Mobil. TUM 2014 “Sustainable Mobility in Metropolitan Regions”, May 19-20, 2014

Sustainable Mobility and Living in Alpine Metropolitan Regions

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Abstract

This paper is to present an explanatory approach for the description and analysis of mobility and its impacts on spatial development and accessibility in Alpine Metropolitan Regions. A special focus is laid on sustainable development emphasizing the economic, environmental and social aspects and impacts of mobility. Several approaches that have been developed and discussed during recent years were mainly focused either on areas outside Alpine Regions or special functions and types of transport in mountainous areas (e.g. transit traffic, leisure traffic). Many strategies for sustainable development are addressing the environmental impacts of traffic but neglect the social aspects of mobility. This paper, however, presents a comprehensive approach combining the different mobility demands that determine traffic patterns in Alpine Regions with the requirements of sustainability not only in the ecologic and economic but especially in the social perspective.

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Selection and peer-review under responsibility of Technische Universität München

Keywords: Mobility; Accessibility; Human needs; Alpine Metropolitan Regions

1. Introduction

1.1. The current Transformation of Alpine Space

The term "Alpine" may be widely associated with images such as gorgeous landscapes, wilderness, glaciers, cultural heritage, farmers busy on their steep grassland and vacation. In fact, this image of an Alpine Region has to be relativized. For example, more than 60% of the Tyrolean inhabitants live below 800m sea level and the dominant role of the agricultural sector lies some decades back in history (Statistics Austria, 2014).

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Looking back at the history of human settlement in mountainous areas, the topographic situation has always required an adopted way of human life. But during the last century, technical progress and infrastructure investments have reduced the barrier effect of distance within mountainous regions and seemed to have increased accessibility considerably. Travel times have been shortened, upcoming tourism and economic development raised prosperity. Widely unnoticed from those - at first sight - positive impacts the new options of realizing mobility result in long-term transformation processes with major impacts on society, environment and the spatial structure.

New opportunities of satisfying basic human needs have initiated a social transformation process within society; the agricultural sector lost its dominating role, the way of life and last but not least Alpine cultures changed. In parallel, the spatial structure and spatial functions were and still are shifting: some communities in remote areas have been converted into small urban metropolis due to tourism especially during winter season; other ones are suffering from rural depopulation.

What are the driving forces behind all these spatial transformation processes in mountainous areas such as the Alps? An answer can be found when studying the interaction between human needs, mobility and the spatial structure in more detail. Due to their outstanding spatial conditions, Alpine Regions such as the European Alps are an excellent example to demonstrate these relationships.

1.2. Objective of this Paper

In general this paper aims to create a deeper understanding of the interactions between mobility, transport and Alpine Space by providing an overview about the specific determining factors for spatial development and to show strategies for sustainable development in Alpine regions. More precisely, this will be done by answering the following three questions:

- What are the outstanding characteristics of Alpine regions regarding mobility, transport and spatial structure?
- What processes have major influence on everyday mobility and life and how are they implemented in theories and models dealing with the interactions of mobility, transport and spatial structures?
- How can sustainable strategies regarding the further spatial development of Alpine regions be defined, taking into consideration the requirements of human needs in everyday life?

Although the reference area of this article is focused on the European mountain range of the Alps, the illustrated special aspects of spatial development - on a general level - are suitable to be transferred to other mountains regions in the world as well.

2. Alpine Regions and their Characteristics

Describing the specific situation inside mountainous regions requires a clarification of attributes and characteristics which make Alpine regions and their urban areas unique especially regarding mobility, space and traffic. Some of the most outstanding aspects will be discussed in the next chapters:

2.1. Area of Permanent Settlement

It is in the nature of things that the topographic situation determines land use. Some of those numerous determination factors of land use such as natural hazards, geological conditions and ecologically sensitive habitats or outstanding landscapes are more or less well known from flat terrain, too. Some others like geographical aspects such as fall of ground or the altitude are specific to Alpine regions. And other factors which influence the spatial structure like the exposure of sunlight in narrow valleys in winter can be found only in the mountains.

All factors together limit the area suitable for human settlement. In the province of Tyrol in Austria for example only 11.9% of the area can be used for permanent settlement (Statistics Austria, 2014) - as shown (fig. 1):
Even communities close to the provincial capital of Tyrol (Innsbruck) show extreme values: for example, less than 4% of the total area of the community of St. Sigmund can be used for permanent settlement (Statistics Austria, 2014).

Due to this extensive limitation of usable space, human activities are concentrated in the main valleys. Regions such as the urban and suburban area of Innsbruck and the eastern part of the Inn valley are characterized by some of the highest population and building densities in whole Austria (ÖROK, 2014), although the Alps are one of the less populated areas in whole Europe (Alpine Convention, 2007, p.41). As a consequence the pressure on undeveloped areas is still rising and results in land use conflicts between divergent usages of space.

2.2. Spatial Structure

When analyzing land use and human activities in mountainous regions it becomes clear very soon that - especially in the Alps - there are no homogeneous types of spatial structures. Alpine space is rather characterized by a combination of different spatial types. Therefore it is necessary to define those types of land use in order to analyze the current situation as well as likely development of space, mobility and traffic. Although there might be numerous approaches with suitable parameters for such classifications it is not the intention to perform a socio-geographic-analysis. Hence, the research is based on the following classification, defined by the administration of the Austrian province Tyrol. Taking the indicators of population density, employment opportunities as well as structure and influence of economic sectors into consideration, five major spatial types within the area of permanent settlement have been defined in Tyrol:

- provincial capital (urban / metropolitan area)
- agglomeration & central place
- agglomeration
- intensive tourism area
- rural area
The classification was done for each community and represents only the area of permanent settlement. The following figure (fig. 2) illustrates quite well that areas with high settlement densities are concentrated in the main valley of the river Inn ("Inntal"), while the (intensive) tourism communities are often located at the end of (narrow) side valleys:

![Diagram of land use types](source: Province of the Tyrol, Department Statistics, 2014; edited by Stephan Tischler)

Fig. 2. Types of land use (source: Province of the Tyrol, Department Statistics, 2014; edited by Stephan Tischler)

It is the combination of those different types of land use and spatial functions and its impacts and mutual interferences in a small area that defines the characteristic for mountainous regions. In addition to that, tourism is able to change the type of land use of an area or even a whole community during a year several times: during high-season regions such as the Tyrolean Sölden or Ischgl show attributes (high population density, traffic etc.) similar to an urban area while during off-season they can be assigned to a rural type of land use.

2.3. Mobility Behavior

As shown in the figure below, the defined spatial types within the area of permanent settlement are related to specific aspects of mobility. At first sight it seems that this finding is not something which makes mobility in Alpine regions unique: regarding the modal split in different Alpine areas the diagrammed values are comparable to those in flat areas: the use of private cars increases in rural areas, non-motorized means of transportation such as walking or cycling dominate in urban mountain areas, too (figure 3):
It can be summed up that concerning the mobility behavior of local population of mountainous regions there is generally no significant difference to values of similar types of land use in flat terrain. What characterizes mobility in Alpine regions is the mixture of different types of spatial functions and land use on short distance and especially during high-season - mobility of tourists and employees in the tourism business. Up to now data which allow analyzing the total mobility behavior of all people - local population, employees and tourists - is not available on a precise level. Such analysis should be carried out on a scientific basis in the near future.

2.4. Structure and Dynamic of Traffic Volume

Due to different methods of collecting and analyzing data as well as simple gaps due to unverified information it is still very challenging to get an overview about the structure and total volume of traffic in the Alps. In the public and even among popular media and politicians Alpine motorized traffic has always been related especially to freight transit crossing the Alps. In fact, studies conducted by the Alpine Convention (ALPINE CONVENTION, 2007) came to different conclusions:

- The main traffic volumes can be found in and around Alpine Metropolitan Areas
- individual motorized transport is by far dominating with (still) rising tendency
- more than 50% of the through traffic (road and rail journeys) is made for holiday purposes
- short distance traffic (origin and destination within the Alps) represents more than 53% of the total Alpine-crossing freight movement; tendency rising

The structure and dynamics of traffic in Alpine Regions is structured in the same way according to the regional spatial types and daily, weekly and seasonal patterns.
Urban and suburban areas such as Innsbruck and its surrounding communities show the typical image of commuting traffic: from Monday to Friday high traffic volume during the morning and another peak in the late afternoon. On Saturday and especially Sunday the traffic volumes decreases to low levels.

Especially tourism areas but also periurban as well as some rural regions show a different rhythm: the highest traffic volumes are on Saturday and Sunday, with the highest peaks from mid of December to April and during the summer months.

When analyzing the structure and volume of traffic in Alpine regions it is necessary to consider that these rhythms in traffic volume in different types of land use create overlapping effects. For example, the (locally created) traffic volume in the Alpine Metropolitan Area of an inner-Alpine valley such as the Innatal generally decreases on Saturday. But combined with the traffic volume occurring in the surrounding tourism areas it can reach the highest values during a week. Therefore, traffic modelling within Alpine Metropolitan Regions has to take care of all other spatial types which may have potential impacts on the total traffic volume as well.

2.5. Accessibility

When talking about mobility in mountainous areas the discussion sooner or later inevitably turns to the parameter of accessibility. There are plenty of discussions in literature concerning definitions, input indicators, variation of variables and last but not least critical review of its relevance and influence in further spatial development strategies.

"Accessibility is a slippery notion… one of those common terms that everyone uses until faced with the problem of defining and measuring it" (Gould, 1969)

Looking at the topographic situation of Alpine regions it is obvious that accessibility must be one of the key-indicators regarding mobility and spatial development. The crucial point is its definition which is more complex than it seems (Geurs, 2004).

For a long time, transport and spatial planners have set the focus on optimizing travel times. Investments in transport infrastructure (e.g. building tunnels, extending roads etc.) are reducing the travel time by decreasing spatial resistance. Consequently accessibility has to increase because more opportunities are available within the same travel time. In theory that might be an obvious conclusion, but reality demonstrates that it is not such simple.

Increased accessibility in Alpine Regions is linked to the process of concentration of spatial functions. Starting with private-owned services such as retail, more and more (previously) state-owned public-services such as postal services, public administration offices and last but not least facilities for education and medical service etc. are closed in peripheral located communities. The driving force for this process is economic efficiency, activated by extended transport infrastructure. Consequently spatial disparities between inner-alpine regions are intensified. This process of concentration is well known from other rural areas outside mountainous regions. But in Alpine regions, where transport infrastructure provides just one or a few alternatives, its impacts are more extensive due to strong dependencies on the availability of transport infrastructure with no or just a few alternatives.

One example is the choice of means of transport. When drawing the attention to all people with direct or indirect access to a car or a public transport system reality shows that investments in transport infrastructure is not stringently suitable to increase accessibility for all inhabitants. Recent mobility data from the province of the Tyrol show that the availability of vehicles within communities in remote areas like in the Alps becomes the highest rate at all in whole Austria. But there are still significant parts of the population in such communities who do not have access to a car and therefore are depending on the passenger cars owned by other persons or local mobility services by the communities.

Although it still is the "target group" of the political parties as well as the economy the following figure shows that in the Province of the Tyrol nearly half of the inhabitants in urban areas such as Innsbruck do not have a passenger car available at any time (figure 4):
That might be of no greater concern in Innsbruck as the city and its surrounding area is well served by public transport. But in remote areas the availability of an appropriate (public) transport system is still a major problem. And even in Alpine Metropolitan Areas such as the Inntal with its disperse settlement areas mostly communities with higher numbers of inhabitants offer their people options for realizing local mobility in everyday life.

In summary, the definition and operationalization of accessibility has to take care of issues related to spatial resistance as well as the quantity and quality of available alternatives. Decades ago, accessibility in everyday life for local people has not been much worse than today - in many places even better. Children could reach their primary school without taking long bus rides; small retail stores in the village offered enough goods to satisfy the basic needs.

2.6. Summary

Alpine metropolitan areas show attributes and characteristics which make them unique and different from urban regions in flat terrain due to their topographic conditions. The limited area for permanent settlement results in high population densities and overlapping types of land use, although the total area still remains one of the sparsely populated places in Europe. As a consequence, conflicts of different types of land use between social, ecologic and economic interests are nearly daily topics in the local media.

Regarding mobility, the behavior of inhabitants in Alpine Areas is quite similar to people living in flat terrain. The difference is the overlapping of various types of traffic which results in special structures and rhythms of traffic volume. Although mountain ranges such as the Alps are a highly visible barrier to local mobility it can be shown that such an image was created by the construction and use of technical transport infrastructure. Spatial structure in former times allowed inhabitants to satisfy their needs locally, independent of the availability of technical infrastructure.

3. Interdependencies between Mobility, Human Activities and Space - Theoretical Basis

3.1. Traditional Approaches and Models

Models are inherently a simplified image of reality. It was none less than David L. Huff who once remarked that the inclusion of all potential decision aspects in a model is nearly impossible. However, such simple models as - for example - the gravitation model have been "state of the art" in regional sciences during the last decades. There have
been various attempts and numerous studies to optimize their validity by adding or varying indicators. But the basic concept still remains borrowed from the physics, inherently neglecting the human factor of mobility.

Although these traditional models enjoyed great popularity within traffic engineers as well as spatial planners, their results are nowadays subject of rising criticism. Looking back at the history of their origins it is no wonder that their informative value has to be scrutinized critically:

Most of the models used in regional sciences as well as traffic engineering are still based on the approach of economies of scale. It is supposed that the spatial activities of human individuals are based on the concept of "optimizing behavior", assuming that automatically locations with more opportunities are preferred. Regarding selection processes which influence mobility and spatial structures especially in Alpine regions such as choosing a new place of residence or locations for leisure time activities this approach has to be reviewed critically.

Traditional theories assume that a person is omniscient regarding all potential alternatives. The preferred option is selected using a rational concept of acting. Simplified, the benefit has to be higher than the costs - presumed, that human acting is based on the concept of a rational thinking "homo oeconomicus". But when analyzing mobility behavior in more detail, can that be true? For example, explanation and modelling of leisure time traffic - which covers a major part of total traffic in some inner Alpine regions especially during high season weekends - cannot be based on such a simplified concept of human decision making. There must be other factors which affect mobility choices and influence spatial structures and functions. People living in urban areas with negative environmental impacts due to high densities often feel the urge for relaxing in regions with low settlement density and diversion from the daily routine in their leisure time. When doing so they are willing to take long distance drives upon themselves to reach such destinations. Social economy calls them "satisfier" as they are satisfying their needs for recreation.

Modelling traffic quantity and distribution especially resulting from basic needs and the spatial structures is a very complex and challenging task. Transport in Alpine metropolitan regions such as Innsbruck and its surrounding communities is a result of the overlapping of different types of traffic with daily, weekly and seasonal rhythms. Therefore a combination of different approaches is required to estimate quantity and further development more precisely.

Critics note that the traditional models determine urban development as a system of traffic flow or spatial interactions (Franck, Wegener, 2002). They argue that these models are based on a static balance approach without any reference to time and reality. Especially the assumption that the spatial interactions determine activities in space (and not the other way round) mixes decisions regarding location and mobility choice which should be analyzed separately.

It is evident that the traditional models and their understanding of spatial structure as a system of spatial interactions are turning off the influence of decisions made by humans, households, companies, land owners etc. More than that, modelling urban or regional development - no matter if inside or outside mountainous regions - has to take care of uncertainties, prejudices adaption, learning. Transformation processes such as - for example - changes in the real estate economy (rising or decreasing market prices etc.), modifications of the legislative or revised urban development strategies and implementing programs need to be considered, too, if such an approach claims to be more than just a rough simulation. From the current point of view it seems to be unfeasible that all these aspects can be placed in an algorithm - and one might raise the question if the effort is really required for mapping the further spatial development.

3.2. Mobility and the Satisfaction of Needs

Up to now it was established why traditional approaches and models in transport planning and regional analysis are limited in mapping for mapping such complex spatial transformation processes in Alpine Regions - at least they should not be the core of an explanatory model. There is a strong need for an adopted concept of analyzing and modeling transport and spatial development, especially within mountainous regions. It has to be a concept which follows an integrative sustainability approach by considering needs and basic functions of a human individual as well as the preservation of mountain habitats as sensitive ecologic systems. Therefore it is necessary to step back into the definition of mobility and have a closer look to the processes behind human requirements of moving.
Starting point of the following concept of an expanded explanatory model for the description and analysis of mobility and its impacts on spatial development are the needs and basic functions of human individuals making them travel. In his 1943 published paper "A Theory of Human Motivation" Maslow described his theory of hierarchically structured human needs. Physiological needs are the physical requirements for human survival and form the basis, followed by safety needs, love and belonging and esteem (Maslow, 1943). On top there's "self-actualization", the need of a person to realize its full potential.

The following figure (fig. 5) shows schematically the basic concept of the approach that brings together these needs of the individuals with spatial aspects:

![Diagram](image)

Fig. 5. Schematic diagram of the explanation model regarding interferences between mobility, spatial structure and traffic based on the satisfaction of needs; own production

First, there are two levels: one for sequences and activities of the individual itself and the other one dealing with processes in society and environment. Both levels cannot be separated as they have various two-way interdependencies. Basic functions of human life such as home, work, recreation, shopping and disposal, education and social contacts have their origin in the human needs and generate a necessity to get satisfied by appropriate acting. Due to the fact that each function is related to specific requirements such activities require movement as they can rarely be executed at the same place.

Looking back into history of human settlement within Alpine regions one might explore that the distances between the locations of these basic functions of human life were much shorter just a few decades ago. This issue is not a groundbreaking finding as it is already well known from other rural areas all over the world. But the difference is that settlements in mountainous regions had (and some still have) to be able to deal with longer periods of isolation due to unavailability of transport infrastructure. Therefore, the settlement structure in mountainous regions often consisted of numerous small groups of houses with appropriate social infrastructure such as a small school, church and other joint facilities. When satisfying their needs human individuals had the opportunities to locate their activities within or close to their living area.

Accessibility had not been a relevant issue until central places and cities in the main valleys grew up (Denecke, 2001). They offered better facilities, allowed personal choice and therefore soon became the preferred location for activities such as education, health or shopping. Together with the changing ideals of the society (here it has to be referred again to the hierarchy of needs by Maslow) satisfaction of needs scattered in the region. Population demanded for extended transport infrastructure and soon after finishing a new road or railway line the spatial impacts intensified this process.
In this regard, the spatial functions of a region are defined by the location and spatial distribution of the basic functions of human living. Regions such as metropolitan areas can offer numerous options of functions, the greater proportion of them accessible within short distances. Alpine metropolitan areas such as Innsbruck are able to offer additional functions especially regarding recreation, but are themselves attractive to tourists living outside the mountainous area.

The question whether the spatial distribution of human activities or spatial functions is responsible for traffic volumes and all related spatial impacts cannot be answered correctly. Undoubtedly, it is the spatial distribution of those functions which influences the mobility behavior of the inhabitants. Finally it is important to know that activities are able to change much faster than spatial structures because this fact is of great influence when generating sustainable development strategies.

Simplified and similar to the multidimensional concept of sustainability, spatial impacts can have ecological, economic and social functions:

- Social functions such as settlement, recreation, vacation, social contacts etc.
- Ecologic functions like natural habitats for flora and fauna
- Economic functions such as industry and commerce, agriculture, forestry, crude materials etc.

It might be clear that these wide range of functions result in numerous possibilities of land use and - often - potential conflicts due to mutually contradictory functions. For a considerable time, mountainous areas had been affected by disperse rural settlement structures of a rural society and a small group of travelers. Later, the generation of central places and cities yields a differentiation of long-distance as well as local traffic relations and changed the spatial functions (Denecke, 2001). This change process is still ongoing in Alpine metropolitan regions, although nowadays with much more velocity than centuries ago.

4. A Concept for Sustainable Mobility and Living in Alpine Regions

Although concepts of sustainability have been discussed extensively in numerous conferences, literature and other documents among experts it is necessary to outline the main aspects of sustainability here again to provide a common understanding as basis for the integrative approach.

4.1. The Dimensions of Sustainability

From the handling of natural resources, the safekeeping of social equity, preservation of cultural aspects and establishment of a suitable politic-institutional framework - sustainable development always comprises various thematic fields (Grunwald, 2012). When discussing strategies and precise measures for implementing sustainability conflicts between these different dimensions will appear inevitable which require the definition of priorities and last but not least to make decisions.

The (negative) impacts of human activities on the sensitive system earth have been the first approach towards sustainability. It was Hans Carl von Carlowitz who broached the issue of sustainable forestry in his book "Sylvicultura oeconomica" in the 18th century. Beginning in the late 70s of the 20th century, discussions about how the exponential economic and population growth interacts with finite resources came up. The satisfaction of human needs of the present and next generation has to be in line with the preservation of nature as livelihood and foundation of economic prosperity (Grünwald et. al., 2012).

Although the ecologic based concept is still widely associated with sustainability especially amongst politicians, media and last but not least the public it was soon clear those questions about distributive justice, participation, preservation of cultural heritage to the next generation etc. need a revised concept of sustainability.

Based on a so called "magic triangle" or "three-pillars", the ecologic concept of sustainability is expanded by adding a social and economic to the ecological dimension (Grünwald et. al., 2012). This concept is usually designed equilateral to illustrate that all three dimensions are of the same importance. It can be critically observed that this multidimensional concept motivates someone to realize ecological, economic and social sustainability separately.
Although it is not clear how all three dimensions can be integrated, the triangle has remained the mainstream framework to analyze sustainability. But the premises future responsibility and distributive justice are comprehensive to all dimensions of sustainability due to numerous interferences. As a consequence it is not feasible to consider them separately. More than that, the huge complexity of problems resulting from non-sustainable development requires an integrative approach (Kopfmüller et. al, 2001). The integrative concept aims to refer the global understanding of social equity in space and time to human usage of natural and social resources and their enhancements.

4.2. Sustainability Concepts in Alpine Regions

For the last two decades, negative spatial developments in mountainous regions have initiated discussions upon scientists, politicians and especially the engaged public community to start a trend reversal. The countries of the Alps and the European Union have established the "Alpine Convention" as an international treaty aimed to provide sustainable development and protection for the Alps.

But over the years, the term of "sustainability" was used inflationary by the media and politics and far away from its original concept. The idea of just copying sustainability concepts from other countries and regions failed, measures remained non-concrete and the public became tired hearing the same campaigns every year again. Up to now, strategies promoting sustainable mobility and living in Alpine Areas are based on the ecologic dimension of sustainability, focused on specific topics which allow simple promotion such as "e-mobility" or "green-transport" strategies. For example, studies have been prepared to evaluate strategies for sustainable mobility of passengers in access to tourist sites; others are analyzing the potential of "e-mobility" in local communities etc. Beside their concentration on solutions for reducing the negative ecologic impacts of traffic one has to remark that the studies are often focused on small municipalities or remain on a very general level without any references to the whole spatial structure. References to social and as well as economic aspects of sustainability and the role of mobility remain untreated.

From the current point of view it is unrealistic to think about Alpine metropolitan regions as huge cities. But recent indicators such as population and settlement density of inner-Alpine valleys show that Alpine metropolitan regions tend to get "urbanized", while on short distance the wilderness of the mountain area is still dominating space. It's this disparity between human activities and a sensitive and unique ecologic system which impressively illustrates why concepts of sustainability in Alpine metropolitan regions require a special approach of an integrative understanding. But the prioritization of the ecologic dimension of sustainability has its limits, which can be checked easily by analyzing real estate advertisements.

Many companies are offering "low-energy" houses, promising less carbon dioxide and less energy consumption due to improved heating efficiency. But regarding mobility it can be assumed that the satisfaction of basic needs of human life such as shopping, education, working etc. is still depending on the availability of cars. Not to mention the fact that the location of this building is a good example of stimulating urban sprawl. The advertisement demonstrates quite well that the concept of sustainability in reality is still reduced to the ecologic dimension of reducing emissions and energy for heating because it suggest that for example saving energy results in saving money and "by-the-way" protects the environment. The social dimension (e.g. dependency on passenger cars, total travel time of the household etc.) as well as the total economic dimension (e.g. mobility costs etc.) are neither aware nor are they communicated.

Within Alpine regions, climate change and its impact is another aspect which has to be taken into consideration when talking about sustainability and mobility. With reference to recent meteorological data it is ascertain that global warming is already ongoing (Stocker. et. al., 2013). Mountainous areas such as the Alps are affected by the impacts in other occurrences than flat terrain: the defrosting of permafrost destabilizes slopes and rock fall is blocking traffic infrastructure for days, weeks and sometimes years. During the last years the quantity but also the quality in the meaning of size of loss due to natural hazards have raised significantly (Berz, 2008). Therefore, there is the requirement for integrating concepts of resilience and vulnerability into sustainable development strategies, too. Resilience in mobility and spatial development means that a region must be able to be self-sufficient in case of crises, that there are alternative ways of accessibility, negative impacts can be minimized and damages can be
restored. For example, if the main roads are blocked due to rock fall, avalanches or flooding there are still ways to communicate. Although at first sight such issues might be of more relevance in communities located in remote areas recent incidences such as for example heavy rainfall in July 2013 show that a whole district such as the Metropolitan Area of Innsbruck can be - in that case fortunately only for a short time - be separated from the surrounding areas.

4.3. Spatial Development Scenarios

In the chapters before it was explained why investments into transport infrastructure are resulting in a spatial concentration of opportunities. Looking back into the history of human settlement in Alpine Regions one might explore that the spatial structure was formed by a disperse distribution of small groups of settlements, consisting of a few farm houses, a church, a school, maybe a guesthouse and some other facilities necessary for the basic services. This spatial structure has not changed over many centuries until the first railways were built and soon after that the road network and motorization increased.

The inhabitants in the small side valleys moved into the main valleys to seek for a better life, working in industry than on the grassland. It was the first wave of rural depopulation, which never really stopped until today and formed the spatial structure by Inner-Alpine migration. Upcoming tourism was able to slow down that spatial transformation process, but could not stop it. At present, the spatial development is still dominated by an ongoing process of concentration, but the further direction of the development remains unclear (fig. 6):

![Fig. 6. Spatial Development Scenarios; own production](image)

Taking into consideration the requirements of an sustainable spatial development it is hereby assumed that only the scenario of a polycentric spatial concept is suitable to successfully implement social, ecologic and economic aspects of sustainable living:

- Renaissance of proximity: services necessary to fulfill basic human requirements have to be placed close to the living areas and should be available for nearly all mobile human individuals without using motorized transport infrastructure
There is no need for a radical change in the personal lifestyle within a short time; therefore it should be easier to implement such a concept successfully without serious public opposition.

It is obvious that the term "polycentricity" with regard to Alpine Spatial Development has to be seen from a different scale. Related to the principle of subsidiarity, spatial functions have to be located on the lowest spatial level according to the corresponding level in the hierarchy of needs. Especially - but not only - from the economic point of view it is inevitable to group opportunities and services in a hierarchy of central places, which form a polycentric spatial pattern consisting of bigger villages and small cities.

4.4. At the end: Alpine Urban Cities?

Approximately 10 years ago, a group of architects and regional planners have published their vision of a "TyrolCity" assuming that those developments are continuing (Andexlinger, 2005). Indeed, it is a provocative image of Alpine spatial development, but it outlines that discussions about sustainable development should not be focused on urban development of (large) cities and metropolitan regions in flat terrain only.

Meanwhile, numerous initiatives have been undertaken or proposed to reduce the negative impact of current transport systems on nature and health in the Alps. In this regard it is no wonder that statements such as "Increasing mobility threatens the natural and human environment in the Alpine region." (CIPRA, 2013) are still appearing in official papers. But is it the simple truth that mobility is increasing and threatening the Alpine environment?

5. Conclusions

Although change processes and their impacts are highly visible almost every day, there is still a gap between the theoretical concepts of sustainability and reality. The objective of this article is to demonstrate that sustainability regarding mobility and spatial development has to be derived from human needs and activities. Considering the required satisfaction of basic functions of human life it is unthinkable that strategies dealing with sustainable living, mobility and traffic are still skipping the social aspects and requirements. Undoubtedly, ecological as well as economical issues have to remain integrative parts of sustainable development strategies, but without including the social dimension the successful implementation is likely to fail.

Actually, we know more about the mobility behavior of bees and other insects in their Alpine habitat than about human individuals. There is a wide field of activities for interdisciplinary researchers - from transport engineers, spatial planners up to historians - to study aspects of mobility and spatial development in Alpine Regions in more detail:

- Mobility in everyday life - parameters of mobility (number and length of trips in everyday life) over the centuries, influence on settlement structures (mental barriers vs. topographic barriers etc.)
- leisure time and mobility - interaction between metropolitan areas around the Alps and traffic caused by leisure time activities
- climate change, natural hazards and sustainable development
- strategies for spatial planning taking into consideration the requirements of satisfying human needs and mobility in resilient regions
- Sustainable mobility and living in Alpine Metropolitan Regions has to ensure that satisfaction of human needs and basic functions is enabled for all groups of society, regardless of age, location or income on an ecological and economical adjusted basis by respecting the characteristic features of mountainous areas.
Such a strategy requires an integrative approach, considering the mutual interferences between various aspects of human needs and activities as well as spatial structures. It has to be the objective of further scientific studies to prepare comprehensive basic data and define potential approaches towards such concepts on a detailed level.

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