

# **Polycentric Structures and Mobility in Agglomerations – an Analysis of the Vorarlberg Rhine Valley in Austria**

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## **1 ABSTRACT**

Sustainable urban mobility always stands between conflicting priorities of different stakeholder groups and is even more difficult to achieve in a region with several municipalities with a similar number of inhabitants. The Vorarlberger Rhine Valley (Vorarlberger Rheintal) consists of 29 municipalities including the capital city of the Province, Bregenz, and the even bigger cities Dornbirn and Feldkirch. In the last 50 years the number of inhabitants almost doubled up to 250 000 inhabitants (reference year: 2011). The built up area has increased even more forming a single area of settlements with a widely polycentric structure. In 2003 a co-operation among the 29 municipalities has been established following the aim of a common vision of the Rhine Valley (“Vision Rheintal”) including a balanced distribution of economic, cultural, educational, retail, recreational and administrative institutions across different locations.

The Rhine Valley has been selected as demonstration site of the Poly-SUMP project commissioned by the European Commission in 2012. The idea of the project is to understand elements of a successful implementation of a polycentric co-operation, to analyse to which extent polycentric structures are able to support sustainable mobility and to exchange experiences with other regions on a European level.

20 Stakeholders have been interviewed in the Rhine Valley covering a variety of stakeholder groups (local and provincial government, transport planner, cyclist group, economic sector etc.). It turned out that almost all experts ranked the collaboration among different stakeholder groups as well-established. Regular conferences and meetings as well as transparent transport planning processes are an ideal platform for exchanging interests and for finding common solutions.

Polycentric structures have an influence on the daily mobility of the inhabitants, e.g. the average trip distance is shorter than a region with just one major city, as people find appropriate destinations more likely nearby. Data of a mobility survey launched in 2008 show that the average trip length in the Rhine Valley is 8.6 kilometres, which is about 1/3 shorter compared to the rest of Vorarlberg. In order to be able to compare the degree of polycentricity and its effect in mobility among different regions a set of indicators has been developed including not only spatial data (e.g. population density) but mobility data as well (average distance travelled to work).

## **2 INTRODUCTION**

Depending on local circumstances, the historical growth of population led to different settlement patterns, caused by the increasing number of centres and/or an increasing concentration of the population within one dominant centre (Figure 1). These effects create different settlement patterns (Bus et al. 2012):

(1) Monocentric regions are characterised by a high density central city which attracts and directs daily commuting flows from and to the surrounding regions, often leading to a high amount of mileage driven. Centripetal mobility patterns are aggregated on radial road or rail axes penetrating the major city core. Most of the inhabitants of a region live in the major city, almost all facilities of the daily life (work places, education, shopping ...) are concentrated in this city.

(2) Disperse settlements are characterised by the equal distribution of the population all over the region without clear defined centres.

(3) Polycentric regions are characterised by a number of centres forming a network of cities of equal size with a balanced distribution of economic, cultural, educational, retail, recreational and administrative institutions across different locations.

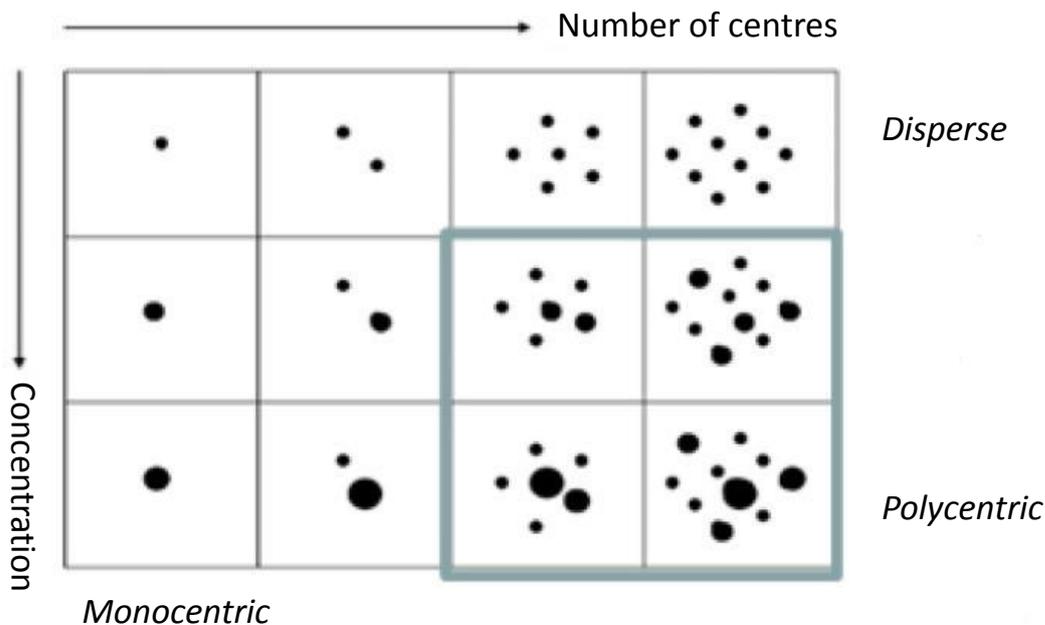


Figure 1: Settlement patterns (Source: Bus et al. 2012)

The Poly-SUMP project commissioned by the European Commission within the Intelligent Energy Europe programme in October 2012 is dealing with the special needs of polycentric regions in terms of spatial and transport planning, as this is an even more difficult undertaken in a region with several municipalities of almost equal status and with a similar number of inhabitants. The idea of the project is to understand elements of a successful implementation of a polycentric co-operation, to analyse how polycentric structures support sustainable mobility, and to exchange experiences and transfer knowledge within polycentric regions. Based on lessons learnt a common methodology for Polycentric Sustainable Urban Mobility Plans (Poly-SUMP) is developed by testing practical planning approaches in European regions of Europe. The Vorarlberger Rhine Valley in Austria (Vorarlberger Rheintal) has been selected as demonstration site in the Poly-SUMP project as it has a long tradition of polycentric co-operation among the municipalities of the Rhine Valley.



Figure 2 Location of the Province of Vorarlberg in Europe (Source: google maps)

### 3 THE VORARLBERGER RHINE VALLEY

#### 3.1 Characteristics of the region

The Province of Vorarlberg is the most western province of Austria and is mainly a mountainous area where more than 2/3 of the territory is 1000 m above sea level (Figure 2). Thus, only 25 % of the area can be used as built up area or for agricultural use. Due to this land use restrictions the provincial government developed a soil protection concept early in the 1990'ies already. This concept considers real estate transfers, spatial planning and agriculture polices as well as aspects of air pollution control, environmental, landscape and nature protection [Amt der Vorarlberger Landesregierung 1992]. The province of Vorarlberg has an over average flourishing economy at Austrian as well as European level. Only 3.6 % of the population (reference year 2011) are currently unemployed [Statistik Austria 2012].

In 2011 the Province of Vorarlberg had about 372.000 inhabitants [Amt der Vorarlberger Landesregierung 2012]. Almost 2/3 of the population lives in the Vorarlberger Rhine Valley, which consists of 29 municipalities including the capital city of Bregenz, and the even bigger cities Dornbirn and Feldkirch. This is caused by the fact, that this region is one of the rare plain areas in the province and at low altitude between 400m (Bregenz) and 450m (Feldkirch). The extent is about 40 km from North to South and about 10 km from West to East. The river Rhine, which is bordering the region in the west, represents the national border between Austria and Switzerland at the same time.

#### 3.2 Establishing polycentric concepts in the Vorarlberger Rhine Valley

In the last 50 years the number of inhabitants in the region almost doubled, the amount of buildings and the area of settlements increased even more, so that several municipalities have grown together forming an almost single area of settlement. Therefore the administrative boarders do not always represent areas functionally belonging to each other (Figure 3). Although Austrian municipalities are responsible for the construction of the local road infrastructure in their area as well as for the local spatial planning the project "Vision Rheintal" has been founded more than 10 years ago with the aim to establish a discussion platform across all 29 municipalities of the region and to develop strategies for integrated spatial and transport planning, following the principles of polycentric developments. One of the key topics is mobility, enabling sustainable transport by fostering settlement structures, which decreases the traffic demand and supports environmental friendly modes. These can be achieved by a balanced distribution of economic, cultural, educational, retail, recreational and administrative institutions across all 29 municipalities.

Some examples of the functional division for the major settlements in the area of the Rhine Valley are:

- Bregenz as the capital of the Province of Vorarlberg, but only the third biggest city in the region, hosts the provincial government, provincial police, provincial library, provincial school administration and main cultural facilities (theatre, festivals) whereas
- Wolfurt hosts the logistic centre for goods distribution for the whole area and cross border transport;
- Dornbirn hosts the polytechnic college, provincial television, provincial health insurance organization, chamber of commerce including supporting funds for economic development;
- Feldkirch hosts provincial court of justice, chamber of labour, pedagogical college, unions headquarter, provincial hospital, provincial finance office and act as diocesan town of the province,
- Lustenau hosts the provincial chamber of industry and the central provincial storage facility for oil supply.

### 4 ASSESSMENT OF THE CURRENT SITUATION IN THE VORARLBERGER RHINE VALLEY

The analysis of the current situation is based on a desk research of information mainly provided by the project "Vision Rheintal" and in-depth interviews with 20 stakeholders representing different stakeholder groups.

#### 4.1 Assessment of the current transport situation

The evaluation of the current transport situation is based on a ranking provided by stakeholders on a scale from 1 (best) to 5 (worst). The mean value is 2.7, however, with a strong polarisation between

representatives of the chamber of commerce and oppositional parties scoring “unsatisfying” and local government and transport planners scoring “satisfying” on the other.



Figure 3: The Vorarlberger Rhine Valley Region with 29 municipalities (Source: Assmann 2006, own modification)

The situation for pedestrians and public transport users are rated positive by almost all respondents, whereas the ranking of situation for cyclists and car users depends on the group of stakeholder the respondent belongs to. In particular, too restrictive policy towards private car traffic or missing capacity extensions of the road network are mentioned by car-oriented persons. On the other hand, there are stakeholders criticizing the car friendly policy in the area.

The questions for measures to be implemented in the near future in order to improve the traffic situation polarised as well. The majority of respondents argued to invest in new infrastructure measures, however the focus on the transport mode differs depending on the particular interests, e.g. car-oriented stakeholders mentioned the missing extensions of the road network (e.g. a new link to Switzerland, bypass road for city of Feldkirch and Lustenau). Only a few times organisational measures are mentioned, i.e. public transport at traffic signals, mobility management, pricing measures (parking pricing, reduced public transport ticket) or improved marketing.

## 4.2 Assessment of competences

Sustainable development requires the coordination of policies and services of many actors – transport and urban planners, local and regional policy makers, urban and interurban public transport providers etc. – within and across different urban and administrative boundaries. Therefore, regular conferences and meetings as well as common transparent transport planning processes are pre-requisites for exchanging interests and finding common solutions in the Vorarlberger Rhine Valley.

Identifying stakeholders and understanding their current and potential role are important conditions to map the actors to be involved in a polycentric planning process. In the Vorarlberger Rhine Valley seems to be a common sense that all relevant institutions (and therefore competences) are involved in the current planning processes. It seems that these activities do not comply with the transport strategy in the region. Institution and persons primarily mentioned by the respondents are politicians (most important), administration staff at local and regional level, public transport operators as well as public transport consortia, citizens and the energy agency. A bicycle-coordinator, transport user's lobby group and the industry dealing with electric supply was mentioned only a few times.

In addition, the provincial government commissioned a regional transport masterplan for the Vorarlberger Rhine Valley. In 2006 a collaborative, consensus-oriented planning process was initiated to solve the traffic problems of this particular region. A multi-modal package of measures should be developed through a mediation process led by an external team, i.e. departments of the provincial government, the highway agency (ASFINAG), representatives of all affected communities, interest groups, and representatives of lobbying organizations as well as the conservation organisation in order to ensure the widest possible consideration of all interests. The aim of the process was to find a consensus on comprehensive mobility solutions, most suited to reduce negative impacts of transportation significantly. Thus, not only new road infrastructure for private car traffic has been considered, but more a useful combination of improvement of cycling and public transport measures.

## 4.3 Assessment of the implementation of sustainable mobility

Stakeholders interviewed were asked to score the importance of considering sustainable mobility in transport plans. Nearly all respondents fully identify themselves with the concept of sustainability. Elements often mentioned to be included in sustainable mobility plans are the maximum freedom of mode choice, efficient use of resources, less use of private car and not to stress future generations.

The good planning culture and the communication established among the 29 municipalities are one of the most important drivers enabling the implementation of sustainable mobility plans. In particular, this includes the cooperation between the municipalities on an administrative level within the region. Additionally, the awareness of the citizens with regard to the importance of sustainable mobility is seen at high level, which increases the acceptance towards sustainable transport planning.

The dominance of private car use and corresponding infrastructure supply in the region is still seen as main barrier. In addition, economic pressure on enterprises offering mobility supply (public transport, car sharing, etc.) sometimes prevents sustainable developments. Moreover, it is often difficult to change habitual mobility behaviour of the transport users.

Stakeholders scored the importance of different planning elements on a scale from 1 (not important) to 4 (most important). Generally, all elements discussed are important or very important. However, as it can be seen in Figure 4 political support is of most importance, followed by measurable goals and awareness measures.

## 4.4 Pros and cons of polycentric structures in terms of sustainability

The term polycentrism is known by the majority of the stakeholders asked. A missing dominate city was mentioned as characteristic of a polycentric settlement area by almost all stakeholders asked. This leads to a cooperation of municipalities at an equal level in order to develop the region commonly and to share administrative or spatial functions. Consequences on the transport system are noticed by a more homogeneous distributed transport demand and the option to create axes which supports the rail based public transport system. Advantages of polycentric regions are shorter distances between origins and destinations of trips, the opportunity to find smart solution on a smaller scale, keeping smaller villages attractive as

investments are more even distributed, a bigger variety of land use and infrastructure within the region. Generally, the co-operation among the municipalities enables more sustainable solutions for the whole region.

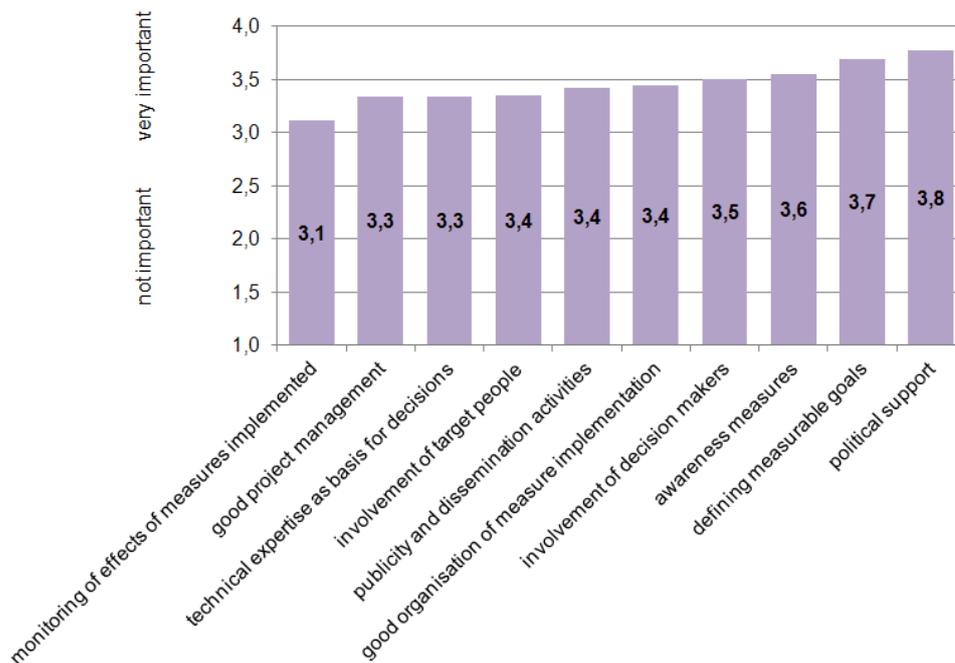


Figure 4: Importance of planning elements

Arguments against polycentrism are the more effective possibilities to access a dominant city by high capacity modes and the need of goods transport to drive through settlements areas as a clear segregation between settlement areas and transport corridors is missing.

## 5 MOBILITY PATTERNS OF THE VORARLBERGER RHINE VALLEY

For the comparison of mobility patterns of polycentric areas with monocentric regions a matrix is built where the capital city of the region is fixed as central spatial reference point with four classes of distance. This is a residual of a monocentric vision with the capital city considered as the most prominent centre of a region, where the higher urban/regional authority functions are located. However, thanks to the matrix structure, it is possible to analyse and compare the degree of polycentricity vs monocentricity of the regions in two ways:

Along the diagonal cells key land use variables (resident population, workplaces, total area, and settlement area) are recorded for the capital city and for the other communities grouped by class of distance from the capital city. These data allow computing population and jobs density indicators that may typically show a marked density gradient (from high value in the central city to low values in the distant poles) in monocentric regions, and a less steep density gradient in polycentric regions, where population and jobs are more distributed across the region. The first row and column of the matrix include mobility flows within the capital city (first cell) and to/from the capital city to the other poles. These are monocentric (centripetal/centrifugal) mobility flows. They can be compared with the magnitude of the mobility flows within the other distance groups of poles (recorded in the diagonal cells) and within these groups, which represent polycentric/transversal mobility flows (i.e. not gravitating towards the capital city).

Following the concept as mentioned above 4 areas are defined:

- (1) Capital city (Bregenz)
- (2) First ring around the capital city (poles of Dornbirn, Hohenems, Lustenau), which is about 8 to 20 km away from Bregenz)
- (3) Second ring around the capital city (poles of Feldkirch, Götzis, Rankweil), which is about 20 to 40 km away from Bregenz)
- (4) Other areas (remaining parts in the Province of Vorarlberg, Switzerland, Germany etc.)

For the analysis of the mobility pattern data of a mobility survey launched in 2008 are used. In total in this survey 17 140 households of 96 municipalities were contacted by mail or phone, which is about 12 % of all households in Vorarlberg. As reference days Tuesday, Thursday and Sunday were defined. More than 4 000 households responded and gave information about their daily mobility on a weekday as well as on Sundays (Herry et al. 2009).

The number of inhabitants is almost the same in the different areas as defined above and ranges from 70 000 to 95 000 inhabitants. Although Bregenz is the capital city of Province of Vorarlberg and place of the provincial government, it is even the smallest agglomeration of the Vorarlberger Rhine Valley. Same applies to workplaces which are well distributed over the poles with a slightly domination of the second ring, as this comprises the largest area (210 km<sup>2</sup>) and includes the biggest city of Dornbirn (Table 1).

Based on the number of trips stated in Table 1 the share of trips has been calculated according to the given O-D matrix. In monocentric areas it can be assumed, that the dominant (capital) city is attracting more trips. The share of these trips having other destination than the capital gives an indication on the degree of polycentrism. The analysis of the mobility data of inhabitants of the Vorarlberger Rhine Valley shows that  $\frac{3}{4}$  of all trips are internal trips. A predomination of the relation to/from the capital city of Bregenz cannot be identified, only 10 % of trips originated in the first ring have the destination in Bregenz, and this value is even lower for the second ring.

		Destination poles				
		Capital city (Bregenz) approx. 0-8 km	First ring around capital approx. 8-20 km	Second ring around capital approx. 20-40 km	Other areas -	
Origin poles	Dist. from capital city					
	Capital city (Bregenz)	70 477 inhabitants 28 715 workplaces  96,98 km <sup>2</sup> in total, 55,91 km <sup>2</sup> (58 %) settlement area  <b>183 097</b> trips in tot. on the average, 75 % of all trips (working day)	<b>31 483</b> trips in total on the average, 13 % of all trips (working day)	<b>7 208</b> trips in total on the average, 3 % of all trips (working day)	<b>20 774</b> trips in total on the average, 9 % of all trips (working day)	
	First ring around capital		96 225 inhabitants 38 634 workplaces  210,92 km <sup>2</sup> in total, 96,71 km <sup>2</sup> (46 %) settlement area  <b>30 671</b> trips in total on the average, 10 % of all trips (working day)	<b>221 382</b> trips in total on the average, 75 % of all trips (working day)	<b>23 434</b> trips in total on the average, 8 % of all trips (working day)	<b>19 166</b> trips in total on the average, 7 % of all trips (working day)
	Second ring around capital			84 289 inhabitants 29 551 workplaces  158,77 km <sup>2</sup> in total, 85,45 km <sup>2</sup> (54 %) settlement area  <b>194 552</b> trips in total on the average, 76 % of all trips (working day)	<b>29 605</b> trips in total on the average, 12 % of all trips (working day)	
	Other areas	<b>20 797</b> trips in total on the average (working day)	<b>17 294</b> trips in total on the average (working day)	<b>30 580</b> trips in total on the average (working day)	<i>Not available</i>	

Table 1: Key land use and mobility data

In monocentric areas people often have to commute to the capital city, as workplaces are concentrated there. Therefore, the share of trips with the purpose “to work place” gives an indication of the advantage of polycentric structures, as it can be assumed that the inhabitants are able to find a proper workplace in a city nearby. Between 65 % and 69 % of all trips to work are internal trips, i.e. as workplaces are available at site (long-distance) commuting is necessary at a lower share only, even in the light of attractive (and assumable well paid) workplaces across the border in Switzerland (Table 2).

		Destination				<i>in total</i>
		capital city	ring #1	ring #2	other areas	
Origin	capital city	69 %	15 %	4 %	12 %	100 %
	ring #1	14 %	65 %	11 %	10 %	100 %
	ring #2	4 %	12 %	67 %	17 %	100 %

Table 2: Share of trips to work based on the origin of trips based on ring concept (working day)

People who have to commute to the capital city for work are often using these opportunity to go shopping at this destination as well, as shopping facilities are established in dominant cities. This leads to a serious reduction of shops in the city centres of the surrounding municipalities and reduces the attractiveness of the overall appearance of public spaces in these areas. So it is of major interest to offer appropriate shopping facilities in each municipality. Due to the polycentric structure, no particular need to buy goods preferable in the capital city is identified. Up to 88 % of shopping trips are internal trips (Table 3).

		Destination				<i>in total</i>
		capital city	ring #1	ring #2	other areas	
Origin	capital city	86 %	9 %	0 %	5 %	100 %
	ring #1	7 %	85 %	4 %	4 %	100 %
	ring #2	0 %	5 %	88 %	6 %	100 %

Table 3: Share of trips to shopping destination based on the origin of trips (working day)

The share of public transport trips on an average working day is less than in the other regions, however the use of the bicycle and walking seems to be more attractive compared to other regions of Vorarlberg. More than 1/3 of the trips are made by bicycle or on foot. This values give an indication that people living in polycentric structures are able to find their desired destinations nearby, so that the use of public transport, e.g. for commuting longer distances, is not that necessary than in other regions. Even leisure activities on Sundays are preferable undertaken by bike or are situated within walking distance, as more than 37 % of trips are undertaken by these modes (30 % car-driver, 28 % car-passenger). The share of car use is almost the same all over the Province of Vorarlberg, e.g. the share of car-driver or car-passenger is about 55 % on an average working day (Figure 5).

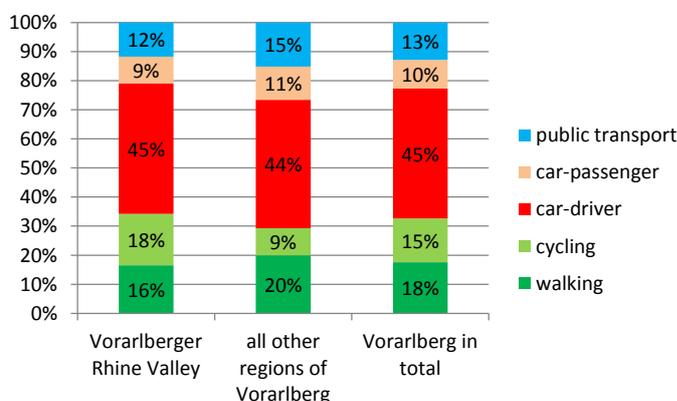


Figure 5: Modal Split on an average working day

The analysis of the average trip length per person and day determine the hypothesis that establishing polycentric structures are a proper tool to contribute to a more environmental friendly mobility. On an average working day the car trips of a car-driver in the Vorarlberger Rhine Valley are about 22 % shorter compared to the other regions in Vorarlberg, public transport trips shows a reduction of almost 25 % (Table 4).

average trip length [km]	Vorarlberger Rhine Valley	All other regions of Vorarlberg	Vorarlberg in total
car-driver	10,8	13,9	11,8
car-passenger	13,4	12,7	13,1
public transport	15,1	20,7	17,2
<b>all modes</b>	<b>8,6</b>	<b>11,4</b>	<b>9,5</b>

Table 4: average trip length (working day) [km]

In monocentric regions people often have to commute long distances to reach their workplace or schoolyard. Moreover, leisure and shopping facilities are concentrated to just one dominant city. The analysis of the trip length according to purposes shows the advantage of a polycentric region. Instead of commuting to the capital city of Bregenz only, the inhabitants of the Vorarlberger Rhine Valley find appropriate workplaces or schoolyards in one of the poles nearby. The same applies for leisure activities. Almost all trips of all purposes are shorter compared to the other regions in Vorarlberg (Table 5).

average trip length [km]	Vorarlberger Rhine Valley	All other regions of Vorarlberg	Vorarlberg in total
workplace	9,3	11,8	10,1
business	22,2	21,4	21,9
education	7,0	9,8	7,9
service	4,5	6,5	5,1
shopping	4,0	6,3	4,7
private purpose	6,6	9,8	7,6
leisure	9,4	13,2	10,5

Table 5: average daily trip length according to purpose (working day) [km]

At the same time people spend less time in transportation. On the average the daily trip duration on a working day is 20 minutes in the Vorarlberger Rhine Valley and 23 minutes in all other regions of Vorarlberg.

## 6 CONCLUSIONS

The Vorarlberg Rhine Valley has a long tradition of polycentric structures. 29 municipalities have established a common platform for the consensual development of spatial and transport plans in the region. Based on the results of interviews with stakeholders of the region it turned out that the communication culture among different interest groups is a major key for the implementation of sustainable measures in the region. Polycentric structures are able to support sustainable goals, as it offers the possibilities of finding points of interests nearby, so that the daily mileage driven is less than compared to other regions. Moreover, environmental friendly modes like bike or walking can be used more often. This has been determined by the analysis of mobility data. The average trip in the Vorarlberger Rhine Valley is 8.6 km, which is 2.6 km less than in the other region of the Province of Vorarlberg.

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