd Litman (2011), there are primarily three different methods for evaluating the performance of a transportation system and for making planning decisions. Traffic-based measurements (such as vehicle trips, traffic speed and roadway level of service) evaluate motor vehicle movement. Mobility-based measurements (such as person-miles, door-to-door traffic times and ton-miles) evaluate person and freight movement. Accessibility-based measurements (such as person-trips and generalized travel costs) evaluate the ability of people and businesses to reach desired goods, services and activities (Meyer and Schuman, 2002).

Let us now focus on mobility and sustainable development. Both are critical to sustain the local population and also to generate economy. Transport and mobility are now high on many agendas as countries and regions across the world seek to increase mobility and to diminish transport's impact. Over the past few years, various researches on mobility have been made that involve the movement of people and information in a dynamic manner. The words 'movement' and 'stillness' have various meanings and ideologies which are attached to them. The Mobilities theory talk about the complex relations between bodies, movement and space. Further, it draws from Foucauldian genealogies for addressing the meanings of (im)mobility, discourses and visual representations of speed and slowness.

Mobilities go beyond flow, nomadism and globalisation. Critical mobilities research instead interrogates who and what is demobilised and remobilised across many different scales, and in what situations mobility or immobility might be desired options, coerced, or paradoxically interconnected (Adey, 2010).

"If movement and spatial fixity are always co-constituted, then mobilities are a central aspect of both historical and contemporary existence, and are always being reconfigured in complex ways to support different modes of trade, interaction and communication, as was recognised by early sociological theorists such as the Chicago School of urban sociology in the early 20th century. Social mobility and infrastructures of human, technological and informational mobility were as crucial to the existence of ancient imperial cities, seafaring empires of early modernity and 19th century industrialising cities as of the modern megacities today (not to mention of non-urban rural and island locations"(Vannini, 2011).

Mobility has three main sustainability issues: CO2 emissions from cars and air transport, congestion and casualties due to road traffic. Sustainable mobility innovations usually bring about changes across one, two or three of the main system elements: infrastructure, vehicles, and behaviour.

2.3.Quality targets and indicators for sustainable mobility in cities and regions

Indicators as assessment parameters

"Indicators are necessary for assessing mobility and transport development, but requires differentiated use and in many cases additional interpretation. They serve to indicate states, illustrate progress (and possibly stagnation and setbacks), and indicate qualities and deficits on the road to sustainable development. They are not, however, a substitute for the formulation of quality targets. The indicators developed in the model project can be classified in three types, and these are explained in more detail below:

• Quantifiable measures-oriented indicators,

• Quantifiable impact-oriented indicators, and

• Action-oriented and project-oriented indicators not suitable for quantification.

All three types of indicators are equally important in relation to the overall objective of "sustainable mobility"(Umweltbundesamt Dessau, 2005).

The four main players in the sociotechnical regime are authorities, vehicle producers, users and fuel producers. They are tightly connected to the system elements but authorities have the most

intertwined role in the system as a provider and owner of road and public transport infrastructure, as an operator of public transport services (although privatisation is starting up), as a regulator for safety, traffic rules, product standards and so on, as a cashier for the fuel, vehicle and road taxes and excises and as a public procurer of mobility. This large number of 'buttons' creates enormous opportunities to exert influence but also requires coordinated efforts to show effect (Geerken and Borup, 2009).

'Sustainable mobility' is a term which summarises that which is at stake in contemporary attempts to change the parity of costs and benefits in the transport sector. Those who said that sustainable development has nothing to do with transport or mobility have to take back their words since it has been proved as an integral part of today's planning.

2.4. Global Positioning System (GPS)

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with a GPS receiver. The design of GPS is based partly on similar ground-based radio-navigation systems, such as LORAN and the Decca Navigator, developed in the early 1940s and used by the British Royal Navy during World War II (Wikipedia).

GPS answers five questions simultaneously:

a. "Where am I?"
b. "Where am I going?"
c. "Where are you?"
d. "What's the best way to get there?
e. "When will I get there?"

"A GPS navigation device is a device that accurately calculates geographical location by receiving information from GPS satellites. Initially it was used by the United States military, but now most receivers are in automobiles and smartphones.

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of a minimum of 24, but currently 30, satellites placed into orbit by the U.S. Department of Defence. Military action was the original intent for GPS, but in the 1980s, the U.S. government decided to allow the GPS program to be used by civilians. The satellite data is free and works anywhere in the world.

GPS devices may have capabilities such as:

- maps, including streets maps, displayed in human readable format via text or in a graphical format,
- turn-by-turn navigation directions to a human in charge of a vehicle or vessel via text or speech,
- directions fed directly to an autonomous vehicle such as a robotic probe,
- traffic congestion maps (depicting either historical or real time data) and suggested alternative directions,
- information on nearby amenities such as restaurants, fueling stations, and tourist attractions.

GPS devices may be able to answer:

a. the roads or paths available,
b. traffic congestion and alternative routes,
c. roads or paths that might be taken to get to the destination,
d. if some roads are busy (now or historically) the best route to take,
e. The location of food, banks, hotels, fuel, airports or other places of interests,
f. the shortest route between the two locations,
g. the different options to drive on highway or back roads."(Wikipedia)

CHAPTER 3

C. RESEARCH METHODOLOGY

The research work has been carried out to fulfil the aim of the study which is to answer the research question- "What is the influence of the size of the territory in rural France on the mobility of its people?" This was possible by analysing the current issues facing the rural communities of the world and connectivity seemed as an issue for research. Mobility research carried out so far by different authors stress the importance of understanding the psychology and travel characteristics of the rural people. This can differ with the time of the day, weekdays and weekends, age, gender, type of the vehicle i.e. the mode of travel, the motive or purpose behind the trip, the distance to the facilities and the size of the territory. This study included an experiment to check how the size of the rural territory could influence the mobility trend of the people. For this, results of a GPS Dataset for a small sample set of volunteers from two different territories of rural France – the Communauté de Communes du Bouchardais (CCB) and La Communauté de communes Touraine Nord-Ouest (CCTNO) were considered. The study area is shown in the figures below (Figures 3.1.a, 3.1.b and 3.1.c).

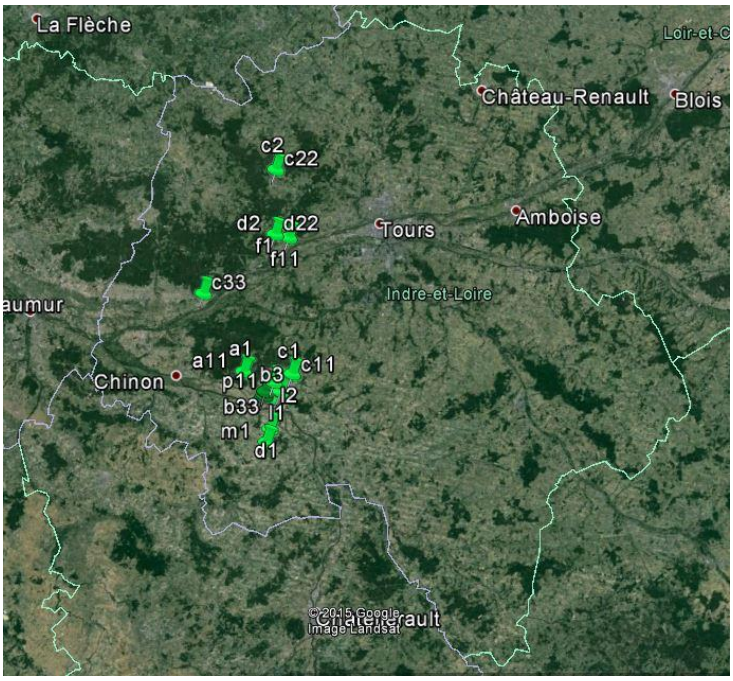


Figure3.1. c. Location of residences of people in CCB and CCTNO

Figure 3.1.a. Study area CCB

Figure 3.1.b. Study area CCTNO

3.1. Study Area

Communauté de Communes du Bouchardais (CCB):

A community of communes is a public intermunicipal cooperation (EPCI) French with their own tax, which provides limited integration of common members.

It is defined as:

"[...] A public institution for cooperation involving several towns in one piece and without enclave. It aims to involve municipalities in an area of solidarity, for the preparation of draft common development and spatial planning. "

-. Beginning of the article L 5214-1 of the General Code of local authorities.

CCB is a French intermunicipality located in the department of Indre-et-Loire region and Loire Valley Centre

- Population: 7243 inhabitants (2007)
- Density: 31 inhabitants / Km^2
- Area: 235.86 km^2).

La Communauté de communes Touraine Nord-Ouest (CCTNO):

- This is one of the largest EPCI (Etablissement Public Intermunicipal Cooperation) Indre et Loire.
- Its territory, vast, encompassing the cantons of Langeais (Val de Loire) and Château la Valliere (Green Zone Castelvalérie) and extends from north to south of the town of Villiers au Bouin in the commune of Saint Patrick, and to the transverse axis, to Rillé Ambillou.
- Touraine North West is in the perimeter of the Pays Loire Nature. The association brings together three communities of municipalities:

    1. Touraine North West (23 communes)
    2. Gâtine Choisille (10 towns)

3. Racan (10 towns)

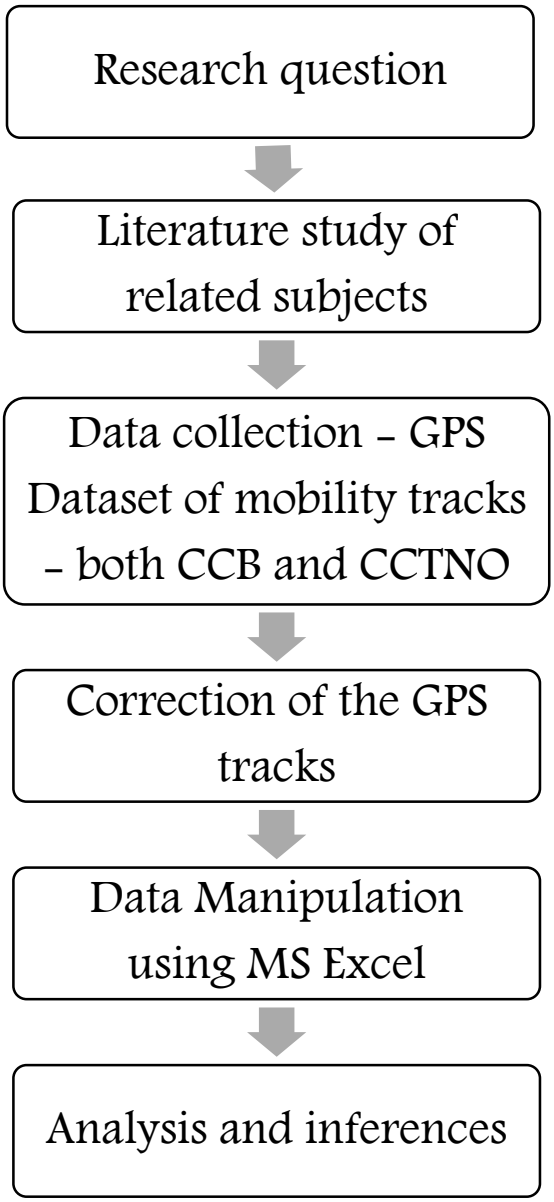
- Population : 21,303 inhabitants (2007)
- Density: 38 inhabitatnts / Km^2
- Area: 556.21 km^2

The GPS dataset for the movement of the volunteers from both CCB and the CCTNO rural areas of France was obtained. The study area which encompasses the mobility traces of the volunteers is as shown in Figure 3.2

3.2.Research Methodology

The study follows a carefully structured methodology which relates with the research question. The flow chart (Figure 3.2.) gives the research methodology that has been adopted for the study:

Figure 3.2. Research Methodology



I. Initially the GPS track of an individual from CCTNO (say C2.gpx) was taken for analysis. The track was first edited for local inconsistencies using the GPS Track Editor Software v1.14.135. The raw GPS track consisted of 55464 points. The first iteration removed 47341 points. The second iteration removed 6 points. The third iteration removed 5 points. The fourth iteration removed 2 points. The final iteration did not show any inconsistent points. Now, 8110 points remained.

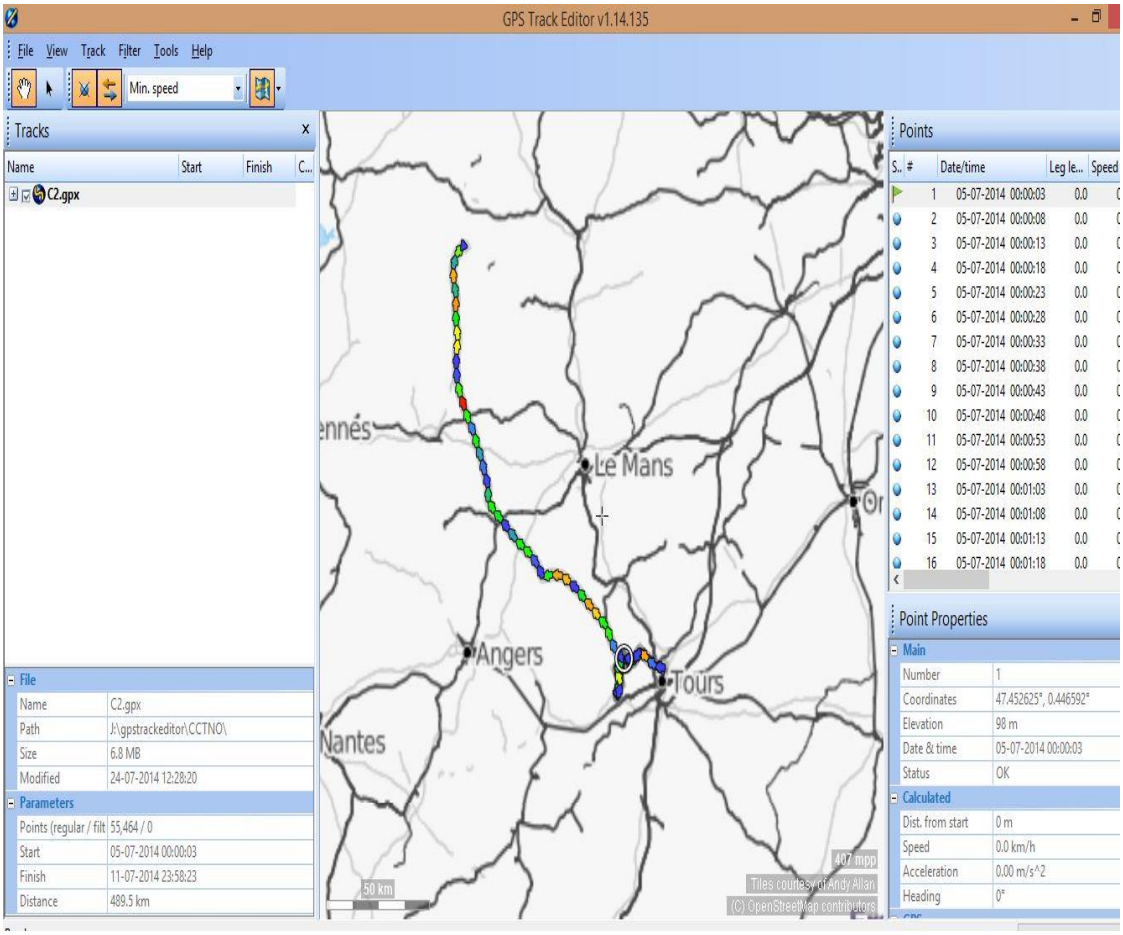
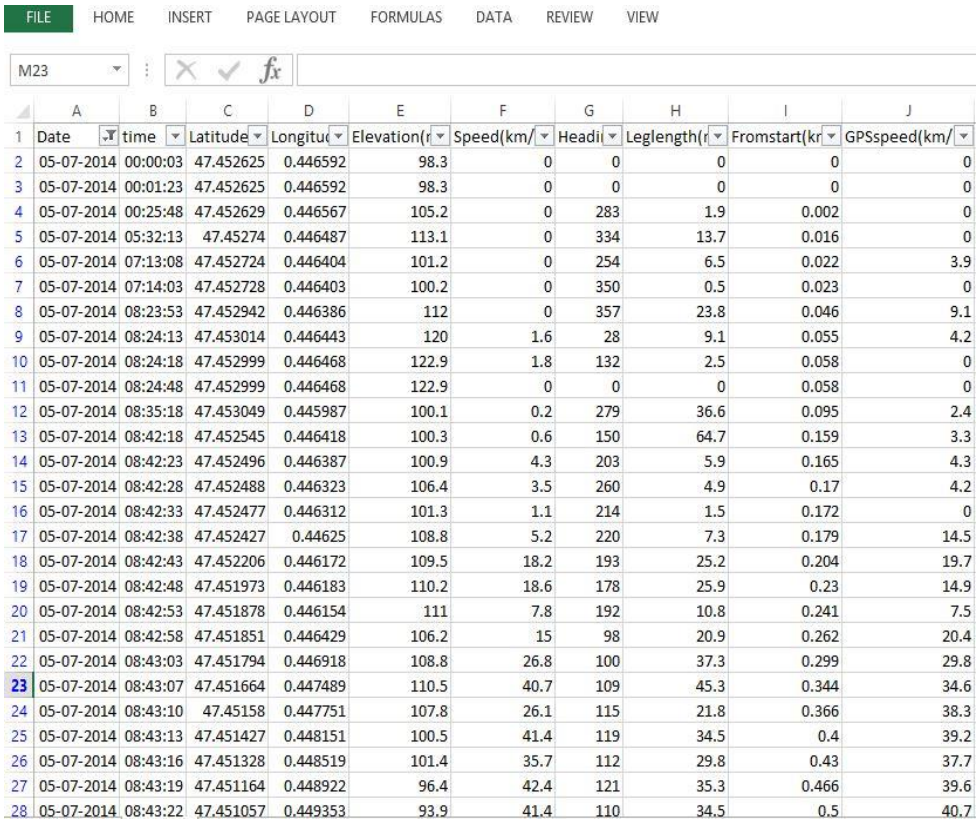


Figure 3.3. GPX Track Editor

II. The filtered points were observed closely and they were checked once again for errors. Once the track was error-free, the .gpx file was exported to Microsoft word. All information like date, time, Latitude, longitude, elevation, speed, leg length, heading, etc., were exported.

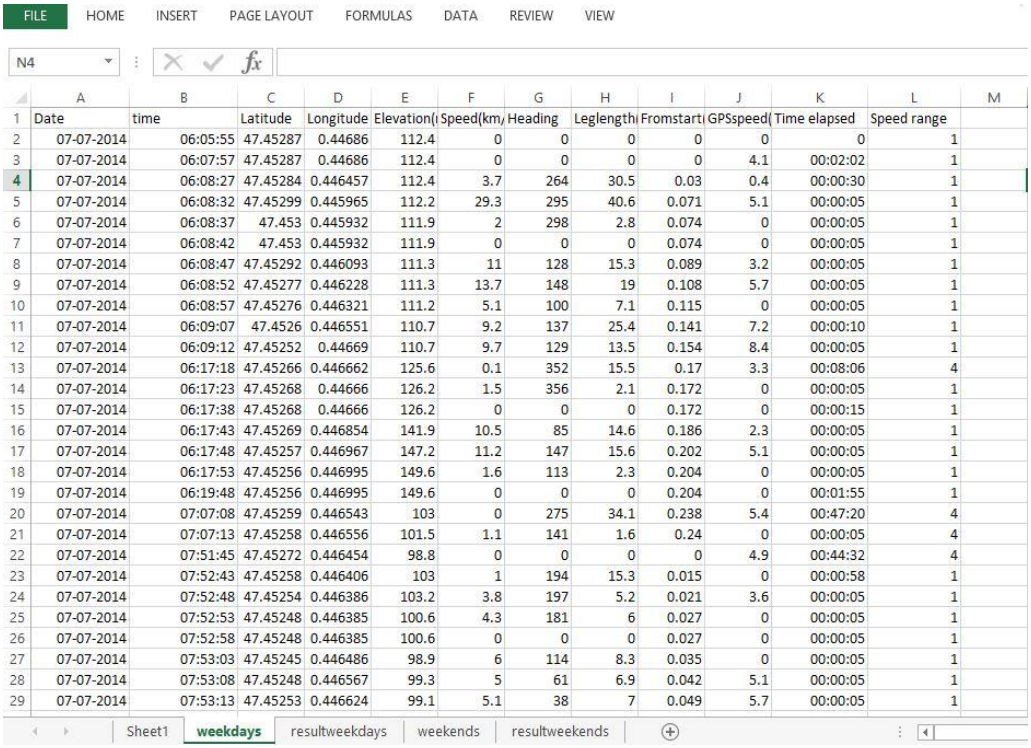
III. The points were then sorted separately into weekdays and weekends so that we could compare their results. The track under consideration C2.gpx dated from 05/07/2014 to 11/07/2014. Hence it has five weekdays and two weekend days.

IV. The time elapsed between every two GPS track points can be determined because we already have the instantaneous time at every reading.



	A	B	C	D	E	F	G	H	I	J
1	Date	time	Latitude	Longitu	Elevation(r	Speed(km/	Headi	Leglength(r	Fromstart(kr	GPSspeed(km/
2	05-07-2014	00:00:03	47.452625	0.446592	98.3	0	0	0	0	0
3	05-07-2014	00:01:23	47.452625	0.446592	98.3	0	0	0	0	0
4	05-07-2014	00:25:48	47.452629	0.446567	105.2	0	283	1.9	0.002	0
5	05-07-2014	05:32:13	47.45274	0.446487	113.1	0	334	13.7	0.016	0
6	05-07-2014	07:13:08	47.452724	0.446404	101.2	0	254	6.5	0.022	3.9
7	05-07-2014	07:14:03	47.452728	0.446403	100.2	0	350	0.5	0.023	0
8	05-07-2014	08:23:53	47.452942	0.446386	112	0	357	23.8	0.046	9.1
9	05-07-2014	08:24:13	47.453014	0.446443	120	1.6	28	9.1	0.055	4.2
10	05-07-2014	08:24:18	47.452999	0.446468	122.9	1.8	132	2.5	0.058	0
11	05-07-2014	08:24:48	47.452999	0.446468	122.9	0	0	0	0.058	0
12	05-07-2014	08:35:18	47.453049	0.445987	100.1	0.2	279	36.6	0.095	2.4
13	05-07-2014	08:42:18	47.452545	0.446418	100.3	0.6	150	64.7	0.159	3.3
14	05-07-2014	08:42:23	47.452496	0.446387	100.9	4.3	203	5.9	0.165	4.3
15	05-07-2014	08:42:28	47.452488	0.446323	106.4	3.5	260	4.9	0.17	4.2
16	05-07-2014	08:42:33	47.452477	0.446312	101.3	1.1	214	1.5	0.172	0
17	05-07-2014	08:42:38	47.452427	0.44625	108.8	5.2	220	7.3	0.179	14.5
18	05-07-2014	08:42:43	47.452206	0.446172	109.5	18.2	193	25.2	0.204	19.7
19	05-07-2014	08:42:48	47.451973	0.446183	110.2	18.6	178	25.9	0.23	14.9
20	05-07-2014	08:42:53	47.451878	0.446154	111	7.8	192	10.8	0.241	7.5
21	05-07-2014	08:42:58	47.451851	0.446429	106.2	15	98	20.9	0.262	20.4
22	05-07-2014	08:43:03	47.451794	0.446918	108.8	26.8	100	37.3	0.299	29.8
23	05-07-2014	08:43:07	47.451664	0.447489	110.5	40.7	109	45.3	0.344	34.6
24	05-07-2014	08:43:10	47.45158	0.447751	107.8	26.1	115	21.8	0.366	38.3
25	05-07-2014	08:43:13	47.451427	0.448151	100.5	41.4	119	34.5	0.4	39.2
26	05-07-2014	08:43:16	47.451328	0.448519	101.4	35.7	112	29.8	0.43	37.7
27	05-07-2014	08:43:19	47.451164	0.448922	96.4	42.4	121	35.3	0.466	39.6
28	05-07-2014	08:43:22	47.451057	0.449353	93.9	41.4	110	34.5	0.5	40.7

Figure 3.4. Export of .gpx file to .csv format



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Date	time	Latitude	Longitude	Elevation(i	Speed(km/	Heading	Leglengthi	Fromstarti	GPSspeed(	Time elapsed	Speed range	
2	07-07-2014	06:05:55	47.45287	0.44686	112.4	0	0	0	0	0	0	1	
3	07-07-2014	06:07:57	47.45287	0.44686	112.4	0	0	0	0	4.1	00:02:02	1	
4	07-07-2014	06:08:27	47.45284	0.446457	112.4	3.7	264	30.5	0.03	0.4	00:00:30	1	
5	07-07-2014	06:08:32	47.45299	0.445965	112.2	29.3	295	40.6	0.071	5.1	00:00:05	1	
6	07-07-2014	06:08:37	47.453	0.445932	111.9	2	298	2.8	0.074	0	00:00:05	1	
7	07-07-2014	06:08:42	47.453	0.445932	111.9	0	0	0	0.074	0	00:00:05	1	
8	07-07-2014	06:08:47	47.45292	0.446093	111.3	11	128	15.3	0.089	3.2	00:00:05	1	
9	07-07-2014	06:08:52	47.45277	0.446228	111.3	13.7	148	19	0.108	5.7	00:00:05	1	
10	07-07-2014	06:08:57	47.45276	0.446321	111.2	5.1	100	7.1	0.115	0	00:00:05	1	
11	07-07-2014	06:09:07	47.4526	0.446551	110.7	9.2	137	25.4	0.141	7.2	00:00:10	1	
12	07-07-2014	06:09:12	47.45252	0.44669	110.7	9.7	129	13.5	0.154	8.4	00:00:05	1	
13	07-07-2014	06:17:18	47.45266	0.446662	125.6	0.1	352	15.5	0.17	3.3	00:08:06	4	
14	07-07-2014	06:17:23	47.45268	0.44666	126.2	1.5	356	2.1	0.172	0	00:00:05	1	
15	07-07-2014	06:17:38	47.45268	0.44666	126.2	0	0	0	0.172	0	00:00:15	1	
16	07-07-2014	06:17:43	47.45269	0.446854	141.9	10.5	85	14.6	0.186	2.3	00:00:05	1	
17	07-07-2014	06:17:48	47.45257	0.446967	147.2	11.2	147	15.6	0.202	5.1	00:00:05	1	
18	07-07-2014	06:17:53	47.45256	0.446995	149.6	1.6	113	2.3	0.204	0	00:00:05	1	
19	07-07-2014	06:19:48	47.45256	0.446995	149.6	0	0	0	0.204	0	00:01:55	1	
20	07-07-2014	07:07:08	47.45259	0.446543	103	0	275	34.1	0.238	5.4	00:47:20	4	
21	07-07-2014	07:07:13	47.45258	0.446556	101.5	1.1	141	1.6	0.24	0	00:00:05	4	
22	07-07-2014	07:51:45	47.45272	0.446454	98.8	0	0	0	0	4.9	00:44:32	4	
23	07-07-2014	07:52:43	47.45258	0.446406	103	1	194	15.3	0.015	0	00:00:58	1	
24	07-07-2014	07:52:48	47.45254	0.446386	103.2	3.8	197	5.2	0.021	3.6	00:00:05	1	
25	07-07-2014	07:52:53	47.45248	0.446385	100.6	4.3	181	6	0.027	0	00:00:05	1	
26	07-07-2014	07:52:58	47.45248	0.446385	100.6	0	0	0	0.027	0	00:00:05	1	
27	07-07-2014	07:53:03	47.45245	0.446486	98.9	6	114	8.3	0.035	0	00:00:05	1	
28	07-07-2014	07:53:08	47.45248	0.446567	99.3	5	61	6.9	0.042	5.1	00:00:05	1	
29	07-07-2014	07:53:13	47.45253	0.446624	99.1	5.1	38	7	0.049	5.7	00:00:05	1	

Figure 3.5. MS Excel sheet with GPS track for the weekdays in C2.gpx track

V. From the speed column, the speed of the movement is known for every point of time. So, we can judge the rate of change of speed. At certain periods of time, we

can find abnormal speeds which may be possible due to the error in the GPS system. So those erroneous rows were deleted.

VI. Certain assumptions were then made regarding the travel for easier data manipulation. They are listed below:

a. Instantaneous Speed of "0 Kmph" indicates either

1. State of rest (or)

2. Braking

b. Every track segment starts and ends with an instantaneous speed of "0 Kmph"
c. Highest Speed within a track segment indicates the mode of transport within that segment
d. Continuity of the mode of transport is taken into account by considering elapsed time

VII. Now, the mode of transport for each segment of time starting from an instantaneous speed of 0 kmph to the next instantaneous speed of 0 kmph or the stop time of more than a minute and a half from the time and speed columns were considered to assign indicators for the speed range to determine the mode of travel resorted to. But this for now shall not include the other considerations to be given while determining the mode of transport such as the exact speed limit of the vehicles on the roads, the maximum speed of vehicles differ in each segment, i.e a cycle can sometimes travel at 3 kmph and at certain times it can travel at 20 kmph, also age and health plays a vital role in the speed of travel and elevation plays an important role in travelling in France due to the rolling terrain that is predominant.

VIII. Speed ranges assumed for the mode of transport is as follows:

Speed (kmph)	**Mode of transport**
0-3	Walk & wheelchair
3-16	Other Non – Motorised transport
16-130	Non – Motorised transport

French roads have a variable speed limit that depends on weather conditions. In dry weather rural 2- or 3-lane roads are limited to 90 km/h, 4-lane expressways (in rural areas) 110 km/h, and highways (in rural areas) 130 km/h.

IX. By comparing the speed range for the different segments of the whole track, the time elapsed and the leg length, we could find the travel characteristics for weekdays and weekend. Taking the mean for number of weekdays and weekends, we get results for one weekday and one weekend such as:

- Time in travel for each mode of transport (per day) per individual, for weekdays and weekends separately.
- Distance travelled by each mode of transport per day per individual (in metres)

More findings are possible for an analysis for a longer period of time. For the time being, only the time of travel and distance travelled per mode have been worker upon.

X. After working upon an individual's track, the same procedure was carried upon the other tracks. Totally six tracks were analysed – three from CCB and three from CCTNO. More accuracy can be achieved by analysing more number of tracks. We need not analyse equal number of tracks from CCB and CCTNO because the length of the tracks vary and also because the time and distance calculated are for per person per day (weekday or weekend). So, only the mean distance or time are required. Any number of available tracks for the region can be analysed and accuracy can be gained with analysis of as many tracks as possible.

XI. After that, we could also find the gender-wise differences in travel trend. i.e, how a male traveller and a female traveller spend time in travel and how long they travel. Since, the exact age of the persons are not known, a generalisation may not be accurate. But still the method holds good. We can categorise the tracks according to the age group and find the travel trends in different age groups and can also compare the difference in the travel trend of age group within the CCB and the CCTNO communes. This will give us a clear understanding of the mobility within both regions.

Similarly, we can analyse for any track within any rural commune and compare mobility among different communes.

CHAPTER 4

D. RESULTS & DISCUSSION

The various GPS tracks of different people from two different communes of rural France were analysed over a period of time and the results obtained were consolidated in Microsoft Excel. The results of the individual tracks analysed are published below:

Assuming a = walking, wheelchair,

b = other non-motorised transport such as cycling, jogging, etc.

c = motorised transport (mostly cars)

d = state of rest (either in braking or spent at a facility)

CCB:

B3.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:10:38	42.3
b	00:25:38	801.65
c	00:40:38	108706.7
d	00:55:38	1666.475
Total (per day)	**01:16:53**	**109550.7**

Table 4.1. Results for B3.gpx file – per weekday per person

B3.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	0:01:47	36.75
b	0:04:46	245.25
c	0:04:09	496.4
d	4:58:28	357.65
Total (per day)	**0:10:42**	**778.4**

Table 4.2. Results for B3.gpx file – per weekend per person

B33.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:06:16	28.16666667
b	00:16:37	619.0666667
c	02:13:41	93871.96667
d	10:03:06	1469.7
Total (per day)	**2:36:34**	**94519.2**

Table 4.3. Results for B33.gpx file – per weekday per person

B33.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:00:00	0
b	00:03:35	50
c	00:00:00	0
d	03:17:03	12.8
Total (per day)	**0:03:35**	**50**

Table 4.4. Results for B33.gpx file – per weekend per person

A11.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	6:12:31	1562.5
b	0:36:15	2899.62
c	0:45:39	27693.92
d	3:40:26	370.8
Total (per day)	**7:34:25**	**32156.04**

Table 4.5. Results for A11.gpx file – per weekday per person

A11.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:03:37	74.4
b	00:14:23	634.7
c	01:03:01	51305.1
d	19:15:38	2232.1
Total (per day)	**1:21:01**	**52014.2**

Table 4.6. Results for A11.gpx file – per weekend per person

CCTNO:

C33.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:09:04	99.42
b	01:32:18	1152.84
c	02:45:28	51582
d	07:20:03	1732.74
Total (per day)	**4:26:50**	**52834.26**

Table 4.7. Results for C33.gpx file – per weekday per person

B3.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	0:08:58	17.55
b	1:07:04	1206.4
c	2:15:41	60844.6
d	7:17:32	1097.7
Total (per day)	**3:31:44**	**62068.55**

Table 4.8. Results for C33.gpx file – per weekend per person

Table 4.9. Results for C22.gpx file – per weekday per person

C22.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	8:22:29	264.725
b	3:25:50	1162.7
c	3:30:13	114491.8
d	3:38:09	360.15
Total (per day)	**15:18:31**	**115919.2**

C22.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:19:15	108.2
b	00:56:03	1172.7
c	01:41:46	43939.6
d	16:53:22	519.1
Total (per day)	**2:57:04**	**45220.5**

Table 4.10. Results for C22.gpx file – per weekend per person

C2.gpx	Weekdays	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	04:32:31	42.04
b	02:12:27	403
c	05:35:53	66610.98
d	01:51:39	1290.06
Total (per day)	**12:20:50**	**67056.02**

Table 4.11. Results for C2.gpx file – per weekday per person

C2.gpx	Weekends	
Mode of travel	**Time in travel (hh:mm:ss)**	**Distance travelled (m)**
a	00:13:08	16.35
b	00:12:32	300.4
c	01:28:51	33019.2
d	21:03:52	1860.65
Total (per day)	**1:54:31**	**33335.95**

Table 4.12. Results for C2.gpx file – per weekend per person

The above results can be consolidated for each person's week of tracking and taking average of different persons' tracks for weekdays and weekends to find the mean distance travelled by the persons per weekday and per weekend for both CCB and CCTNO communes. The results obtained here are only tentative since the sample size was small. But the same procedure could be adopted to find the exact travel trend if we analyse more number of GPS tracks.

From the results, we find that the percentage of time spent in motorised transport like cars is higher than the other modes.

		WEEKDAYS		WEEKENDS	
		Time(hh:mm:ss)	Distance(m)	Time(hh:mm:ss)	Distance(m)
CCB	B3	01:16:53	109550.7	0:10:42	778.4
	A11	7:34:25	32156.04	1:21:01	52014.2
	B33	2:36:34	94519.2	0:03:35	50
	Mean	**03:49:18**	**78741.97**	**0:31:46**	**17614.2**
CCTNO	C33	4:26:50	52834.26	3:31:44	62068.55
	C22	15:18:31	115919.2	2:57:04	45220.5
	C2	12:20:50	67056.02	1:54:31	33335.95
	Mean	**10:42:04**	**78603.16**	**2:47:46**	**46875**

Table 4.13. Comparison of CCB and CCTNO - mean travel time and distances

		WEEKDAYS		WEEKENDS	
		Time(hh:mm:ss)	Distance(m)	Time(hh:mm:ss)	Distance(m)
CCB	**a**	02:09:48	544.3222	0:01:48	37.05
	b	00:26:10	1440.112	0:07:34	309.9833
	c	01:13:19	76757.54	0:22:23	17267.17
	d	04:53:03	1168.992	09:10:23	867.5167
CCTNO	**a**	4:21:21	135.395	00:13:47	47.36667
	b	2:23:32	906.18	00:45:13	893.1667
	c	3:57:11	77561.59	01:48:46	45934.47
	d	4:16:37	1127.65	15:04:55	1159.15

Table 4.14. Mean travel time and distances for each mode of transport

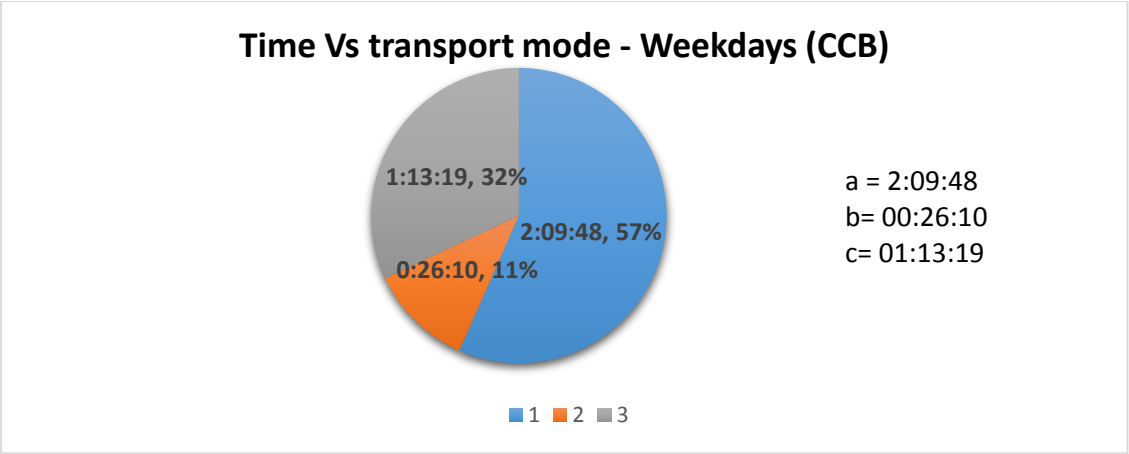


Figure 4.15. Time vs transport mode for weekdays (CCB)

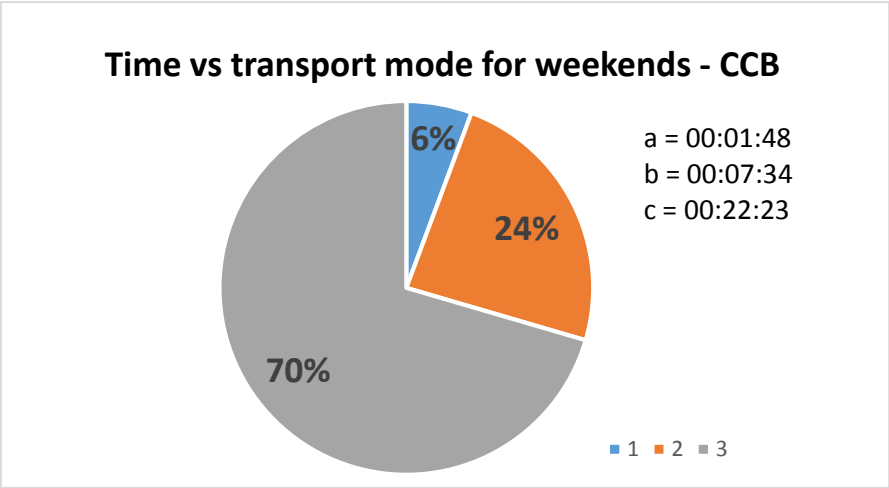


Figure 4.15.a. Time vs transport mode for weekends - CCB

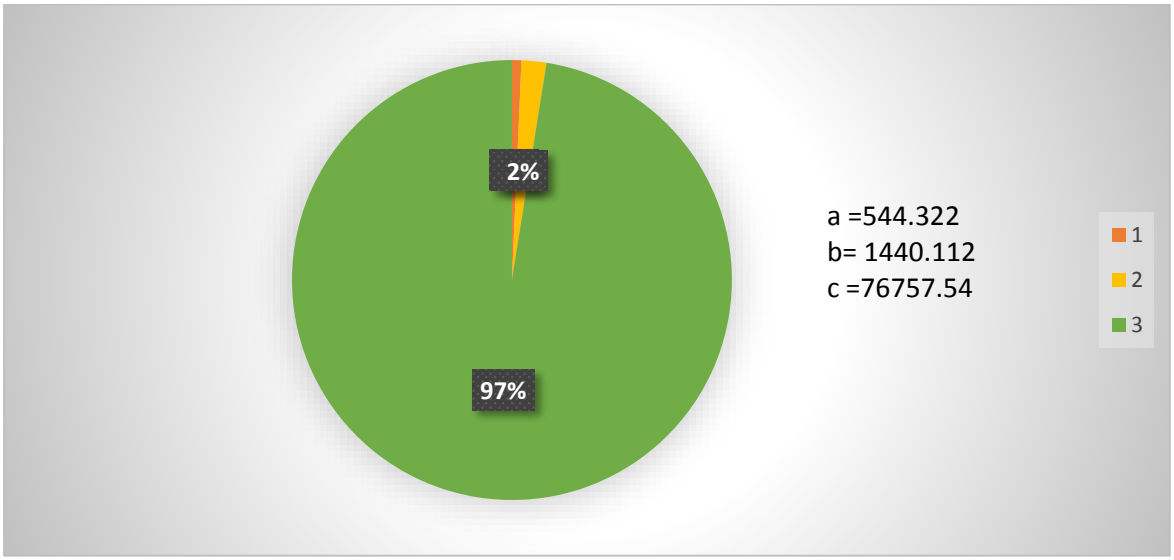


Figure 4.16. Distance vs transport mode for weekdays (CCTNO)

From the above table, we can say that the time travelled by preliminary mode of transport such as walking is predominant in both the rural territories. Mobility by car travel plays an important role in the rural transportation.

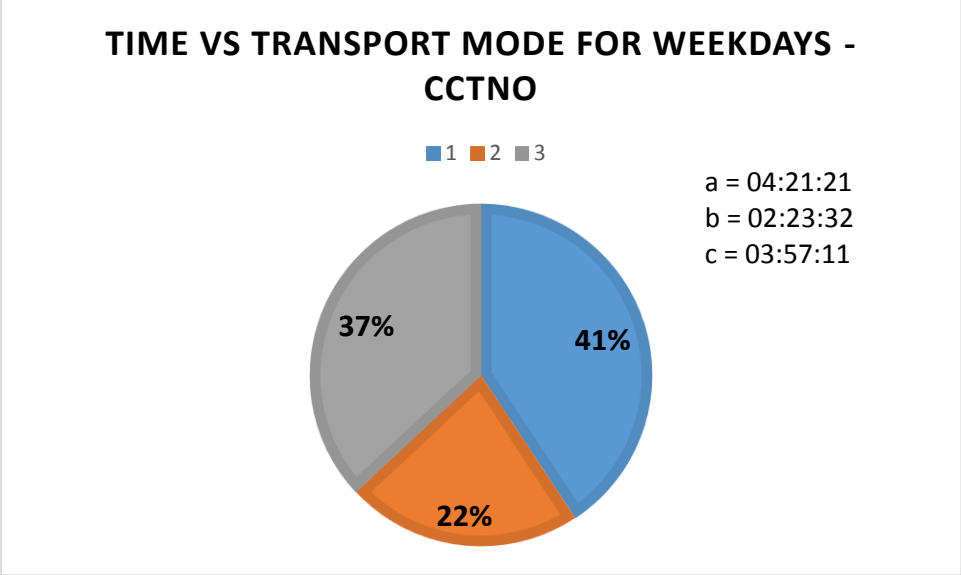


Figure 4.17. Time vs transport mode for weekdays (CCTNO)

We could observe that most of the travel took place by motorised transport, only next to walking. Comparing both the territories, it is observed that there is almost triple the time of travel by motorised transport such as car and bikes in CCTNO compared to the CCB. Though it cannot be generalised and called the preference of the people, we could still observe that maximum proportion of the distance travelled in a day is carried out by way of using motorised transport such as bikes or cars.

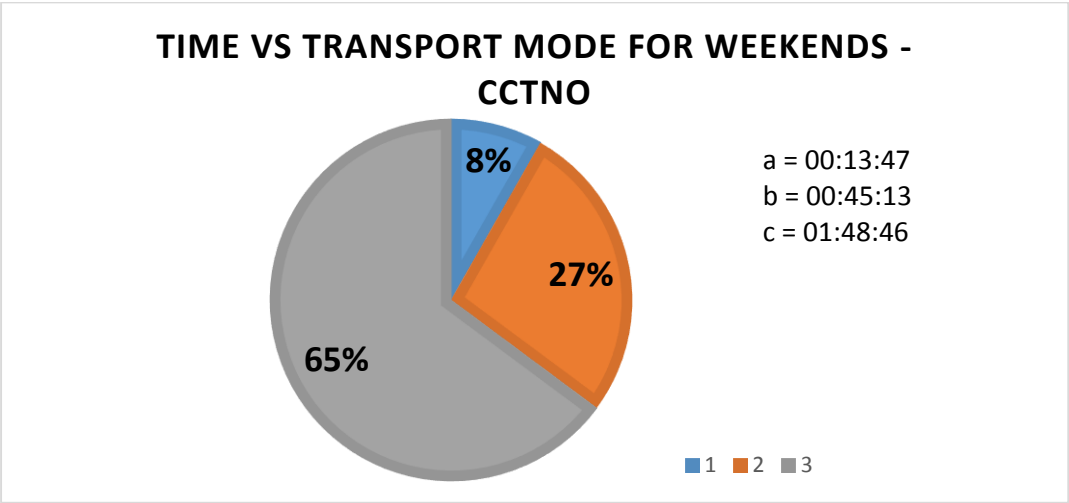


Figure 4.18. Time vs transport mode for weekends - CCTNO

Comparing to the weekdays, the distance as well as the time in travel during the weekends is lesser in the rural territories under consideration. We could not judge where the public transport (especially buses) can be placed within these criteria since the public transport needs much higher and repeated braking times for the pickup and drop of passengers and for exchange of drivers.

Also the speed of the buses may not be constant. Sometimes they are very fast and at other times, slow depending on whether they are running late or on time. If detailed information is obtained regarding such factors, it will indeed be possible to suggest methodology for finding out exact results for future reference.

Similar analysis can be done for a variety of variables such as age, gender, time of the year, etc using the same methodology. The above experiment gives us an idea how GPS can help in data mining for analysis of mobility trends and also patterns when detailed geographical information is available. From such an analysis, we can find whether a rural territory is sustainable in the transport sector by comparing with a theoretical model or guideline for distance and time of travel and other such characteristics.

CONCLUSION

This study has benefitted from the studies by Beuhler (2011) who analysed the contribution of cycling and walking to the physical activity in the US and Germany proving that transport-related physical activity (i.e. walking or bicycling for travel) can contribute considerably to total physical activity, identification of active or sedentary modes of transport is of importance e.g. for studies assessing physical activity. Distinguishing among modes of transport might also be of interest in studies addressing personal exposure to air pollution (Dirks et al., 2012). But more data are required for including them in the calculations of travel time. There are also other factors like climate and elevation of the roads which play an important role in the desire to travel. All these could be included for mobility research. Availability of transport and income are also determining factors for mobility. In recent years many research studies have attempted to distinguish modes of transport using either measured accelerometer data along with GPS logs, or a combination of Global Positing System (GPS) and Geographical Information System (GIS). This study was an attempt to understand how the GPS tracks of people from two different sizes of French communes could be used to understand the differences in travel behaviour of people. It is seen that as the size of the territory increases, the time spent in daily travel also increases and the time spent in travel during weekdays is comparatively higher than the weekends.

REFERENCES

1. Litman,T. (2001), "Evaluating Transportation Choice," Transportation Research Record 1756, Transportation Research Board (www.trb.org), , pp. 32-41
2. Ellis, S.D. (1997), "Key Issues In Rural Transport in developing countries," Transport Research Laboratory Library
3. OECD (1996a) Better Policies for Rural Development (Paris: OECD).
4. Rossi Luca., Walker, James. and Musolesi, Mirco.(2015), "Spatio-Temporal Techniques for User Identification by means of GPS Mobility Data"
5. Litman, Todd. (2005), *Evaluating Transportation Land Use Impacts*, VTPI (www.vtpi.org); at www.vtpi.org/landuse.pdf.
6. Litman, Todd (2003), "Measuring Transportation: Traffic, Mobility and Accessibility," ITE Journal (www.ite.org), Vol. 73, No. 10, October 2003, pp. 28-32; at www.vtpi.org/measure.pdf.
7. Yu Zheng, Quannan Li, Yukun Chen, Xing Xie, Wei-Ying Ma,"Understanding Mobility Based on GPS Data"
8. Zheng, Y., Liu, L., Wang, L., Xie, X, Learning transportation mode from raw GPS data for geographic applications on the Web. In Proc. *WWW 2008*, ACM Press (2008), 247-256.
9. Holger Dalkmann, Sabine Hutfilter, Karin Vogelpohl, Peter Schnabel. (2007),"Sustainable mobility in rural China", Journal of Environmental Management 87 (2008) 249–261.
10. Umweltbundesamt Dessau, (2005), "Quality Targets and Indicators for Sustainable Mobility"
11. Geerken, Borup.(2009), "System Innovation for Sustainability 2: Case Studies in Sustainable Consumpttion and Production Mobility"
12. Halfacree, K.H. (1993) "Locality and Social Representation: Space, Discourse and Alternative Definitions of Rural," Journal of Rural Studies. Vol.9, No.1, pp.23-37.
13. John Urry, (2011), "Mobilities: New Perspectives on Transport and Society"
14. www.wikipedia.org
15. Buehler R, Pucher J, Merom D, Bauman A: Active travel in Germany and the US: contributions of daily walking and cycling to physical activity.Am J Prev Med 2011, 41(3):241–250.