ALPINE CONVENTION

Report on the State of the Alps

Alpine Signals – Special edition 1

Transport and Mobility in the Alps

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The present document has been established under the coordination of the Permanent Secretariat of the Alpine Convention involving an "Integration Group" composed by experts from different Member Countries of the Alpine Convention. Based on discussions in this group, the different chapters have been drafted by different authors. The Working Group "RSA/SOIA" and the Working Group "Transport" have accompanied the drafting process. National delegations have provided extensive comments on previous drafts. The Permanent Secretariat thanks all persons involved for their intensive cooperation.

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E2	The Main Challenges for the Future	Permanent Secretariat / Working Group Transport	R. Schleicher-Tappeser, M. Meaux

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- The Statistical Office of the Republic Slovenia.

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Abbreviations

AC	Alpine Convention
ADTV	Average Daily Traffic Volumes
AMS	Arbeitsmarktservice Österreich
AMSL	Above Mean Sea Level
AOT	Accumulated Exposure Over a Threshold
APAT	L'Agenzia per la protezione dell'ambiente e per i servizi tecnici (Italian Agency for Environmental Protection and Technical Services)
ARE	Bundesamt für Raumentwicklung (Swiss Federal Office for Spatial Development)
ASFINAG	Autobahnen- und Schnellstrassenfinanzierungsaktiengesellschaft [Interstate and Highway Financing Inc. (AT)]
AT	Austria
AVW	Amt für Volkswirtschaft, Liechtenstein
AWNL	Amt für Wald, Natur und Landschaft, Liechtenstein
BAG	Bundesamt für Güterverkehr in Deutschland
BEV	Bundesamt für Eich- und Vermessungswesen in Österreich (Austrian Federal Office for Calibration and Measurement)
BFS	Bundesamt für Statistik in der Schweiz (Swiss Federal Statistical Office)
BGA	Bundesverband des Deutschen Groß- und Außenhandels (German Federal Office for Goods Transport)
BLS	Berner Alpenbahngesellschaft Bern–Lötschberg–Simplon (Bernese Alpine Rail Company)
BMVIT	Bundesministerium für Verkehr, Innovation und Technologie, Austria
BRAVO	Brenner Rail Freight Action Strategy Aimed at Achieving a Sustainable Increase of Intermodal Transport Volume by Enhancing Quality, Efficiency and System Technologies
BBT SE	Brenner Basistunnel Societas Europaea (European Corporation Brenner Base Tunnel)
CAFT	Cross-Alpine Freight Traffic
cfr.	Cross-reference
CH	Switzerland
CHF	Swiss Francs (Conversion rate as of 1 July 2006: 1 CHF = 0.63849 EUR)
CIG	Commission Inter-Gouvernementale (Intergovernmental Commission)
cp.	Compare
CSST	Centro Studi sui Sistemi di Trasporto (Italian Center for the Study of Transport Systems)
DB	Deutsche Bahn AG (German Federal Railway)
DE	Germany
DETEC	Swiss Federal Department of Environment, Transport, Energy and Communications
DG TREN	European Commission's Directorate-General for Energy and Transport
EC	European Community
ETCS	European Train Control System
EEA	European Environmental Agency
EEC	European Economic Community
ESPON	European Spatial Planning and Observation Network
EU	European Union
EU-15	15 EU Member Countries following the accession of Austria, Finland and Sweden in 1995
EU-25	25 EU Member Countries after the eastward enlargement on 1 May 2004
EUR	Euro
EUROSTAT	Statistical Office of the European Communities
ETA	Estimated Time of Arrival
ETCS	European Train Control System
FR	France
FSO	Swiss Federal Statistical Office, Switzerland
GDP	Gross Domestic Product
GHG	Green House Gases
GIS	Geographical Information System
GPS	Global Positioning System
HDV	Heavy Duty Vehicle
ICT	Information and Communications Technology
IFEN	Institut Francais de l´Environnement (Environmental Institute of France)
INEA	Istituto Nazionale di Economia Agraria (Italian National Institute for Agricultural Economics)

INSEE	Institut National de la Statistique et des Études Économiques (National Institute for Statistics and Economic Studies, France)
IQ-C	International Group for Improving the Quality of Rail Freight Traffic on the North-South-Corridor
ISTAT	Istituto nazionale di statistica (Italian National Institute of Statistics)
IT	Italy
LAU	Local Administrative Unit
LDV	Light Duty Vehicles
LfStaD	Bayerisches Landesamt für Statistik und Datenverarbeitung (Bavarian State Office for Statistics and Data Processing)
LI	Liechtenstein
LLV	Liechtensteinische Landesverwaltung
LSVA	Leistungsabhängige Schwerverkehrsabgabe (Swiss Mileage Related Heavy Vehicle Tax)
LTF	Lyon Turin Ferroviaire
LUCAS	Land use and cover area statistical survey; introduced by EUROSTAT in 2000.
MC	Monaco
MRHVT	Mileage Related Heavy Vehicle Tax
MoT	Margin of Tolerance
NEAT	Neue Eisenbahn-Alpentransversalen (Swiss New Rail Link Through the Alps)
Nox	Nitrogen oxide
NRLA	Swiss New Rail Link Through the Alps (NEAT)
NUTS	Nomenclature of Territorial Units for Statistics
ÖBB	Österreichische Bundesbahnen (Austrian Federal Railway)
OD	Origin-Destination
OECD	Organisation for Economic Co-operation and Development
p.a.	Per anno (per year)
Pkm	Person kilometres
PC	Passenger car
PM10	Particulate Matter < 10 µm
ppb	parts per billion
PPP	Public-Private-Partnership
PSA	Permanent Settlement Area
RCA	Rail Cargo Austria
RFF	Réseau Ferré de France (French Federal Railway)
RFI	Rete Ferroviaria Italia (Italian Federal Railway)
SABE	Seamless Administrative Boundaries of Europe
SCEES	Service Central des Enquêtes et Études Statistiques, Ministère de l'Agriculture
SI	Slovenia
SME	Small and Medium Sized Enterprises
SNCF	Société Nationale des Chemins de fer Français (French National Railway Company)
SOIA	System for the Observation of and Information on the Alps
TEN	Trans-European Networks
THEPEP	Transport, Health and Environment Pan-European Programme
TIPP	Taxe intérieure sur les produits pétroliers
Tkm	Tonnes kilometres
UBA Wien	Umweltbundesamt, Austria
UBA Berlin	Umweltbundesamt, Germany
UN-ECE	United Nations Economic Commission for Europe
VOC	Volatile Organic Compounds
WG EOI	Working Group on Environmental Objectives and Indicators
WG T	Working Group on Transport
WHO	World Health Organisation

Preface

The Alpine Convention is a multilateral framework treaty, signed in 1991, between the eight states of the Alpine bow as well as the European Community. Its main objectives are the protection of the Alpine territory and the safeguarding of the interests of the people inhabiting it, embracing the environmental, social and economic dimensions in the broadest sense. In order to achieve its objectives, over the years the framework treaty has been equipped with a large number of thematic protocols.

As stated in the Multi-Annual Work Programme of the Alpine Conference for the years 2005–2010, the Report on the State of the Alps is an instrument designed to provide a broader public with information and appraisals on the main developments taking place in the Alps, and at the same time it serves as a basis for strategy development for politics and administration.

The Transport Protocol to the Alpine Convention, adopted in the year 2000, represents one of the most important cornerstones of the whole Alpine Convention. This first Report on the State of the Alps addresses coherently the subject of transport and mobility within the Alps, and between the Alpine space and other European regions, from environmental, social and economic perspectives.

This report is the result of a joint effort by authors from various contracting parties and was approved by the IXth Alpine Conference in 2006 in Alpbach (Austria). It is the outcome of a complex process of data collection and assessment, as for the first time Alpine-wide statistical data were provided by the contracting parties in order to be analysed from a pan-Alpine perspective. This sometimes revealed inconsistencies between the data, as well as interpretation difficulties, but also facilitated discussions, raised awareness and improved comprehension of the transport dynamics among the contracting parties.

The final outcome provides readers with a report rich in data, information and analysis, embracing a wide range of challenges, which it is hoped will further stimulate the discussions in the competent political fora. The key questions, not surprisingly, are all related to the dichotomy between the need to combine mobility and accessibility with the preservation of the Alpine environment and the quality of life of the population living in the Alps. Technological development plays an important role and already provides a set of improvements to the aforementioned dichotomy. However, key problems remain open and important political decisions lie unavoidably ahead of us. The last part of the report, “Main challenges for the future”, aims to contribute to the corresponding decision-making process.

The Permanent Secretariat of the Alpine Convention wishes to thank all authors and representatives of the contracting parties for their contributions. Special thanks go to Mr Stefan Marzelli and his collaborators at ifuplan for the valuable editorial work.

This report, published in a special edition series of the “Alpine Signals”, will be followed by other reports on the State of the Alps on other themes, with the aim of continuing to provide a dynamic picture of some of the important developments for the Alps and their population. At the time of publication of this first report, work has already begun on data collection and analysis in view of the second report, on the subject of water in the Alps.

Marco Onida

Secretary General of the Alpine Convention

Introduction

Reporting on the state of the Alps is an important tool for developing and monitoring policies for the sustainable development of the Alpine space. Not by chance this first report on the state of the Alps focuses on transport and mobility. This introduction will first give some background on the role of this issue in the Alpine context and then introduce the aim, the focus and the structure of the present report.

The evolution of the role of transport in the Alps

Since the beginnings of human history in the Alps, transport has been a central issue. The Romans succeeded in constructing and securing cross-Alpine roads which guaranteed the connection to their territories on the other side of the Alps. Likewise, the main valleys, at least on the southern side of the Alps, developed thanks to ensured accessibility. With the breakdown of the Roman Empire connections became unsafe, infrastructure partly decayed; settlements in the Alps became isolated and declined. In the boom time of the High Middle Ages, transport and trade along the valleys and across the Alps again played an important role. How-ever, in the following centuries the development of Alpine cities lagged behind, mainly because of the transport restrictions of the Alpine topography: the cultivated area accessible within a one-day there-and-back journey was only half as large for a city such as Innsbruck and two thirds as large for Bolzano compared to that for a city in the plains. Only the introduction of the railway drastically changed the situation – cities no longer depend on their immediate surroundings for everyday supplies.

Facilitation of transport allowed for a strong development of tourism from the late 19th century – the Alps had become the romantic symbol for freedom, peacefulness and authenticity, for the absence of the stress and dirt of industrialised cities – and led to a further improvement in the transport infrastructure. Cross-Alpine trade and Industries developed, but also increasing nationalism and militarisation and corresponding efforts for fortification boosted the construction of railways. However, for most of the Alpine territory access remained very difficult.

Only some 100 years ago, the introduction of the motor car started to change the situation completely. Especially mass motorisation in the last 50 years and heavy investment in the infrastructure in particular have led to a full integration of the Alpine economies into the European markets, to rather late – compared to other regions – but radical changes in lifestyle, to a decline of Alpine agriculture and to new opportunities for Alpine locations. Directly (construction, transport services) and indirectly (tourism, new industries, trade) transport has led to the creation of new economic activities.

Thanks to the central position of the Alpine mountain range in European geography, many Alpine regions, which were once among the most peripheral in Europe, today are in a rather favourable situation concerning accessibility.

Changes in transport infrastructure and technology have always had a complex impact on local and overall development, creating new opportunities and new imbalances. The strong impact on the environment, however, is a rather new problem that has arisen already with the railways but acquired a new dimension with widespread motorised transport and the corresponding massive infrastructure. Environmental concerns have raised sharp political debates about Alpine transport in recent years; often they were associated with a concern for disappearing ways of life, and the spreading of urban settlement structures. The huge increase in cross-Alpine freight transport has met resistance by the Alpine population largely supported by the population outside the perimeter of the Alpine Convention.

The concepts of transport and mobility

Transport and mobility are closely linked, but they are not identical. Transport is a means of changing the location of people and of goods in order to fulfil different needs, such as going to school, shopping, meeting colleagues or delivering industrial products. The extent to which transport is needed to fulfil these needs depends on many trends and policies which shape the spatial organisation of society. The use of different transport modes – walking, bicycle, car, railway, truck, plane etc. – depends on distance, frequency, availability, degree of comfort, prices, and – last but not least – habits.

Mobility, on the other hand is a much more abstract and emotionally charged concept. Mobility is associated with the freedom of moving, of making experiences, of exchanging goods and views, of having access to the rest of the world. Mobility is essential for personal development, for innovation, for trade, for business, for culture, for everything that makes up society.

Mobility necessarily involves transport. However, how much, and which kind of transport is needed for ensuring a certain degree of mobility, depends on the spatial organisation of society, the transport systems and alternative means of communication. Most people like travelling for fun. However, in everyday life there is also much compulsory, unpleasant mobility: we would often like to avoid commuting, business travel, driving to a distant office or hospital, shipping goods over long distances if only jobs, schools, services, clients were nearby. The different lifestyles and the different structures we can find in the Alps involve very different mobility patterns. Mobility as opportunity is an important goal in modern societies, but mobility as obligation should be minimised.

Different structures and interests across the Alpine space

Given the strong pressure on some main corridors, the accelerated integration of the European economies, the declining market share of the railway, steadily increasing passenger mileage and the considerable costs of transport infrastructure, transport has for many years been the main political issue concerning the Alps. It is a complex issue for international negotiation as structures, needs, perspectives and interests vary considerably between the countries and regions involved.

The main European economic centres are interested in easy and cheap transit through the Alps and therefore have a different perspective than the Alpine population. Tourism operators have different interests from freight hauliers. Densely populated valleys like those in the central Alps have completely different preconditions for public transport and other needs than large areas in the eastern and especially the western Alps with very few inhabitants. Settlement structures and tourism patterns differ strongly between the east and the west. Regions in federal states have more leeway for action than those in centralised countries. Road operators easily operate across borders whereas national railways still maintain different regulatory, tariff and technical systems. The relationship between direct and indirect costs differs between the main corridors making comparisons difficult. And finally the political and economic role of the Alpine population and the symbolic significance of the Alps differs from country to country.

Therefore, transport is not merely a technical issue. Transport decisions are intrinsically linked to a regional specific mix of different economic, environmental, social, cultural and political issues which needs to be considered when looking for common solutions.

The role of transport in the sustainable development of the Alpine space

This historical and conceptual overview already shows that the issue of transport in the Alps – as few others – intensely concerns all kinds of policies and all dimensions of sustainable development.

Evidently, the three basic development dimensions – *economy, environment, society and culture* – are all most relevant in this context.

Also, all equity issues of sustainable development, i.e. *social equity*, *equity between generations* and *equity between territories* are essentially affected by Alpine transport policies.

And finally, the systemic principles associated with sustainable development play a central role in the discussion of transport issues in the Alps: the *diversity* of conditions across the Alps has to be respected, while the diversity of approaches in different regions is a great potential. Respecting and making sensible use of *subsidiarity*, i.e. differentiatedly involving the appropriate levels in the multi-level governance systems in the Alps improves effectiveness. *Networking and cooperation* are essential for mutual learning, especially in international and cross-border activities. *Participation* of those ultimately concerned is a prerequisite for lasting changes.

As will be evident throughout this report, solving problems and conflicts seriously requires a spirit of integrated sustainable development.

The role of transport in the Alpine Convention

Since the beginnings, transport has played an important role in the Alpine Convention although main transport decisions for the Alps are being taken by the transport ministers in other institutional settings. Among the eight implementation protocols of the Alpine Convention, the transport protocol was the one that was the most difficult to negotiate. It also raises the most controversial discussions in the ratification process. The transport protocol gives a broad overview on the issue and its interlinkage with other policy fields. It sets rules and gives general orientation for transport policies in the Alpine space. The Working Group Transport is the one with the longest history in the Alpine Convention and has the task of monitoring progress along the guidelines given by the protocol. It also maintains contacts with other institutions such as the Zurich Group, the coordination body of the Alpine Transport Ministers.

The aim and focus of the report

The report is addressed to the wide range of politicians, professionals and non-professionals involved or interested in the debate on transport in the Alpine space.

The aims of the report can be summarised in four points:

- to provide an understanding of the complex issue of transport in the Alps,
- to provide overview on present state and on trends,
- to show different structures and problems in different parts of the Alps,
- to identify the main challenges that call for joint action.

Compared to other European, national and regional reports on this issue, the specific focus of this report lies in:

- the presentation of harmonised data for the whole Alpine area,
- putting the issue of Alpine transport in the context of an sustainable development,
- showing the specifics of transport problems in the Alps compared to other regions which might justify specific policies, and
- formulating the relevant questions and challenges without however formulating a political programme.

The first edition of such a report does not yet fully meet all these objectives. The limited availability of appropriate data and the difficulties of data harmonisation have shown the importance of joint efforts. However, the overall approach has proven to be valuable for contributing to a coherent Alpine perspective on the subject.

The indicator-related data that have been collected by the contracting parties of the Alpine Convention represent the skeleton of the facts presented in this report. In addition, data from other sources have been used in addition and have always been quoted with their source.

Writing the first report on the state of the Alps

The present report is the first approach to writing a report on the state of the Alps.

Since the nineties there have been efforts to establish a System for the observation of and information on the Alps (SOIA) which suffered from insufficient funds and coordination. New efforts have been made by a Working Group of the Alpine Conference, working on “Mountain Specific Environmental

Objectives" (2000–2002) and then on "Environmental Objectives and Indicators" (2003–2004). In its final report (WG EOI 2004) this group has proposed an indicator system. The group also outlined a corresponding reporting structure and format and delivered pilot chapters for selected topics.

In November 2004, the Alpine Conference asked the Permanent Secretariat (established in 2003) to prepare a first report on the state of the Alps. Due to limited resources, in autumn 2005 the Permanent Committee decided to produce a report focused on transport and mobility based on original data from the member states according to the indicators proposed by the WG EOI.

Besides the importance of the transport issue and its many links to all dimensions of sustainable development, as outlined above, the long experience of the Working Group Transport of the Alpine Convention and its willingness to be involved in this endeavour, were decisive for the decision to focus the first report on the state of the Alps on this issue.

This report is a result of the joint effort of national teams provided by Italy, Germany and Austria, of the French Presidency, of the Working Group Transport and of the Permanent Secretariat. Chapters have been written by different authors considering the comments of the Contracting Parties. After the approval of the contents, final editing has been undertaken by the Permanent Secretariat supported by an external contractor and in close consultation with the authors.

This approach of distributed responsibilities has enabled the report to be produced with very limited resources on all sides. However, it has also led to limitations in the homogeneity of the approach and concerning cross-references between the chapters. Case studies representing different Alpine realities and comparisons between different regions were only possible to a limited extent.

To look at the driving forces and at the impact of transport in a perspective of sustainable development is an ambitious task which involves a range of theories and perspectives where the selected focus is not necessarily shared across all disciplines and countries involved. In this report it was not possible to provide a complete picture – especially concerning the impacts it was necessary to focus on a deliberate selection of relevant and well-documented issues. Undoubtedly, readers could possibly miss a more detailed discussion on social aspects, on biodiversity, on water etc. However, this report is only the first product in the long-term project of monitoring developments in the Alps.

The construction logic of the report

The report has five parts which correspond to its major intentions.

Part A describes the Alpine Transport System. This chapter has a deliberate transport perspective. It provides facts about the situation and the trends concerning the infrastructure, freight transport, passenger transport and the overlapping of these systems and uses as well as an outlook on new infrastructures being built. Based on the most recent figures from the member states it provides a comprehensive overview on cross-Alpine and intra-Alpine traffic.

Part B looks at the driving forces behind the developments described in part A. What are the services that the transport system is delivering? Why is freight transport increasing? How has the Alpine population, its distribution and its demands evolved? How does tourism create transport demands?

Part C looks in the opposite direction and deals with selected impacts of transport in the Alps. The structure of part C corresponds to the three main pillars of sustainable development: chapter C1 deals with the impact on the economy, chapter C2 with the social impacts and chapter C3 with some selected environmental and health impacts. Given the wide range of issues on which transport has an effect, it was not possible to treat all of them.

Part D again takes a different look at the subject: it describes transport-related policies at European, national and for some issues also at regional and local levels. In doing so, it tries to relate these policies to the facts and trends, to the drivers and the impacts described previously, allowing at the end to get an overall impression – surely not a systematic assessment – of the variety and the adequacy of these policies.

Part E, finally, against the background of the foregoing descriptions and explanations and considering fundamental overall policy objectives, looks at the fundamental service functions Alpine transport is supposed to provide for identifying the main political challenges that have to be addressed in the future.

A The Alpine Transport System

Road and rail at the Brenner (Source: S. Marzelli).

In part A of this report the basis of the central topic is presented, the Alpine transport system. This complex system of local, regional, national and international transport systems comprises all the different types of infrastructure, such as railways, roads, waterways, airports and even urban transport systems such as trams, trolley buses and underground railways.

In this report the focus is laid on:

- road and rail infrastructure as these play the most important role for the Alpine transport infrastructure, and
- freight and passenger transport which represent the highest traffic volume on the transport modes of road and rail transport. Passenger transport is subdivided into individual and public transport.

As this report seeks to compile information for the whole area of the Alpine Convention for the first time, some deficiencies are unavoidable. These shortcomings are related to the different administrative structures of the Alpine Convention area and to the heterogeneity of road and railway companies and systems, which result in data differences due to the different categories and monitoring systems in place. Consequently, information and data research and their harmonisation is in some cases a time-consuming and long-term task.

The need for an Alpine transport system

The transport system of the Alps has to fulfil different functions and services (cp. basic service functions in chap. E2):

- First, the transport system is necessary for the daily activities of the inhabitants of the Alpine area, such as work, shopping, business, education and leisure, as well as for their supply with public and private services.
- Furthermore, the transport system is a main economic factor, as the infrastructure is used by the different economic sectors of the Alpine area to exchange goods within and beyond the Alpine region. This includes the access of tourists from and to the Alpine destinations and the mobility of tourists around their holiday destination.
- Because of its central geographical position between strong European economies, the transport system in the Alpine area has a vitally important role in the transit of passengers and freight from north to south as well from east to west.

The chapters in part A of the report will outline

- the Alpine transport infrastructure and its development for road and rail (chapter A1),
- the status, trends and backgrounds of freight transport (chapter A2) both on road and rail, and finally
- the passenger transport (chapter A3) in its forms of motorised individual and public transport by rail and bus.

Setting the frame for these chapters in the following sections, the overall issue and its internal links will be presented and key terms for Alpine transport will be introduced.

Road and rail transport infrastructure

The mountainous topography of the Alps constitutes a particular challenge for transport infrastructures. Thanks to technical progress, it has become easier to overcome steep slopes and deep valleys with the construction of long tunnels and bridges. But the topography, natural hazards and weather conditions still play an important role in regard to infrastructure and maintenance costs as well as duration of construction.

Nösslachbrücke, Austria (Source: BMVIT Alpenstraßen AG).

The Alpine road infrastructure is characterised by several motorways especially from north to south and a few motorways – mainly in the western Alps – from east to west. By building a series of tunnels and Alpine passes over the last century, large part of the physical barriers of mountain ridges have been overcome. Higher ranked national roads connect the different motorways; in the end a dense road network has evolved through the Alpine valleys.

The rail infrastructure has developed in another way. Within the last years the development focused on the expansion of both the high-speed inter-city system, and of the rail network in urban and suburban regions. Because of insufficient demand in some rural regions, more and more light railways are threatened with closure, or have already closed. Therefore in some countries the length of the railway network decreased in the last decades.

Freight transport

The transport of goods to or from, as well as within and through, the Alpine area may be the most controversial topic of Alpine transport (see types of transport in the Alps on the next page). The wide breadth of study involved is impossible to reflect comprehensively in this report. But the report will go into the topic, giving an overview of freight transport development in the last ten years in general, as well as in terms of short and long distance freight transport. The use of road and rail for freight transport, and their areas of congestion, are also presented. Trends in freight transport show an overall increase, which will continue in the coming decades. With the exception of Switzerland, this increase will occur predominantly in road freight transport.

Freight transport by rail (Source: Rail Cargo Austria).

Passenger transport

The demand for passenger transport is also growing, reflecting an increased demand for mobility as already mentioned above. Therefore the major question is, which transport mode is chosen to serve these needs. Some case studies will offer insights into the general trend which is often in favour of motorised car transport. Car transport is increasing both on short- and long-distance journeys. Public transport performance remains difficult to examine as information is collected according to individual methods by different providers and modal split studies. However, some examples give an impression of railway and bus service development.

The provision of public transport has in general changed over the last few years; particularly in rural areas it has declined in many cases. Development differs between regions:

- Some light railway services were closed and replaced by bus systems; bus systems sometimes could not be conducted efficiently and were closed too, in the best cases they were substituted by on-demand systems.
- In some rural regions this development could be halted by well-planned public transport concepts which include, for instance, mobility management, on-demand systems or synchronised bus and railway timetables.
- Other regions may have access to profitable railway or post bus services, as is reported from Switzerland.

Mobility

Mobility is a complex concept as it represents an amalgamation of social and physical aspects. Mobility from a social perspective may be observed at three levels (Götz 2003):

- Mobility is the physical movement of people and goods in space,
- mobility simultaneously indicates the accessibility of personal options and opportunities to serve human needs in a social sense, and
- mobility also describes the position of humans in a symbolic space and, vice versa, social position and lifestyle have an influence on mobility practice.

The physical aspects are outlined according to UBA Berlin (2006): the term “mobility” is used to describe two aspects, the movability (possibility to move) and the actual movement of people and objects.

Mobility can also be quantified. The more “activity objectives” (e.g. certain shops, restaurants, work places) are accessible within a given time frame, the higher the mobility. This definition implies that reaching activity objectives is the decisive factor for mobility, and not the distance travelled. It links mobility with the activities individuals seek to pursue (to meet their needs) and does not include a valuation as to whether these are desirable or undesirable, necessary or unnecessary.

Mobility encompasses both the capability to reach (movability) and the actual reaching of objectives (movement) – in short: potential and realised mobility.

Potential mobility is a function of the density and diversity of activity opportunities available within the individual's radius of action, which is influenced by the available transport mode. Hence, potential mobility is above all a measure of the quality of activities and thus a measure of the quality of life.

Realised mobility is quantified by the number of activity objectives actually reached. The variable "number of trips" used in statistics to express mobility is identical with the number of activity objectives.

Changes in potential mobility have on average a relatively minor impact on realised mobility. This may be illustrated by observations within Germany:

In the Federal Republic of Germany, the number of motorised trips, as well as trips on foot and by bike, has increased only slightly, if at all, since 1976, when records began. The daily average is a little more than three trips per person. A similar figure was determined as early as the 1920s for Berlin.

However, those who equate mobility with auto-mobility come up with an impressive increase in mobility. Trips by car grew by more than 100% between 1960 and 1994 alone (UBA Berlin 2006).

With the number of trips – and hence mobility – remaining constant, kilometres travelled can increase or decrease depending on the trend in average trip length. Both developments are possible. In the EU personal mobility in terms of kilometres per day increased from 17 km a day in 1970 to

35 km in 1998 (European Commission 2001). This high level of realised mobility is now more or less seen as an acquired right.

Today, the strategy of choice is to rely on ever faster means of transport. This accelerated transport enhance the accessibility of distant areas, but at the same time it reduces the meaning of spatial distance in terms of spatial qualities such as remoteness, maintaining differences or evaluation of characteristics. Mobility in this case is associated with more travel ("mobility of long distances"). The increasing traffic, generated by more and longer trips, in a feed back loop curbs the mobility of people by congestion, queue times etc. (UBA Berlin 2006).

Accessibility

Accessibility in terms of transport refers to the ease of reaching destinations. People living in highly accessible places can quickly reach many destinations whereas people in inaccessible regions have access to fewer places in the same amount of time.

In a broader sense, accessibility can also be understood as access to information technology such as broadband-internet, mobile phone or service supplies.

More precisely, transport accessibility is the circumstance under which a location or region can be reached in reference to other locations and regions, taking into account the travel time and travel expenses which are necessary to reach them (Wegener 2003). Furthermore, it is the real product of the present transport system. It can be calculated by means of different indicators, which are more or less complex:

- *Simple accessibility indicators:* In the simplest way, accessibility can be defined as the travel effort (in terms of travel time and expenses). Considering certain destinations such as urban centres or tourism destinations, accessibility is normally expressed as travel effort in total or on average (Wegener et al. 2002). Another simple accessibility indicator is the transport infrastructure in a region (e.g. total length of roads, motorways or railway lines, number of railway stations or motorway exits).
- *Complex accessibility indicators:* These indicators take into account the connectivity of transport networks by distinguishing between the network itself and the activities or opportunities that can be reached by it. Normally these indicators integrate a spatial resistance factor (e.g. travel time, cost) in order to describe the possibility of reaching destinations of interest (Spiekermann & Neubauer 2002).

A controversial debate is ongoing on the importance of accessibility to regional economic development (see also chapter C1). The complex relations between accessibility and regional economic success, does not allow to refer to a solid cause-relationship.

However in general many areas with better access to commercial locations and markets will probably be more productive, more competitive and hence more successful than more isolated areas (Spiekermann 2006; Linneker 1997). On the other hand the importance of accessibility to the road network for the economic performance of peripheral regions is constricted due to the decreasing economic importance of the transport of bulk products, new communication technologies, the growing importance of soft location factors (information, services, recreational value) and globalisation. There is no clear evidence that, within peripheral regions, those areas with better accessibility to the road network have better-performing economies.

Accessibility is also one of the main factors influencing spatial development. The access to road and public transport depends on the location of a community within the transport system. In general, urban and suburban areas have better access to the road and public transport network than do rural areas. Accessibility to transport services in urban regions leads to the evolution of a wide suburbanised belt surrounding their centres (Fröhlich, Tschopp & Axhausen 2005).

Types of transport in the Alpine Area

In the Alpine Convention Transport Protocol, Article 2 defines the following types of transport:

- trans-Alpine transport is transport whose destination and origin is outside the Alpine area,
- intra-Alpine transport is transport whose destination and origin lies within the Alpine area, including transport having origin or destination in the Alpine area.

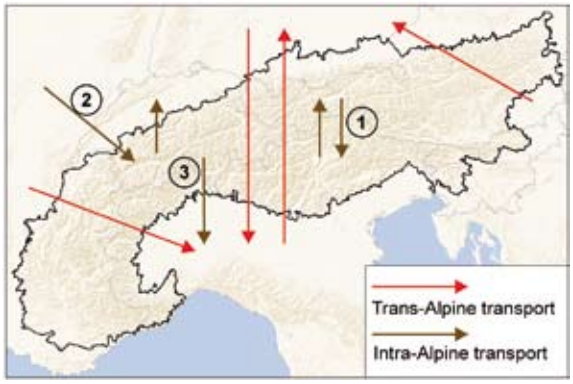

Fig. A-1: Scheme of transport typology.

According to this, intra-Alpine transport may be further subdivided into (see Fig. A-1):

① internal transport (destination and origin within the Alpine area),

② import transport (origin outside and destination inside the Alpine area), and

③ export transport (origin inside and destination outside the Alpine area).

In this report these terms are used in this manner.

However one should recognise different and sometimes confusing meanings from other points of view.

“Alpine crossing” traffic is defined as traffic, both of goods and passengers, which crosses the main Alpine ridge on its way. This is for instance the freight transport monitored by the project “Cross Alpine Freight Transport” (CAFT), which is differentiated as:

- ***Transit traffic:*** The sum of passenger and freight traffic from an origin and to a destination outside the considered location, corresponding to trans-Alpine traffic.
- ***Import traffic:*** The sum of passenger and freight traffic originating outside of the considered location with destination within the considered region.
- ***Export traffic:*** The sum of passenger and freight traffic originating inside the considered region and with destination outside.
- ***Internal traffic:*** Internal traffic originates and ends within the considered region, all of the last three categories correspond to intra-Alpine traffic.

Traffic across national boundaries may fall under different categories depending on the point of view. Depending on its origin and destination in regard to the respective country borders, it may be categorised as import, export or transit traffic. For instance, traffic from the German Alpine area to the Italian Alps, passing through Austria is transit traffic from a national point of view in Austria, trans-Alpine traffic as it crosses the Brenner pass, import traffic from the Italian perspective and internal traffic in regard to the Alpine Convention area.

Modal split

Modal split is the proportion of total journeys (trips), volume, weight, vehicle or transport performance (vehicle, tonne- or passenger-kilometres) carried out by various alternative modes of transport, such as road, rail, inland water, maritime and air, including non-motorised transport. Modal split can also be defined as the share of different modes of transport, including non-motorised modes and pedestrian trips, within overall transport demand.

The modal split differs markedly across the European region, while future trends show a rather similar pattern. For the – at that time – EU-25 countries, road transport (tonne-kilometres for 2002) accounts for around 72%, rail for 16.4%, inland waterway transport for roughly 6% and pipeline transport for the remaining 5.6% of total inland European freight transport (excluding maritime and air transport). 82.5% of passenger transport was undertaken to by private car, 9.5% by bus and coach, 6.8% by rail and 1.1% by tram and metro. These figures do not include air transport that contributed around 5.7% of total transport performance. Also, short sea transport, including ferry-boat, is quite important among EU countries, especially for freight transport (The PEP 2007).

Modal shift requires the existence of suitable alternative modes of transport of the same or similar quality and performance/cost levels. The relevance of modal split policies within the framework of sustainable transport in general and demand management in particular arises from differences in environmental and health impacts (resource consumption, pollutant and noise emissions, land consumption, accidents, physical activity, etc.) of the different transport modes, including non-motorised modes such as walking and cycling.

It is difficult to make general statements about the environmental and health impacts of a modal shift towards the so-called environmentally friendly and healthy modes of transport, such as rail or inland water transport, public transport in urban areas or walking and cycling. While these modes may indeed have fewer negative environmental and health impacts at comparable service levels, it is the total transport chain from origin to destination that needs to be assessed, including the provision and maintenance of the required infrastructures.

The modal split in the Alpine area depends on the available infrastructure (public transport, rail, etc.) and the geographical situation of the community. Because of larger investments in road infrastructure, both passenger (see chapter A3) as well as freight transport (see chapter A2) increased on the road. This trend has been observed continuously over the last decades and will most likely continue in the future.

Due to changing lifestyles, the purpose of transport has changed over the last years, with leisure and tourism transport becoming ever more important. More but shorter holidays, mainly involving car travel to and from the destinations, are resulting in increased traffic volumes on Alpine road connections.

High diversity of conditions for transport in different parts of the Alps

It does not exist an “Alpine transport” as a self-contained system, as conditions for transport systems are even more divers in the Alpine space as they are in lowlands. Transport embraces urban transport in Alpine cities as well as transport in sparsely settled, remote territories.

Furthermore, parts of the Alpine area lie in the catchment area or even the commuter belts of large metropolises outside the Alpine Convention area such as Lyon, Milano, München, Zürich or Wien. Therefore transport in the Alpine area has to consider large traffic flows between these metropolises and their surrounding areas and on the big transit axes as well as very low traffic flows which are however crucial for the survival of low populated areas. Traffic means appropriate to topography and traffic demand include the whole range from motorways and high speed railways to cable cars and even foot paths.

In general, the eight countries which form the Alpine area have developed different transport systems, policies and strategies, and different histories of transport infrastructure, which makes an Alpine synthesis a complex task.

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A1 Transport Infrastructure

Transport infrastructure is the essential frame for the functionality of a transport system. It steers the accessibility of the region as well as the accessibility of perialpine goods and services for the Alpine population. On the other hand, the major transport volumes are increasingly concentrated on a limited number of Alpine crossings.

In the last few decades the Alpine road network has undergone a major extension, whereas the railway is basically still using the network that was established in the first half of the 20th century. Today, the modal split in many Alpine region clearly reflects this transport and infrastructure policy.

The Alps have a longstanding history of ambitious transport infrastructure projects facilitating the transport of passengers and goods between northern and southern Europe. Nowadays, although the system continues to be supplemented by major projects, it is reaching its limits both in capacity as well as in negative environmental and social effects, such as noise, immissions and fragmentation of landscape.

The following chapter will provide an overview of the current status of the Alpine road and rail transport network, and of projects and strategies to cope with the continued increase in traffic volume that is predicted for the European Union.

A1.1 Importance and role of transport infrastructure in the Alps

The transport network in the Alps is characterised by a limited number of corridors, established for fast and easy access and transection of the mountain range in a North-South direction and a dense network of secondary roads. In the course of motorisation, short-distance connections over mountain ridges between neighbouring valleys were abandoned, whereas linear connections between intra- and perialpine regions were greatly improved. This pattern reflects the increasing relevance and integration of the Alpine region in its surrounding lowland and the territory of the European Union as a whole. Today, for many mountain regions the perialpine agglomerations such as München, Milano and Zürich are faster and easier to reach than neighbouring valleys or mountain ridges.

Intra-Alpine transport

In the Alps the transport infrastructure provides links between remote areas and valleys and the centres and villages inside and outside the Alps. Depending on the local situation, an improved accessibility through transport infrastructure can either lead to a strengthening or to a depletion of the local economy (see also Chapter C1). In remote areas with limited employment opportunities and declining economy, the population is on the one side heavily depending on good infrastructure; on the other an improvement of transport infrastructure can also expose the local economy to highly competitive market forces. Transport infrastructure is one of the essential location factors for industry and trade. It is particularly vital for tourist destinations based in remote regions, which, due to their morphological setting, are often difficult to access.

Trans-Alpine transport

Another aspect of the infrastructure of Alpine transport is the role it plays in the international transport network, e.g. the Trans-European Network (TEN). The Alps are in the middle and at the crossroads of vital economic centres of the European Union, most notably between the Mediterranean region and Central and Northern Europe and between the Iberian Peninsula and Southeastern Europe. These economic centres are origins and destinations of significant traffic volumes, part of which transect or closely circumvent the Alpine arc.

A high volume of transport is concentrated on the transport infrastructure in a few valleys, creating enormous pressure on the environment.

Although being aware that the Alpine transport infrastructure has to be seen within the context of its feeders and the overall European transport system, this report strongly focuses on transport infrastructure within the Alps.

Indicators

Road and rail length

Location, length, number of railway stations or free flow speed are typical parameters which give a first impression of an infrastructure system and its developments. These parameters are available for the present situation.

General conclusions are drawn by using national data and the results of the Project 1.2.1 "Transport services and networks: territorial trends and basic supply of infrastructure for territorial cohesion" of the European Spatial Planning Observation Network (ESPON) (EU 2004).

Transport network extension

Furthermore, plans for future widening and extension schemes provide information about the current importance and (political) needs of infrastructure.

Road and rail network density

The density of the network is a suitable parameter for characterising the transport network, especially when comparing different regions within and beyond the Alpine Convention perimeter. This parameter is calculated in relation to both the population and the surface area of a particular region. The density of the network in relation to the surface area covered can be used to describe the accessibility of the Alpine region, whereas the density in relation to the population can also be seen as an indicator for the supply of transport services to the inhabitants of the Alpine region.

A1.2 Road infrastructure

Historic development of road infrastructure

Roads are the oldest form of transport infrastructure. In the second half of the 20th century, mass motorisation and the resulting traffic volumes required an expansion of the existing road network, allowing higher speeds and traffic volumes, particularly on motorways.

The motorway network as it exists today originated in the years after the Second World War. Most of today's motorways in the Alpine space were built before 1981. Since 1981 some sections of the motorway network have been added and conventional roads have been extended or gaps in the network were closed, for instance the Pyhrn pass and the motorways in southern Austria or the Fréjus corridor in Italy / France. However, especially in the western Alps, some Alpine-crossing connections have not been converted into motorways.

A1.2.1 Current road network

To a higher degree than the non-Alpine road network, the Alpine road network had to be adapted to topographic conditions. Roads are often narrow, steep and winding while climbing passes to cross mountain ranges. Crossing small and large valleys requires bridges and preventive measures are sometimes needed against natural hazards such as avalanches and mud slides. To overcome the natural barrier of the Alps, small and large tunnels have been built. Examples are the Tauern tunnel in Austria, the Gotthard tunnel in Switzerland, and the Fréjus and the Mont Blanc tunnels between France and Italy.

All these topographic obstacles, together with Alpine weather conditions, may slow down traffic speed. They lead to long construction periods and high construction and maintenance costs of Alpine infrastructure projects. As far as possible, roads have been built along the main valleys where construction and maintenance costs are significantly lower, but where they are close to residential areas.

Respecting these topographic conditions, the motorway system follows the main valleys of the Alps and connects main Alpine towns and cities (cp. Map A1-1). Additionally, secondary roads connect side valleys and their towns and villages with the motorways, forming a dense road network through the Alpine valleys.

The road infrastructure of the Alpine space includes several motorways from north to south and – especially in the western Alps – from east to west. Further east-west routes closely circumvent the area of the Alpine Convention (for instance the route from Lausanne to Bern and Zürich).

Main roads and motorways as part of the Trans-European Network

The Alpine motorway infrastructure is part of the Trans-European Network and its corridors. Most of it connects Northern Europe (Germany, Netherlands etc.) with Southern Europe (Italy, Greece etc.), e.g. the Brenner route. In the Alps these north–south corridors (cp. Tab. A1-1) have the function of transit routes, but at the same time are used for intra-Alpine traffic. In contrast to this, the west-Alpine axis acts mainly as a trilateral connection between Italy, France and Spain (Alpine Convention 2004).

Corridor	Main connection
South corridor (Semmering / Wechsel)	Brno – Udine
Pyhrn / Schober Pass	Budevice – Maribor
Tauern	Salzburg – Ljubljana
Brenner	München – Verona
Gotthard	Basel – Milano
Ventimiglia	Barcelona – Marseille – Genova
Fréjus – Mont Blanc	Torino – Lyon

Tab. A1-1: Main Alpine road corridors.

The terminology for road network differs between countries. Therefore "main roads" stands here for the high-ranking road network based on selected Tele Atlas[1] and EuroGlobalMap data[2]. In total, there are approximately 4,239 km of these main roads in the Alps, of which Austria and Switzerland feature the highest per capita density (cp. Tab. A1-2).

Country	Main roads in km within AC area	Main roads in m per km² of national AC area	Main roads in m per capita of national AC population
AT	1,547	28.32	0.48
CH	755	30.37	0.41
DE	298	26.91	0.20
FR	742	18.18	0.30
IT	792	15.47	0.19
SI	105	13.35	0.16
Sum	4,239	22.26	0.30

Tab. A1-2: Main roads in relation to area and population of Alpine Convention perimeter (Source: EU 2004 and calculation based on Tab. B1-1).

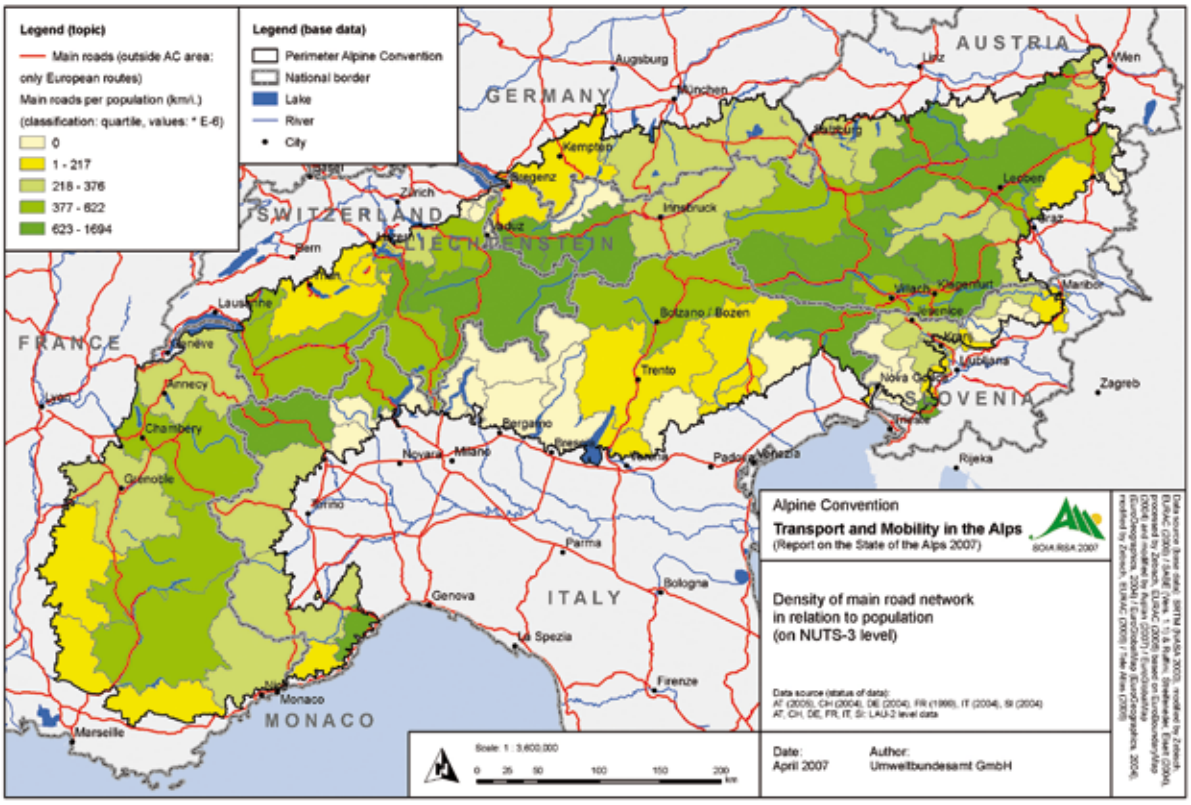
Density above European average

The main characteristic of mountain regions is that, due to topographic conditions, settlement and traffic are concentrated in the valley bottoms. Thus, even though the population density is lower than in most non-Alpine parts of Europe, the remaining land suitable for development is scarce and there is fierce competition between various demands and uses.

In relation to the population, the highest density of the main road network can be found in the middle and eastern parts of the Alps (Switzerland and eastern Austria, cp. Map A1-2). In the western and southern parts, the density of the main road network is slightly lower.

[1] Class 0: Main Road – Motorways
[2] RTE1: European Route

Map A1-1: Road network and main Alpine passes and tunnels.



Map A1-2: Density of main road network in relation to population (on NUTS-3 level).

Density of the Alpine motorway network in the European context

In the ESPON project, amongst other things, the density of the motorway network was analysed for the whole of Europe. The results show that, except for some regions in the western Italian part of the Alps, the density of the motorway network (in relation to the population) is above European average, which can be explained by the relatively small population density.

All in all, the ESPON project classifies the Alpine motorway network as sufficient in relation to the population density (EU 2004).

Road widening and extension plans

With regard to further construction of road infrastructure, widening and extension schemes are planned in all Alpine countries. Some selected examples are illustrated below. In the eastern part, some projects in Germany are either approaching completion or ultimately foreseen in the Federal Transport Network Plan. The completion of the A7 motorway to Füssen is underway, the final part of the A95 motorway to Garmisch-Partenkirchen is in the planning process and the A8 München–Salzburg will be extended to a six-lane motorway between Rosenheim and Bernau.

In Austria an extension of the Tauern and the Katschberg tunnel, both part of the A10 Salzburg–Villach, is in progress. The A1 motorway Wien–Salzburg will subsequently be expanded to six lanes. The S34 will be upgraded to a motorway near St. Pölten while the Pfänder tunnel on the A14 Bregenz–Feldkirch will be extended. The S16 Arlberg motorway will be extended in a second and third stage.

In Italy, some necessary developments of the road network have been undertaken for safety reasons: Strengthening operations (Torino–Milano, Sacile–Conegliano) or creating new links (Asti–Cuneo, Lombardia–Piemonte road, Venitienne–Piemonte road, Brescia–Bergamo–Milan link).

In Switzerland, one exemplary road infrastructure project within the AC area is the extension of the A9 from Sierre to Brig and the closing of gaps of the A8 between Sarnen and Interlaken.

Currently, there is no EU-TEN priority road project planned in the Alpine arc. However, in the course of implementation of Corridor 5 of the Pan-European Corridors, major road constructions are foreseen in the eastern parts of the Italian Alps.

Some of the motorways and international routes are still incomplete, especially in the western Alps. Further investments will be made in road infrastructure; in the Alpine region, national programmes include the closing of infrastructure gaps and, in certain countries, the widening or extension of existing roads. Some of these measures are mainly targeted towards improving safety e.g. the Tende road tunnel between France and Italy.

A1.2.2 Tunnel accidents and safety

The big road tunnels in particular are key infrastructures for the Alpine road network. In the last few years there have been serious accidents in various Alpine tunnels, for example in the Mont Blanc tunnel, the St. Gotthard tunnel in Switzerland and in the Tauern tunnel in Austria (see Tab. A1-3).

Tunnel	Accident	Closure until	Reconstruction costs[1]
Mont Blanc	24 March 1999	March 2002	189 Mio EUR[2]
St. Gotthard	24 October 2001	22 December 2001	No data
Tauern	29 May 1999	August 1999	8.5 Mio EUR

Tab. A1-3: Accidents in Mont Blanc, St. Gotthard and Tauern tunnel.

[1] Source: Munich Re 2003.

[2] This sum only represents the building costs; considering also the income deficit the amount could be estimated between 300 and 500 Mio EUR.

The traffic situation during the reconstruction-related closure of the tunnels dramatically underlined the need for safe and effective road tunnels. Consequently, measures have been taken to improve tunnel safety in the Alpine road transport network (see also chapter D3.2 for some background information).

Tunnel safety measures

These serious accidents, which have left their mark on the Alps since 1999, have raised awareness of the urgent need to equip the major trans-Alpine tunnels with better safety conditions without decreasing their carrying capacity. Despite real financial difficulties, the safety of the tunnels has improved and the major alternative projects have made progress, whether in terms of increasing the efficiency of the services offered or promoting new infrastructure. Almost everywhere, binational management committees have been set up, with suitable emergency plans and appropriate regulations already approved or in the process of research.

France and Italy have agreed on objective of dividing heavy goods traffic in the proportions of at least 35% each from Mont Blanc and Fréjus tunnel, which led to 35% of Mount Blanc and 65% of Fréjus tunnel, as part of the negotiation of the conditions for the reopening of the Mont Blanc tunnel in 2002. These levels have almost been achieved today, in particular after the closure of the Fréjus tunnel in June 2005 due to an accident.

At the Tende pass, France and Italy set up a safety committee in mid-2003, to improve the management and operation of the road tunnel, one of the oldest and narrowest in Europe, and have decided to create a new structure without increasing capacity, on which work should commence at the start of 2008.

Concerning the Franco-Italian roads, traffic measures (alternating, prohibitions, escorts for hazardous substances) to ensure safety were implemented in the Fréjus and Mont Blanc tunnels when the latter was reopened to heavy goods

vehicles on 25 June 2002. Studies are continuing for the creation of a safety tunnel in the Fréjus tunnel.

For safety reasons, France and Italy have agreed to reduce the number of heavy goods vehicles weighing more than 26 tonnes that are allowed into the Tende road tunnel, and ethylene derivatives have also been banned on the south-Alpine branch of the A8 motorway (the coast road between Marseille and Genua) since 23 June 2003, in order to encourage transportation of these items by sea.

In Switzerland, following the accident of 24 October 2001, the St. Gotthard tunnel was reopened to heavy goods traffic under very strict safety conditions (alternating one-way traffic), which remained in force until the completion of the work of installing additional safety systems and stronger ventilation systems at the end of September 2002. Since then, the tunnel has reopened to heavy goods traffic in both directions, accompanied by a traffic control metering system which regulates the flow of heavy goods vehicles at the tunnel entrance in relation to the global volume of traffic. When the maximum tolerated traffic values are exceeded, the lorries are parked on waiting areas. In the case of saturation, the “red phase” is launched and the drivers are invited to use other road routes, as well as the opportunities offered by piggyback railway traffic. These traffic control measures have proved their effectiveness: reduction in risks and free flow of the traffic, without a massive increase in its volume.

The objective of improving road safety has also led to an intensification of mobile controls of heavy traffic. These controls are progressively completed by the creation of control centres spread over the Swiss territory, so that it is possible to monitor heavy traffic on national roads systematically. As far as road provision is concerned, let us recall that the movement of heavy freight vehicles is forbidden on Swiss territory from 10 p.m. till 5 a.m., as well as on Sundays and during national public holidays.

A1.2.3 Traffic related fees and taxes

Road-pricing systems

Each of the countries that form part of the Alpine space has its own pricing system (cp. Tab. A1-4). For their privately owned cars, the Austrians and the Swiss have to buy a motorway tax disc called a “Vignette”, which is valid for a certain time irrespective of the mileage driven. In Slovenia, France and Italy, car users have to pay a fee per kilometre. The average tariff per kilometre for passenger cars ranges from 0.04 EUR (SI) to 0.07 EUR (FR). Germany has implemented a charging system only for Heavy Duty Vehicles (HDV).

The charging system for HDV is almost the same in all countries. The basis of computation is the distance travelled. In general, HDV are charged for the use of motorways; only in Switzerland are levies charged on HDV on other roads as well. Additional factors of pricing systems are permissible maximum weight and the emission class of each vehicle.

Country	Vehicle	Road category	Calculation unit	System	Price in EUR
AT	Car	Motorway	Year	Vignette	72.6
	HDV		km	Go-Box	0.156 – 0.328
	Motor-cycle		Year	Vignette	29
CH	Car	National streets	Year	Vignette	26.5
	HDV	All Streets	km, tonnes, emissions	electronical	0.016/tkm
IT	Car	Motorway	km, section	card	0.05
	HDV		km, section	card	graduated prices
FR	Car	Motorway	km	card	0.07
	HDV		km	card	graduated prices
DE	Car	-	-	-	-
	HDV >12 tonnes	Motorway	km	electronical	0.15
SI	Car	Motorway	km	card	0.04
	HDV		km	card	graduated prices

Tab. A1-4: Road pricing in the Alpine countries (Source: www.oeamtc.at; www.arboe.at).

In the EU Member States, road pricing systems have to conform to the regulations specified in the Eurovignette Directive 1999/62/EC (see chapter D). Until recently, only building and maintenance costs for the road network could be included in road pricing, while external costs like environmental costs could not be covered (for a detailed discussion of external costs see chapter C1). An amendment to the Eurovignette Directive (2006/38/EC), however, foresees that external cost factors (e.g. costs for accidents) as calculated according to a standardised assessment model may be included in road-pricing systems. On some axes (e.g. Fréjus), an additional fee is due for dangerous freight.

The effect on route choice depends on the type of toll. Compared to mileage-related tolls, tolls levied for special infrastructure such as bridges and tunnels have a different effect on specific transport costs. Their influence on long-distance transport is significantly lower than for regional freight transport (Schmutzhard 2005), which is related to the regressive character of the toll (see Fig. A1-1). Therefore supra-regional transport is mostly unaffected by them.

Mileage-related tolls, on the other side, increase travel costs equally for regional and supra-regional transport.

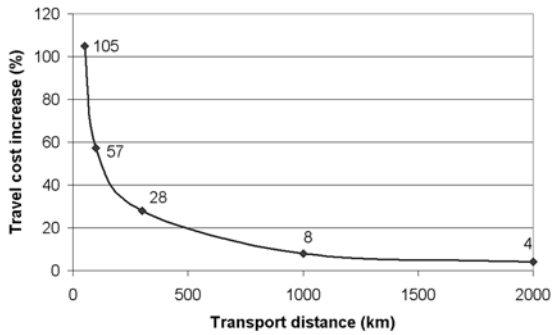


Fig. A1-1: Regressive effect of special toll on the Brenner route 2004 (49 EUR) on HDV transport costs, calculated for 50, 100, 300, 1000 and 2000 km (Source: Schmutzhard 2005).

In Switzerland, the road pricing system (LSVA) covers the whole road network. Two objectives are tied to the LSVA, one being the implementation of the polluter-pays-principle, the other being the improvement of the Swiss railway system's competitiveness. The LSVA covers, in addition, most external costs for environmental damage. The road transport costs in Switzerland therefore contribute to a stabilisation in road transport volumes and to a shift from road to rail transport, reducing environmental damage.

Fuel prices and taxes

Besides reflecting the economic value of the resource, fuel prices are also a source of revenue for state budgets and are perceived by political stakeholders as an instrument to steer transport volumes. Generally speaking, in the Alpine region, taxes levied by the state make up more than half of the fuel price, which is why there are slightly different fuel prices (cp. Tab. A1-5).

Country	Petrol		Diesel
	95 octane	98 octane	
DE	1.305	1.379	1.125
IT	1.241	1.334	1.164
FR	1.239	1.271	1.050
AT	1.033	1.134	0.817
CH	1.002	1.027	1.039
SI	1.015	1.024	0.929

Tab. A1-5: Fuel price differences in the Alpine countries in EUR (Source: ÖAMTC, April 2007).

Freight carriers take these price differences into consideration when planning their routes. Therefore, differences in road pricing and taxes on fuel and vehicles (cp. Tab. A1-6) help explain differences in modal split among Alpine countries.

Instrument	AT	FR	DE	IT	CH	SI
Mineral oil tax	X	X	X	X	X	X
Motor vehicle tax	X		X	X	X	
Vehicle registration tax	X			X		
Tax on vehicle registration for high CO_2 emitters		X				
CO_2 tax						
Incentive tax on sulphur content of motor fuels					X	

Tab. A1-6: Taxes adopted in the Alpine countries as a response to transport pressure (Source: OECD/EEA database on instruments used for environmental policy and natural resources management); since January 2004, motorway user charges in AT are only applied to vehicles up to 3.5 tonnes.

In spite of the charging system for HDV, additional tolls are levied on some routes (cp. Fig. A1-2). These routes are specifically cost-intensive in terms of building and operation. For that reason they have been excluded from the rest of the road network and are regulated through specific toll laws.

Existing routes with special tolls such as the Europabrücke on the Brenner route or the Mont Blanc tunnel are mostly routes with a major share of international traffic which allows for cost-oriented route optimisation. Changes in the relation between special tolls and mileage-related road pricing could cause shifts in international traffic flows.

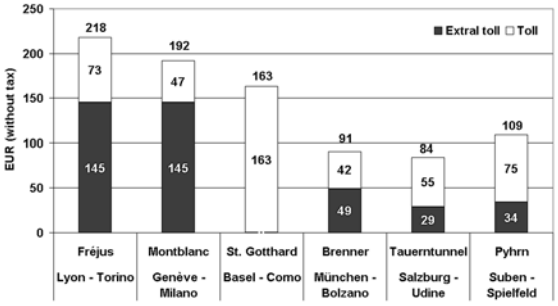
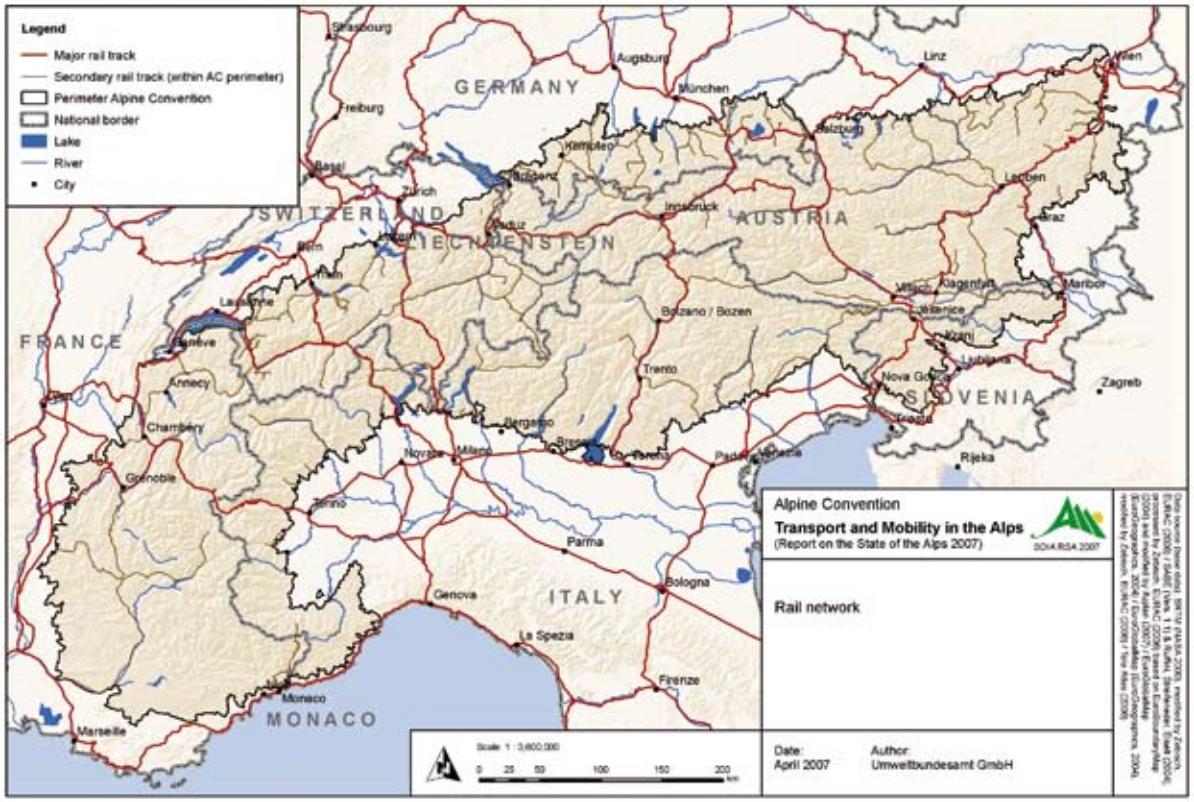


Fig. A1-2: Comparison of road pricing on Alpine crossing routes in EUR for a 40t HDV, 5 axles, Euro-3 emission standard, approx. 300 km (Source: bmvit).

A1.3 Rail infrastructure

The importance and functions of the rail network varied in the past. At the outset (around 100–150 years ago) railways were constructed mainly to provide access to industrial sites. The present major railway extension projects are planned for a significant volume of freight transport crossing the Alps and at the same time serve as a fast connection between major cities of the European central region. Since 1970 there has been a trend towards the construction and extension of these high-speed lines as part of the European railway network.



Map A1-3: Rail network in the Alps.

Therefore, several of the main conventional lines have been upgraded in the last few decades and they are now high-speed lines (e.g. the Pontebbana axis in Italy). At the same time, the light railway network has not been upgraded and some lines have been shut down and replaced by a bus service.

These services appear to be more cost-effective to maintain, but railway services are considered by the public as being more reliable. Thus the closure of these services reduces the use of public transportation in general. However some popular bus systems are expanding (see chapter A3.4.2). Furthermore, the maintenance of railway lines may be advisable as they could be put to use again under changing future economic conditions for the transport of goods.

The main rail network in the Alps runs more or less parallel to the road network (see Map A1-3 and A1-4). Similar to the road network, the main railway lines are part of the Trans-European rail network. In addition to the main railway lines designed for national and international transit traffic, low-speed light railways – mostly not electrified – lead through the Alpine valleys on single-track lines and connect side valleys with the main valleys.

A1.3.1 Density of the rail network

In total there are approximately 8,364 km of railway lines in the Alps, 2,622 km of which are high-speed lines. Switzerland and Austria feature the highest density of railway lines per capita, while Italy, France and Slovenia feature values below the Alpine average.

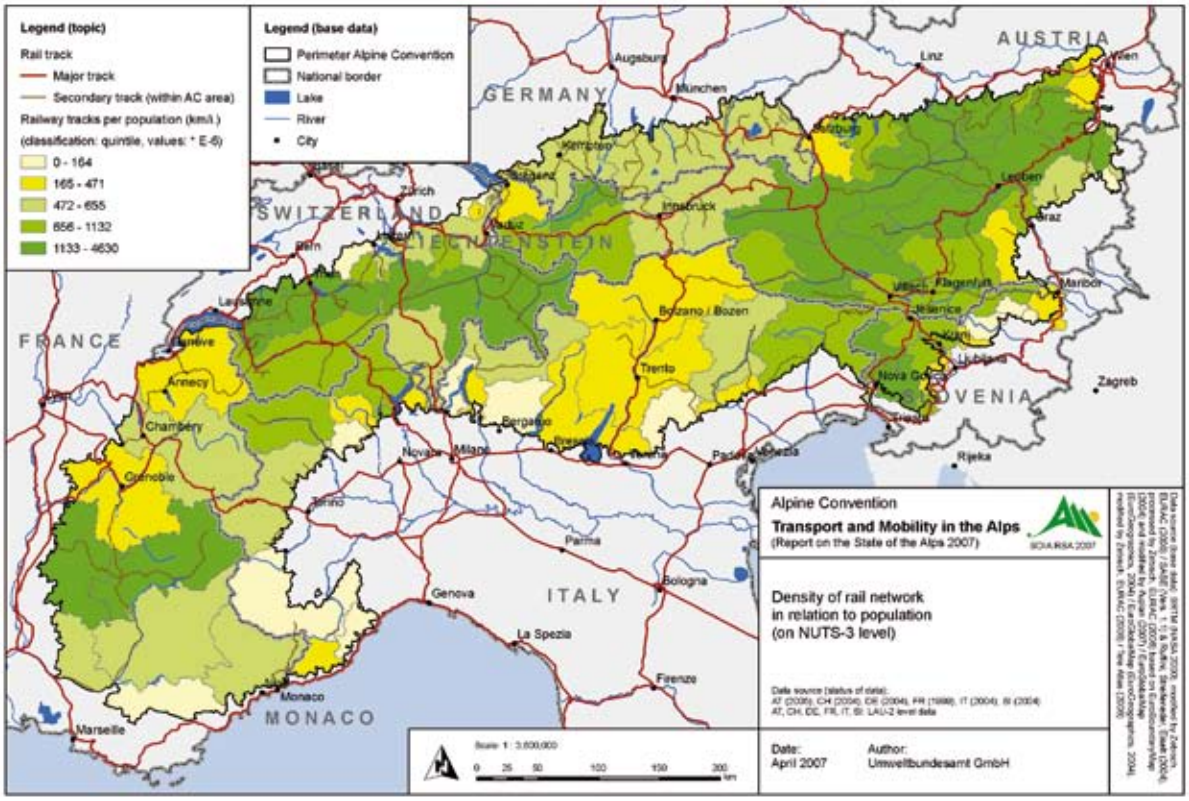
Country	Population within national AC area	km railway within national AC area	Railway km/1000 pop	Railway lines in m per km² of national AC area
AT	3,255,201	2783	0.85	50.95
CH	1,827,754	1639	0.90	65.92
DE	1,473,881	947	0.64	85.53
FR	2,453,605	1128	0.46	27.64
IT	4,210,256	1,530	0.36	29.89
SI	661,135	337	0.51	42.85
Sum	**13,881,832**	**8,364**	**0.60**	**43.93**

Tab. A1-7: Railway lines per country.

Density of the Alpine railway network in the European context

The results of the EU project ESPON on the density of the rail network are similar to those for the road network. Except for some regions in the west of Italy and in the south of Austria, the density of the railway network (in relation to the population) is above European average, which can be explained by the relatively small population density in the Alps.

Consequently, the railway network relative to the density of population is classified as sufficient for most of the area covered by the AC, with a certain lack of railway infrastructure in the regions mentioned above (EU 2004).



Map A1-4: Density of rail network in relation to population (on NUTS-3 level).

A1.3.2 Extension and improvement plans

All Alpine countries aim to improve rail passenger and freight transport and to increase the share of rail transport.

The existing conventional lines are mainly covered by plans for optimising them in public-private partnerships between states and railway operators. The following major extension and improvement schemes exist for the Alpine railway system (Alpenkonvention 2006):

Lyon-Turin (LTF)

The Franco-Italian cross-border base tunnel project foresees a base tunnel of 52 km length establishing a competitive rail transport link on this important western Alpine corridor. Construction costs for the whole project of 73 km, including the cross border tunnel, are calculated at 7 billion EUR and the tunnel is scheduled to be opened in 2020. The Lyon–Turin Project constitutes one of the major Alpine transport infrastructure projects for the next decade both for passenger and goods transport.

Plan Maurienne Corridor (Aiton – Orbassano rail motorway)

Since November 2003, as an experiment, France and Italy have operated an Alpine rail motorway between Aiton and Orbassano, which runs under strict constraints since the historic Mont Cenis tunnel is not built to the European B1 standard facilitating the transport of most HDV on piggyback. Use of this experimental Alpine rail motorway is therefore limited to tanker traffic only until the tunnel modernising work is completed (2008), but it made dramatic progress in 2004 and 2005, in particular when the Fréjus tunnel road was closed on 4 June 2005. For the first time, a rail alternative has been possible for this corridor, particularly for hazardous materials (doubling of traffic between June and July, leading to 530 HDV/week).

Brenner 2005

The following essential results were achieved during the first 18 months of project work:

For the core section of the Brenner corridor between München and Verona, the three rail network operators German Railway Net (DB Netz), Austrian Railway Net (ÖBB Netz) and Italian Federal Railway (RFI) have developed so-called catalogue train paths.

In 2004, the Milano-Segrate terminal which is directly connected with München-Riem by a train link was established as a new gateway terminal for the Brenner corridor.

Finally, the BRAVO partners Kombiverkehr, Ferriere Cattaneo and Combined Transport Management and Transportation S.p.A. (CEMAT) have developed a new high-capacity pocket wagon. The Federal Railway Office has approved this wagon so that in the first half of 2006 the first series of pocket wagons can be put into service.

The Brenner action plan 2005 and BRAVO have contributed to the increase in the traffic volume of unaccompanied combined services between Germany and Italy.

Case study: New locomotive for interoperable services

Since the end of 2004, provisional approval has been granted to the F4 (interoperable multi-system locomotive) by the RFI for the Italian network. Since May 2005, it has been successfully and constantly used in interoperable services. The objectives thus achieved are:

- *higher reliability and punctuality (due to the abolition of interfaces),*
- *shorter transit times due to the prevention of shunting at the Brenner, and*
- *more efficient use of the limited – and in some cases already congested – infrastructure, inter alia, at the Brenner.*

Plan IQ-C (International Group for Improving the Quality of Rail Freight Traffic on the North-South Corridor)/New Rail Link through the Alps

The IQ-C plan envisages 14 measures regarding the removal of bottlenecks and the implementation of the European Train Control System (ETCS) on the entire Simplon–Gotthard line (Rotterdam–Genua). Beyond constructions projects related to the IQ-C such as the Gotthard and Lötschberg base tunnels (NRLA), measures address rail transport operators (co-operation as part of competition), managers of infrastructure and government authorities; many of them have already been implemented. The infrastructure managers have in particular taken measures in order to improve quality, i.e. the creation of a one-stop shop for their clients (the railway undertakings), the setting up of harmonised procedures for railway operations and the co-ordination of international timetables. Progress has also been registered for the admission of engine drivers and the reciprocal recognition of locomotive homologations. Furthermore, a procedure for customs simplification regarding rail freight crossing Switzerland was recently adopted by the four countries.

The action plan for the Tauern rail line (Subproject of the Interreg IIIB-Project "AlpFRail")

The action plan consists of the following measures:

- production of an inventory of the freight transport situation on this line (substantial increase in road traffic and stagnation of rail freight, increase in transport capacity needed between the South of Germany and the South of Europe, environmental problems, unsatisfactory rail service provided),
- establishment of an analysis of the weaknesses of the current rail service (failure to adhere to timetables, poor use of capacity, problems with interface between operators, insufficient capacity of terminals, loss of information in the chain of transport), and
- introduction, in the short term, of three combined transport products, in order to transfer about 5,000 HDV/month from road to rail.

After the completion of the work planned on the Tauern rail line, the number of freight trains could increase by 30% (or 15 additional trains per day) as from the year 2006 onwards, in comparison with 2003. In addition, the journey time could be reduced by 20%.

Additional railway improvement and extension projects include Marseille–Genua (Ventimiglia), Salzburg–Ljubljana (Tauern), Budweis–Maribor corridor (Phyrn–Schober axis), Venezia–Trieste/Koper–Postojna–Ljubljana, Brno–Udine (Semmering, South corridor) and Passau/München–Bratislava/Budapest (Danube axis).

Terminals providing access to the rail network

Freight transport in particular requires large terminals to provide access from road to rail and cargo handling. As with air traffic, large terminals of great importance for the trans-Alpine rail network such as in Basel, München or Wien are located in flat areas outside the Alpine Convention area.

Within the Alpine Convention area there are some terminals that are important for trans-Alpine traffic such as the terminals Villach-Süd (AT; Tauern corridor, south corridor), St. Michael (AT; Pyhrn corridor, south corridor), Domodossola (IT; Gotthard/Simplon/Lötschberg corridor) or the terminal of Aiton (FR) for the experimental rolling road between France and Italy.

A1.4 Bottlenecks

One of the basic principles of the EU is free movement of goods, services and individuals. This inevitably leads to an increase in traffic volume and to bottlenecks, particularly in the Alpine region with its specific morphological situation.

The Alpine transport network suffers from bottlenecks both in regard to road and to rail infrastructure. While the first is mostly due to constantly increasing traffic volumes, the latter seems to result from the political emphasis on individual motorised transport infrastructure over the last decades and the lack of interoperability and intermodality of different national railway networks.

Case study: Swiss national road bottlenecks

In a Swiss study, the potential capacity bottlenecks on national motorways until 2020 were analysed using two different scenarios. The minimum scenario anticipates that, on the basis of investments in rail and public transport, road traffic will grow by only 24%. Nonetheless, the infrastructure mainly in agglomerations (in the Alpine area these are Luzern and Lugano), will not be able to cope with future traffic volumes.

The maximum scenario foresees an increase of about 40%, which is more or less an extrapolation of the trend in the past. On the basis of this scenario, congested road infrastructure is expected both in agglomerations and unpopulated areas (e.g. Gotthard tunnel) (ARE 2002).

Major road bottlenecks in the Alps mainly affect tunnels and the related issue of tunnel safety. Furthermore, urban areas with their related access routes and centres, as well as access routes to tourist destinations with insufficient public transport, also create bottlenecks.

Railway bottlenecks in the Alps are created by an insufficient extension of the railway network, short access to rail for freight transport, deficient electrification and signal systems and single-track railways.

While today it is widely accepted that the Alps cannot accommodate limitless traffic of all modes, specific bottlenecks can cause an inefficient use of the rest of the infrastructure, environmental harm nuisance for the users and economic loss. Especially in cases where transit traffic causes congestion heavily affecting local transportation, the option of using bottlenecks as physical limit to transport growth becomes problematic. Increasingly, financial and regulatory measures are adopted for ensuring an optimal flow within set quantitative limits. The Swiss transport policy aiming at a strong reduction of road freight transport is a case in point.

Main findings

Status

The Alps are covered by a dense, linear network of transport infrastructure. This infrastructure is in some places being significantly improved to serve higher volumes of traffic and to meet the needs of an increasing division of labour in the European economy. Main Alpine corridors are part of the Trans-European Networks. Important projects aim at higher performance of these corridors in a European context.

The density of transport infrastructure in the Alps is reaching average or even above-average levels when compared to EU standards. Tunnel accidents and subsequent closing of traffic corridors illustrate the sensitivity of the system as a whole.

Trends

At the same time, the road network especially is reaching its limits on various corridors, both in capacity and in effects on the population and environment. Bottlenecks arise as a consequence of increasing traffic volumes and insufficient alternatives and regulation of motorised individual traffic. This has been acknowledged by political stakeholders within and beyond the Alpine region and there is increasing international effort to tackle the issue of transport and to improve the competitiveness of the railway links to and across the Alps.

New infrastructure projects are mostly targeted towards improving the Alpine railway system and its connectivity and intermodality to perialpine railway and road infrastructure. In this regard, the plans are in line with the objectives of the Alpine Convention.

Hot issues

The recent amendment of the EU Eurovignette Directive opens the door for the integration of external costs in national road-pricing systems. The LSVA, the Swiss road pricing system, has demonstrated that a substantial integration of external costs has the potential to significantly shift traffic volumes from road to rail. Together with the provision of competitive railway infrastructures, the pricing system is considered to be a key factor for a sustainable transport system in the Alpine region.

The extension of the infrastructure cannot be regarded as a solution for transport problems in the Alpine region alone. There is also a need to deal with temporary peaks and growing traffic volumes, especially in agglomerations. As well as infrastructure improvements, measures of interoperability and traffic-management systems can significantly contribute to a more efficient and cost-effective processing of Alpine traffic volumes.

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A2 Freight Transport

In this chapter, the subject of freight transport in the Alps will be presented on the basis of traffic surveys. The modal split between road and rail transport traffic as well as the characteristics of each of these traffic modes, will be discussed. Furthermore, the relationship between transport traffic within the Alpine region and with regions beyond the Alpine arc will be presented on the basis of traffic surveys.

Trade and economic development and the increasing complexity of production processes in Europe produce a constant increase in freight transport between European regions, of which a good share transits through Alpine passes. Even though freight transport holds only a minor share of the overall Alpine traffic volume, it nevertheless has an outstanding role for the Alpine as well as for the European economy and creates significant environmental and sociocultural impacts particularly along the Alpine road transport corridors.

The movement of goods within the EU territory is increasing because of three main factors:

- **the EU monetary union and market liberalisation,**
- **the evolution of EU internal markets, and**
- **the EU enlargement towards the East.**

A2.1 Freight transport and modal split development

The Alpine main ridge can be crossed on French, Swiss, Italian or Austrian territory. Regarding the tonnage by Alpine crossing country, Switzerland had the biggest percentage increase between 1999 and 2004, both on rail and on road (see Annex A2-1). Austria featured the highest absolute increase, while on French Alpine crossings, road transport volumes stagnated and rail transport decreased.

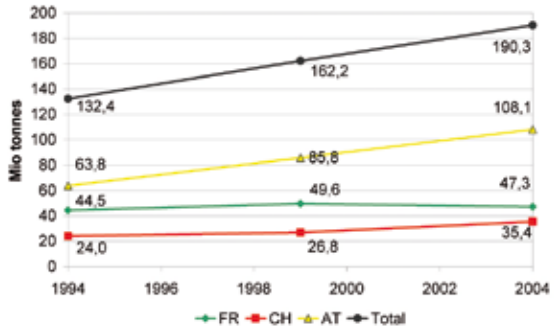


Fig. A2-1: Total transport traffic flows (road and rail) crossing the Alpine Arc by country in Mio of tonnes.

A total of 191.7 Mio tonnes were transported by road and rail across the Alpine arc in 2004, of which 110 Mio tonnes were transported across the inner Alpine bow (Alpine Arc A, see Fig. A2-2) delimited by Mont Cenis-Fréjus and the Brenner, accounting for 57% of the total traffic across the Alps (see Fig. A2-1 and Annex A2-2). On these two Alpine crossings, total freight traffic has doubled over the last two decades. Annex A2-3 shows the transit transport volume of the most important Alpine crossings in 2004.

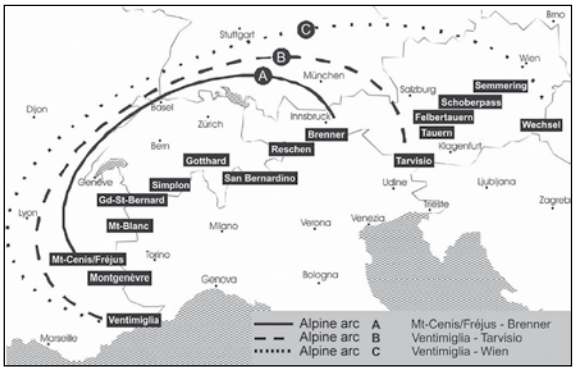


Fig. A2-2: Alpine arc A,B,C (Source: Alpinfo)

In 2004, the modal split for all Alpine crossings was 2/3 to 1/3 in favour of road traffic (Fig. A2-3). Between 1994, 1999 and 2004, the share of rail transport in the modal split has decreased from 38% to 34% to 33%, respectively (CAFT 2004 Survey).

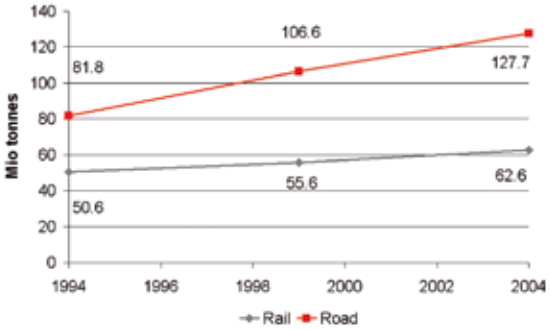


Fig. A2-3: Alpine-crossing transport volume 1994, 1999 and 2004.

When looking at national differences in modal split, the data reveal significant differences within the Alpine region. It is interesting to note that the modal split between rail and road is 64% to 36% in Switzerland, whereas the railway holds shares of only 31% in Austria and 14% in France (Fig. A2-4).

Between 1999 and 2004, rail traffic (in tonnes) decreased by 30% on northern French crossings, whereas rail traffic through Swiss crossings increased by 21%.

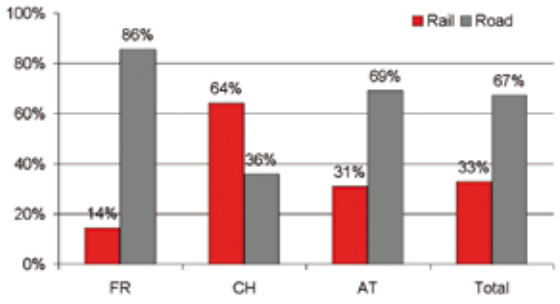


Fig. A2-4: Modal split by Alpine countries in 2004 (Sources: CAFT 2004 Survey).

Intra-Alpine traffic which originates in and/or is destined for an Alpine region was estimated to amount to 60 Mio tonnes in 2004 (CAFT 2004).

From 1994 to 2004, total Alpine traffic increased on average by 3.8% per year, although there was a slight decrease from 2000 to 2001. Generally, the growth of freight transport has slowed down over the last five years. Since 1983, road freight transport has annually grown by an average 5%, while rail freight transport has grown by an average 1%.

A2.2 Freight road transport

A2.2.1 Total traffic

In 2004, trucks transported 129 Mio tonnes of goods across the Alps. This translates into more than 10 Mio heavy duty vehicles (HDV) above 3.5 tonnes crossing the Alpine Arc in 2004.

With 2 Mio vehicles per year, the heavy vehicle traffic is concentrated mainly on the Brenner crossing, followed by Tauern, Ventimiglia, Schoberpass and Fréjus, annually accounting for around 1.2 Mio vehicles. In percentage terms, the shift for each pass showed that almost 60% of freight traffic ran through the Brenner, Tauern, Schoberpass, Semmering and Fréjus crossings together (see Annex A2-4).

The number of vehicles crossing the Alps showed a marked increase until the year 2000, followed by a period of moderate growth and finally an increase to a total of 10 Mio vehicles in 2004.

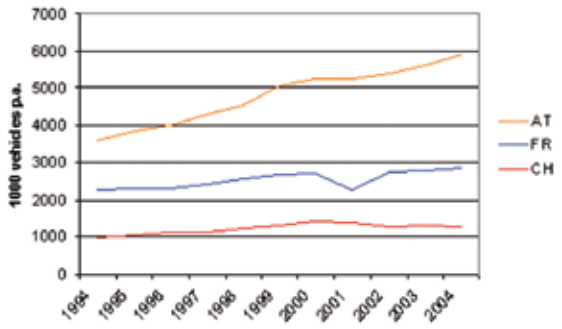


Fig. A2-5: Number of vehicle movements on Alpine arc C by Alpine country (Source: Alpinfo).

This development can be ascribed to the increase on Austrian Alpine crossings, while the trend was less evident in Switzerland. Its slight decrease after 2000 could be due to the increase of the maximum tonnage capacity allowed to cross Switzerland.

Traffic volumes for each Alpine pass indicate that traffic diverted through the closure of the Mont Blanc tunnel did not affect traffic on the Gotthard pass, but was registered crossing the Fréjus pass (see Fig. A2-5).

The status in the year 2004 and the development of road freight traffic in terms of number of trucks is displayed in Fig. A2-6. A constant increase of traffic between 1995 and 2004

Data sources

The following databases have been used to describe the volume of Alpine freight transport:

Cross Alpine Freight Transport (CAFT) Survey:

Carried out every five years and based on interviews with truck drivers crossing the main Alpine ridge. Since 1994, Switzerland, France and Austria (assisted in 2004 by Italy and Germany) carry out a survey on transport traffic movements on the Alpine road system. In 2004, CAFT carried out data collection on Alpine crossing as well as border-crossing traffic movements on all modes (road, rail and piggyback) on the most important Alpine road and rail connections of the participating countries.

The methodology has been harmonised between the project partners to achieve an Alpine-wide consistent database as the basis for transport policy decisions. In 2004, the range of roads assessed was enlarged to include cross-sections with the new EU Member States. In Austria, a total of 23 cross-sections have been selected for the road transport survey. On these cross-sections, truck drivers have been asked to answer a questionnaire on

- *type of vehicle/number of axes/place of registration,*
- *origin and destination or place of unloading,*
- *border crossing for entry and departure, and*
- *main type of transported goods.*

O/D (origin/destination) data is being related to the NUTS system. The survey data is finally being checked for plausibility and extrapolated using data from the electronic toll monitoring system and automatic count locations.

Data on rail transport are obtained from railway companies and supplemented by a survey of combined transport connections.

CAFT 2004 enabled the approximate identification of road and rail freight volumes as well as O/D matrixes NUTS-2 for the Alpine region.

Alpinfo 2004 data collection:

This data collection is carried out each year by the Swiss Federal Department of Environment, Transport, Energy and Communications (UVEK/DATEC), in cooperation with the French Ministère des Transports, de l'Équipement, du Tourisme et de la Mer and the Austrian Bundesministerium für Verkehr, Innovation und Technologie, and includes monitoring of the freight traffic flows. It provides data on the tonnage relating to the flows crossing the main Alpine passes by extrapolating the results of the five yearly CAFT survey (Amt für Raumentwicklung 2004).

Traffic Census Data from Automatic Registration:

Periodical and up-to-date survey of traffic flows on the road network of some Alpine countries, which is carried out through automatic detection of traffic flows (all vehicles). It provides annual data on significant road segments of the Alpine network and covers the period from 1995 to 2005.

has been registered on the Tarvisio, Brenner and Ventimiglia routes.

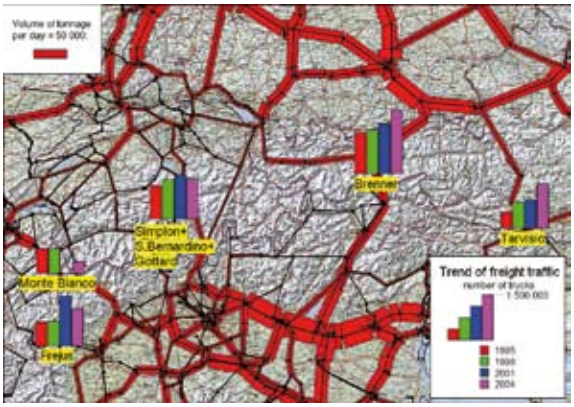


Fig. A2-6: Development of road freight traffic by Alpine crossing (Source: ALPINFO 2004 – representation of flows based on CSST elaboration for AlpFRail INTERREG IIIB Project).

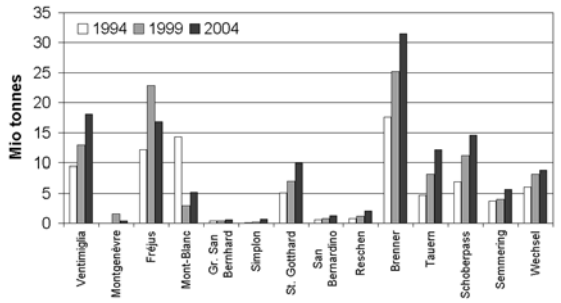


Fig. A2-7: Total road transport volumes on Alpine crossings in 1994, 1999 and 2004 (Sources: CAFT 2004 Survey).

A2.2.2 Long distance traffic

The volume of long distance traffic (transit plus import plus export traffic) expressed in number of vehicles increased from 6.9 Mio in 1994 to 10.0 Mio in 2004, which results in an annual average increase of 5%. This represents 47% of the total traffic on the Alpine road network.

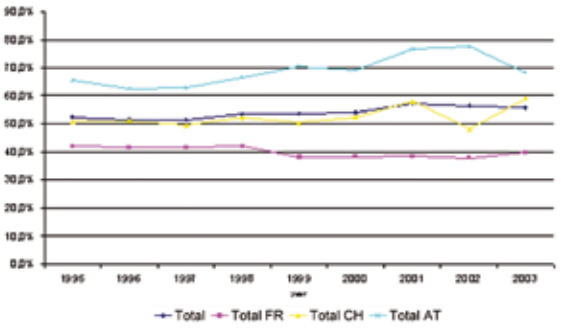


Fig. A2-8: Rate of freight transit traffic in relation to Alpine-crossing transit road traffic – total and per country (Source: Alpinfo).

The traffic through Switzerland experienced a short decline between 2001 and 2002, only to increase again in the following years. At the same time, the growth rate of transit traffic through Austria has been decreasing in recent years.

These trends are influenced not only by general dynamics of transport and logistics and by functional factors, but also by traffic deviation triggered by country-specific tollage and taxation policies. The pass with the highest share of Alpine-crossing freight traffic is the Brenner Pass with 38.5% in 2003 (see Fig. A2-9). The rates or the other major passes range between 14% and 17%.

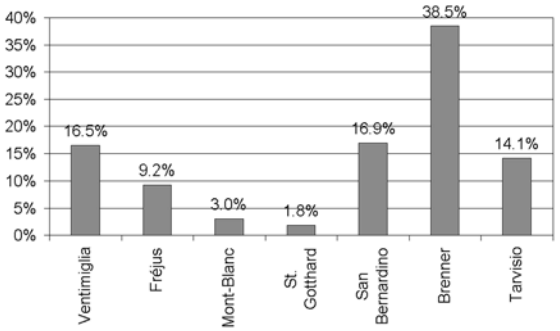
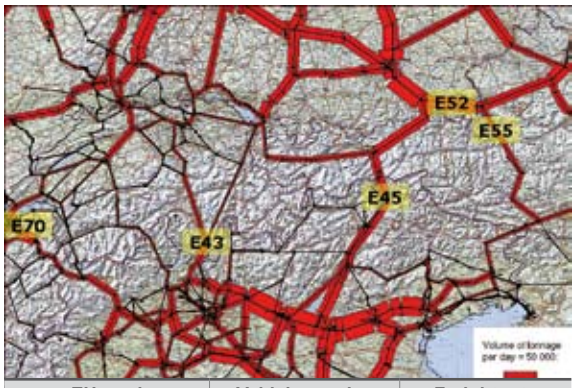


Fig. A2-9: Distribution of Alpine-crossing transit freight traffic on main Alpine crossings in 2003 (Source: Alpinfo).

Data for the Mont Blanc crossing has to be seen in the context of the tunnel accident and preliminary closure of the tunnel.



EU road	Vehicle per day	Freight rate
E43	12,500	22%
E45	6,000	21%
E52	9,000	18%
E55	5,000	12%
E70	5,500	16%

Fig. A2-10: Volumes of road freight traffic on main Alpine passes: bi-directional flows in 2004 (Source: Traffic Census Data provided by France and Germany).

Although tonnage transported on the Brenner route is three times higher than on the Gotthard route (31.5 to 9.9 Mio tonnes), the HDV movements on these two passes are almost identical (see Fig. A2-11).

A2.2.3 Short distance traffic

Short distance traffic, whose origin and destination lies within the area considered by the CAFT survey, represents 53% of the total Alpine-crossing freight movement in tonnes. The main internal flow of goods takes place in Austria, where in 2004, over 1 Mio freight vehicles moved between the regions of Steiermark, Niederösterreich, Oberösterreich and Wien (CAFT 2004).

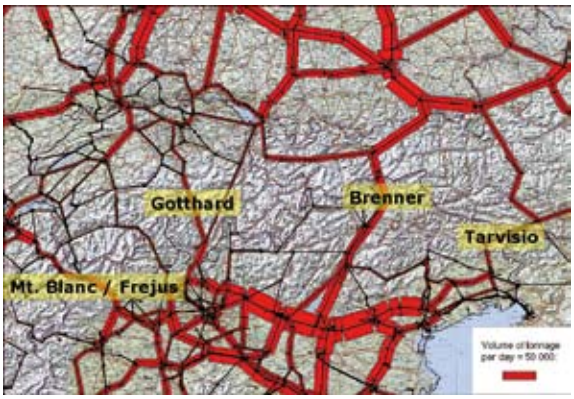
Short-distance commercial traffic is growing quickly due to increasing segmentation of detail load distribution and logistical requirements. In this context, particularly in the surroundings of Alpine towns and cities, traffic is increasing significantly. Retail freight traffic, for instance, accounts for about 20% of all traffic movements during rush hour in major cities of the Alpine region such as Bolzano, Innsbruck and Grenoble.

Total annual traffic gravitating around towns featuring socio-demographic and territorial characteristics of the main Alpine urban areas amounts to 200,000–300,000 HDV per year, with an average annual increase of 5–7%.

A2.2.4 Road transport demand

On a general basis, the Alpine road network is heavily used for freight transport. Based on traffic census data, an increase of 30% of heavy vehicles occurred in the decade between 1995 and 2005 on the most congested motorways.

The share of freight traffic on main Alpine motorways ranges between 15% and 35% on the Brenner and Tauern passes and reaches 60% on the Fréjus pass.



Pass	Vehicles per year
Brenner	2.15 Mio
Gotthard	2.20 Mio
Mt. Blanc / Fréjus	1.10 Mio
Tarvisio	2.10 Mio

Fig. A2-11: Volumes of road freight traffic on main Alpine roads: bi-directional flows in 2004 (Source: "Traffic Census Data from Automatic Registration" and "Statistiche Autostradali AISCAT").

The high rate of trucks travelling on the most important Alpine corridors is the main cause of the critical "level of service" of road infrastructures. Freight traffic flows on the main Alpine motorways are presented in Annex A2-5.

The analysis of road haulage for main O/D in CAFT 2004 takes into account all the traffic movements on the Alpine road network, independently whether the place of origin and/or destination lies within the Alps. It reveals a difference concerning the structure of flows between the western Alpine crossings from Ventimigila to Brenner and the eastern ones, especially Schoberpass, Semmering, Wechsel.

Long-distance transport dominates freight traffic on the western Alpine crossings, while the eastern Alpine crossings show a significant share of regional transport.

Most freight traffic (over 150,000 vehicles per year in 2004) on the Alpine road network originates from or is destined for the NUTS-2 regions presented in Annex A2-6. Some of these regions such as Lombardia or Oberbayern, however, are not entirely situated within the perimeter of the Alpine Convention. Traffic generated by these NUTS-2 entities can therefore only be partly assigned to the Alpine Convention area, as significant shares of their population and economic centres are located beyond its perimeter.

The most important NUTS-2 regions in regard to origin of transport who share at least part of their territory with the Alpine Convention perimeter are Steiermark and Lombardia with over 800,000 vehicles (see Annex A2-6).

The destinations of the traffic flows generated in the five most relevant NUTS-2 regions are presented in Annex A2-7.

The most important single O/D relations (over 100,000 movements) are due to the high proportion of regional traffic on the eastern Austrian Alpine crossings all situated in Austria (between Steiermark, Niederösterreich and Oberösterreich), where they connect neighbouring regions.

Other traffic-generating regions feature high volumes of traffic to non-Alpine regions, most notably Lombardia with 625,000 movements.

From a detailed analysis of the CAFT 2004 O/D matrix it can be summarised, Alpine road freight traffic shows the following general characteristics:

- 47% of all trans-Alpine road transport movements detected by the CAFT Survey connect regions that at least partly belong to the Alpine Convention perimeter with other European regions,
- 33% of all trans-Alpine road transport movements are within regions belonging at least partly to the AC area; here, traffic flows between Austrian regions are dominant,
- 19% of all trans-Alpine road transport movements have neither origin nor destination in a region that at least partly falls within the AC area.

A2.3 Freight rail transport

Alpine-crossing rail transport amounts to 63 Mio tonnes, which is roughly half of the tonnage transported by road (131.5 Mio t) (see Fig. A2-12). 30 Mio tonnes of this Alpine crossing rail transport is either import- or export-related. With 24% increase between 1994 and 2004, the Alpine rail freight transport is losing shares to road freight transport, which has increased by 56% over the same period.

The share of trans-Alpine rail transport differs significantly among the Alpine countries; in Switzerland 65%, in Austria 33% and in France only 15% of freight transport is moved by train.

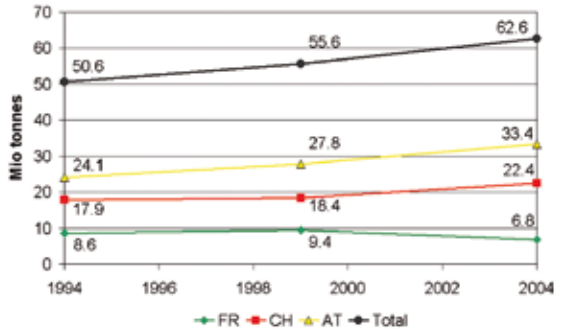


Fig. A2-12: Rail transport volume crossing the Alpine arc in Mio tonnes for 1994, 1999 and 2004 (Source: CAFT 2004 Survey).

The Gotthard Pass is the Alpine-crossing with by far the highest volume of rail freight traffic with 15.5 Mio tonnes (an increase of 2.5 Mio from 1994) (see Fig. A2-13). The share of the Brenner Pass is also high with 10 Mio tonnes (an increase of 2 Mio since 1994), followed by Semmering and Tauern.

Rail freight traffic significantly increases on the Semmering (57%), Simplon (44%) and Tauern (50%) crossings from 1994 to 2004. Besides significant percentage decreases on smaller Alpine crossings such as Ventimiglia and Wechsel (-50% each), the Alpine crossing of Mt. Cenis (-17%) is the only major Alpine crossing with a decrease of rail freight traffic berween 1994 to 2004.

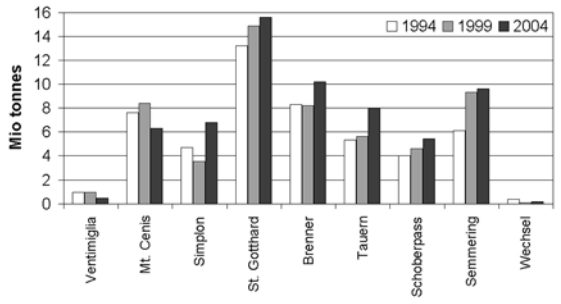


Fig. A2-13: Rail transport volumes on Alpine crossings for 1994, 1999 and 2004 (Sources: CAFT 2004 Survey).

A2.3.1 Rail and intermodal transport demand

The CAFT Survey 2004 includes an O/D matrix of Alpine crossing freight transport. It is assessed on NUTS-2 level for Italy and on NUTS-1 level for the rest of Europe. Most long distance rail freight traffic involves links between Italian regions and other Alpine countries.

In terms of tonnage, traffic towards Italy (North-South direction) is around 150% higher than traffic from Italy (South-North direction). The main O/D pairs are presented in Annex A2-8. Traffic movements between Italian NUTS-2 regions and Alpine countries are displayed in Annex A2-9.

23 Mio tonnes originate in and/or are oriented to intermodal platforms, where they are transferred from trucks to trains and vice versa.

According to the draft of the CAFT survey regarding Alpine Arc C (see Fig. A2-2), unaccompanied combined transport accounts for 21.6 Mio tonnes, while 4.9 Mio tonnes are transported on rolling road.

Combined rail transport in the Alpine region accounts for 17% of the total traffic (14% according to CAFT Survey 2004 – Alpine Arc C). If considering only trans-Alpine freight flows, the rate of combined rail transport is 25%.

Case study: The Swiss rail network

Switzerland is the only country in the Alpine region where rail transport reaches a modal split rate of 64% (2004). All other countries have a rail traffic rate of between 15 and 30%.

Measures endorsed in Switzerland were meant to strengthen the rail network and to make it faster and cheaper to cross Switzerland by train. On the other hand, some restrictions by Switzerland on HDV exceeding a certain weight forced trucks to take other routes through the Alps, often through the Brenner crossing.

A2.4 Main problems of road freight transport

Considerable consequences for transnational road networks can derive from deficiencies in this sector because of the central position of the Alpine area. Another significant issue concerns modal integration and logistic transport.

The fragmentation of international transport segments is a critical element from various perspectives. Increasingly complex production chains are challenging traditional modes of freight transport. Moreover, just-in-time production processes require a synchronisation of providers, producers and dealers with lower transport volumes and faster and more frequent transport movements. The interface between road and rail at intermodal platforms as well as logistic platforms, also creates inefficiencies in the road freight transport system. Different legal frameworks in the Alpine countries are additionally influencing freight transport.

A2.5 Main problems of rail freight transport

Rail freight transport in the Alpine region is impeded by non-competitive pricing structures, lack of punctuality and reliability of Alpine rail services and poor tracking of where goods are in the transport chain. The punctuality of trains operated for combined transport through major trans-Alpine corridors has recently deteriorated. In 1999, only 60% of all the trains were on time. By the first half of 2002, the amount of on time trains further diminished to just 49%. Furthermore, the average speed of international train freight services on major corridors averages around 20 km/h, which is unattractive for potential customers. Moreover service prices are often not competitive and can change widely from one operator to another.

Due to the infrastructural fragmentation, the rail system is further disadvantaged in comparison to the road system. Main bottlenecks in this regard are an incomplete electrification and outdated signalling on Alpine rail corridors. This patchwork of different rail systems and the lack of integration and interoperability reduces the chances of rail companies to offer fast, reliable and efficient international services. Lack of planning, national and sub-national divergences, technological differences in rolling stock and signalling systems, different staff training as well as different management systems all represent problems that must be considered in order to forge a real integrated European railway network.

Nevertheless, there are not only negative aspects and national rail networks are currently transformed into a system which will improve the freight transport sector in terms of competitiveness, flexibility and safety of the services provided.

Main findings

Status

Combined traffic in the Alps is limited. Road transport still plays a prominent role within the transport infrastructure of the region and rail transport continues to lose shares in regard to modal split. The available rail freight services often show functional inefficiencies, especially on key corridors between Germany, Austria and Italy.

The consequence is that the special ecosystem of the Alps suffers from increased noise and air pollution.

Trends

Rail freight transport through the Alps will be enhanced by some highly important tunnel projects (see chapters A1 and D5.2), which will also have effect on freight transport of the feeder lines outside the Alpine area: Switzerland is improving the infrastructural supply by creating the new trans-Alpine tunnels of Simplon-Lötschberg (2007) and Gotthard (2014–2015). Even if the European Union already supports the development of new rail infrastructures across the Alps through the Brenner and the Lyon-Turin-tunnel, these projects are under construction or are in the phase of project definition, and they will not be accomplished before 2015–2020. Further improvements are expected from technical improvements such as for the Aiton-Orbassano rail motorway or the Tauern rail line (see chapter A1.3).

Hot issues

In order to redress this situation, rail freight must offer competitive and efficient services. The sector needs to respond to the customer needs, by ensuring that it provides adequate rail infrastructure capacity and that levels of investment in rolling stock are increased.

The overall quality of available rail services in the Alpine region must be improved in order to shift freight from the road to rail. This is the real challenge.

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A3 Passenger Transport

Passenger transport is the movement of people from one place to another and is presently regarded as a basic part of everyday life in modern civilisation. Living conditions in Europe have improved considerably thanks to fast transportation.

Passenger transport can be distinguished by several characteristics, like the purpose (leisure, work, education, shopping etc.), the access (public or individual transport), the means of transportation (train, car, bus, aircraft) or the distance (local or long-distance traffic).

In the last decades major improvements have been made in the road infrastructure. Therefore the share of individual motorised transport has increased above average. The demand for public passenger transport differs from rural areas with low population density to agglomerations and urban areas with higher population densities and therefore more potential customers.

Different transport modes have different effects on population, economy and the environment. The increase in intra-Alpine traffic and individual motorised traffic along the transit routes causes more and more pressure and leads to protests by the local inhabitants. Multiple efforts and measures undertaken by local and national authorities to reduce the traffic have not been able to prevent these negative developments.

Passenger transport problems within the Alps occur in particular at holiday seasons and weekends near the attractive tourist sights and also at bottlenecks in the Alpine agglomerations due to commuter traffic.

The following chapter provides an overview of passenger transport by road and rail in the Alps. The modal split, individual motorised traffic and public transport, is described – mainly using examples from case studies due to the lack of data for the perimeter of the Alpine Convention.

A3.1 Importance and role of passenger transport in the Alps

Alpine passenger transit plays an important role in the European economy, the Alpine countries and in Alpine tourism.

There are several reasons for the growing importance of passenger transport, such as commuting for work and education (schools, higher education), shopping trips and leisure traffic after work and at weekends. Structural changes like the shift of labour opportunities from the countryside to small and medium-sized towns in rural areas contribute to the increase in passenger transport.

Passenger transport occurs on short distances, such as between small towns, district capitals and rural areas for reasons of general livelihood and services as well as on long distances for business reasons and holidays (see chapter B4).

The increase in passenger transport is distributed unevenly among the different transport modes. In the future, a further increase in passenger transport is expected, both on roads and railways.

With the growing importance of tourism in the Alps, tourist traffic has risen remarkably within the last few decades. In the holidays and at weekends especially, individual motorised traffic causes congestion in tourist regions and on access routes to tourist destinations. Furthermore, it leads to overcrowded roads in and around centres and agglomerations.

Case study: Passenger transport – trend in Switzerland

One of the latest Swiss studies shows that passenger transport will continue to grow in the next 25 years. The car will remain the most popular means of transport, although transport by rail will become more common and provide faster services than transport by car in the next few years due to the transport policy in Switzerland.

Depending on the scenario, the forecast for the increase in passenger transport performance (pkm) is about 15 to 29% up to the year 2030, and public transport could grow by up to 95% – a result of the Swiss transport policy. Dynamic developments are expected for transit traffic (up to plus 45%) and leisure traffic (up to plus 31%) (ARE 2006).

A3.2 Some views on the modes of passenger transport

It is of special interest which means of transport people chose, as the different modes have different impacts on people and on the environment. Here the “modal split” (see Introduction A) shows the shares of each carrier for a particular spatial unit.

Modal split

Passenger transport systems include different modes of transport: walking, going by bicycle, public transport, or car and motorcycle. The “modal split” depends *inter alia* on the accessibility to public transport (or on the availability of vehicles) and on the type of area (urban, suburban, rural). In rural areas especially, there are usually no attractive types of public transport on offer, and people prefer to go by car (ARE 2003). In comparison to the non-Alpine regions, the bicycle is of minor importance in the Alps, usually due to the topographic conditions.

Despite the difficult data situation general developments of modal split may be highlighted by using examples from individual countries.

Data issues:

Comparisons of the modal split are difficult. The measurement of the modal split is mostly included in regional transportation studies. Such studies do not exist at the same level for all regions, nor do they exist for each year. Therefore a description is provided by some case studies.

Generally, sufficient data on the transportation by car are obtained from yearly measurements of the number of vehicles on the roads. Different types of vehicles like passenger car, heavy goods vehicle, trailer truck etc. are documented. There is, however, no information about the transport performance (passenger-km) for the area covered by the AC.

A description of the use of the public transportation network is more difficult. For the rail systems, there are – in general – statistics about the number of passengers for a country as a whole. There is a lack of such information on the AC area in particular and it proved to be difficult to extract it from general statistics.

Also, there are no consistent data about bus services and passengers in the Alpine Convention area. The bus services are run by different companies with different statistics, and some of these statistics are not available due to confidentiality obligations, which is another factor that complicates data comparison.

The problems with on-demand systems are roughly the same: there are no area-wide data about these systems; furthermore there is no system for collecting these data nationwide.

Switzerland: modal split in Alpine and non-Alpine regions

Fig. A3-1 shows the modal split in Switzerland for the year 2000 in Alpine and non-Alpine regions. Cars have the highest share of transport means in Alpine and in non-Alpine regions, but their share in Alpine regions is clearly higher.

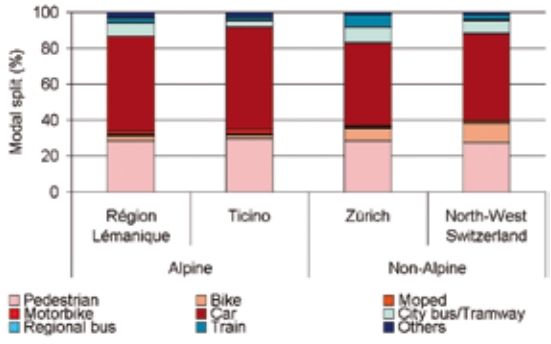

Fig. A3-1: Different modal split (by routes travelled) in Switzerland in Alpine and non-Alpine regions in 2000 (Source: ARE 2003).

Different data (ARE 2003) on the Alpine regions show that

- about 50 – 80% of the journeys in rural areas are made by car and that
- in urban areas, the proportion of journeys made by car is lower than in rural areas (40 – 50%).

The modal split in Innsbruck and its hinterland

One example of the differences in the modal split between different types of area is the modal split currently observed in the Alpine town of Innsbruck and its surroundings as shown in Figure A3-2. While in Innsbruck itself about 40% of the journeys are made by car, the proportion of car journeys is about 70% in the surrounding areas.

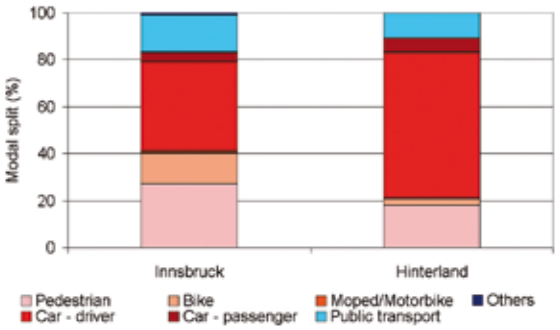

Fig. A3-2: Modal split in different types of area as shown by the example of Innsbruck (Austria) and its surroundings in 2002 (Source: Mobil in Tirol, www.tirol.gv.at, 2006).

Modal split – development and trend

Regarding the modal split, there has been a general shift towards the use of the car in the last two decades.

For example despite major investments in Switzerland in railway infrastructure and improvements on the public transport sector the trend towards the car could not be reversed.

The extension of road infrastructure in combination with high motorisation rates and pricing structures in the transport sector favoured the shift to road transport in the past few decades (see Fig. A3-3).

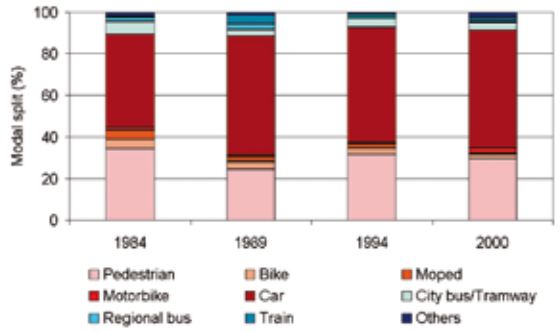

Fig. A3-3: Modal split development as shown by the example of Ticino, Switzerland (Source: ARE 2003).

A3.3 Individual motorised transport

Passenger transport which is carried out by cars and motorcycles is called individual motorised transport.

Generally there are sufficient data on the transportation by car obtained from yearly automatic measurements of the number of vehicles on the roads to outline the main traffic flows. In some countries there are also two different types of automatic measurements, one counting only the volume of traffic and the other counting and classifying different types of vehicles, like passenger car, heavy goods vehicle, trailer truck, etc. There is, however, no coherent information about the transport performance (passenger-km) for the area covered by the Alpine Convention.

To receive more detailed information on the origin and destination of passenger transport, traffic censuses at regional or local level and surveys of drivers are carried out. However in most cases these studies are carried out at project level.

Indicator B7-3: Network load due to cars and trucks at automatic traffic meters in the Alpine region

This indicator monitors the traffic on the main road network, using the results from automatic recording devices. Data were collected for the whole network for the years 1985, 1990, 1995, 2000 and 2005 (Italian data are missing). Although a large data set is available, there are a some inconsistencies:

- *the recording system is not the same in all countries,*
- *the data until 2005 are not available in all countries,*
- *the structures of the different networks are not comparable.*

Due to some of these inconsistencies it has not been possible to carry out an Alpine-wide analysis of passenger traffic. Data for some selected road sections in the Alpine area are given in Fig. A3-4.

Traffic loads on selected Alpine motorways

Fig. A3-4 shows the average numbers of vehicles per day at several measure points on Alpine motorways. On average, the motorways in the Alps have to cope with 10,000 – 30,000 cars per day. The most frequented traffic routes with more than 50,000 cars per day can be found on the edges of the Alpine Convention area near the larger cities (A8 at Rosenheim in Germany, A2 at Luzern in Switzerland). The motorway with the highest traffic loads in Austria is the A12 in the Inn valley with more than 40,000 vehicles per day. In France the A41 at Chambery shows the highest number of vehicles, in Slovenia the A1 at Maribor.

Additionally, routes with a variety of functions (access to tourist destinations, transit routes, access to towns and cities) are affected especially by heavy traffic.

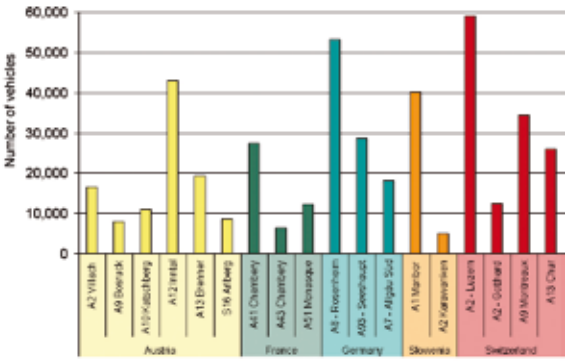

Fig. A3-4: Car traffic in the Alps (Source: Austria http://www.asfinag.at/index.php?idtopic=20, Automatische Dauerzählstellen (AVZ); Switzerland: www.verkehrsdaten.ch; France: Sétra (service d'Études techniques des routes et autoroutes), Cete de l'Est: Données de l'année 2003; Slovenia: Direkcija Republike Slovenije Za Ceste, Podatki za leta: 2005; Germany: Zentrale Datenverarbeitung im Straßenbau, Dauerzählstellen, Jahresauswertung 2003).

The increase in car traffic continues

The last 10 years have seen a continued increase in car traffic. In some places, a rate of increase of up to around 45% has been observed – a rate which varies depending on road function and capacity. Fig. A3-5 shows the increase in car traffic on selected road segments in the Alps between 1995 and 2005.

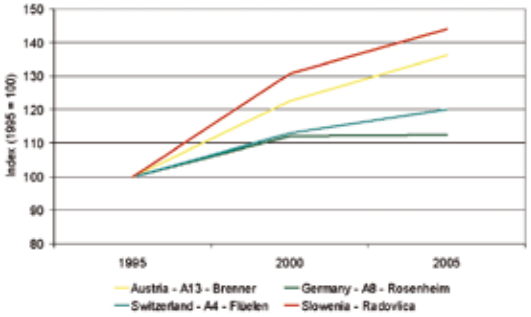

Fig. A3-5: Development of car traffic 1995 – 2005 (Source: Data from automatic recording devices in different AC signatory states).

It is assumed that the traffic volumes will continue to grow in the next few years, although not quite as fast as in the last few years. From 2000 until 2030 traffic volumes will grow on road and rail combined at the rate of 15 to 29% (depending on the scenario), but more slowly than in the past 30 years. The car will still be the favoured means of transport, regardless of the disproportionately high increase in public transport (ARE 2006).

Transport across the Alps is concentrated in the east

When looking at traffic volumes, it is noticeable that passenger transport across the Alps is concentrated in the eastern part of the Alps (see Fig. A3-6). In the western part, the main traffic volumes are observed along the coast in France, and in Switzerland through the Gotthard tunnel as the main

route. This distribution depends directly on the level of road improvement and extension.

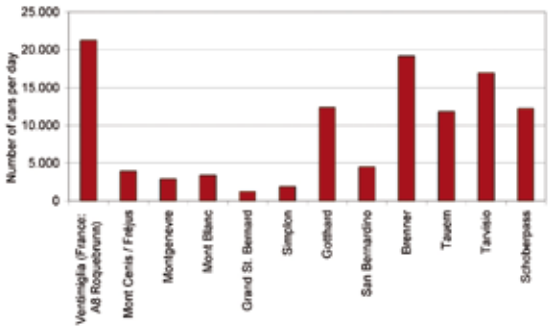

Fig. A3-6: Passenger transport across the Alps for 2004/2005 (Source: Automatic recording devices of the different signatory states; FR: Observatoire des trafics à travers les Alpes Edition 2006).

Purpose of trans-Alpine traffic

Data about the purposes of trans-Alpine passenger transport do not exist Alpine-wide. But some information can be drawn from a national study in Switzerland.

Case study: Trans-Alpine passenger transport in Switzerland

In Switzerland, a study of passenger transport crossing the Alps was completed in 2001. The results show that about half (55%) of the road journeys and 44% of the rail journeys were made for holiday purposes. To this already high percentage the share of road transport for leisure purposes of 29% and of 33% for rail traffic has to be added (ARE 2001).

Fig. A3-7: Purpopse of passenger transport across the Alps in Switzerland (Source: ARE 2001).

Urban traffic

The statistics show that the main traffic volumes can be found around towns and cities. As social and economic centres, towns and cities are the main attractions of a region and, consequently, face more traffic.

For urban passenger traffic a distinction can be made between inner-urban passenger transport and the traffic flows around the core cities, which are the subject of different management methods:

- Motorised passenger traffic around urban areas is often influenced by commuting for work or educational purposes. Main problems are congestion on the access roads and in smaller settlements which are not suited to the increased traffic volume.
- Inner-urban transport problems are characterised by congestion in main access streets, parking problems and traffic safety problems between different mixed transport modes such as car, bicycle or pedestrians.

Due to these problems, several solutions in the major agglomerations were conducted or are in the planning phase. These solutions comprise for instance the development of transport plans (see box), access rights for private cars to inner cities, extension of public transport, cycle lanes or car park management.

One central factor for urban traffic as well as for traffic on main roads is the cost of road traffic. Therefore road pricing will influence the chosen transport mode and may financially support the development of public transport options.

A3.4 Public transport

A3.4.1 Rail transport

Transport by rail is one of the most important alternatives to motorised passenger traffic. Rail transport is important public transport at two levels: local and regional trains provide connections between core towns and their surroundings, long distance trains offer national and international connections.

There are two sides of the rail transport development: on the one hand, light railways have been closed down and replaced by bus services in some of the peripheral regions; on the other hand, passenger transport performance has increased in some areas, namely near towns and cities (commuter traffic) and on long-distance railway lines.

Case study: Traffic calming measures in the Alpine towns and cities

Due to ongoing noise and air emissions in towns and cities (see chapters C3.1 and C3.2) some municipalities have started to formulate urban transport plans.

Transport plans exist in Austria, for example in Salzburg, Innsbruck, Bregenz, Villach and Klagenfurt. But transport plans are (in Austria) not legally binding and so they act more or less as a mere memorandum of understanding.

In Italy, communities with more than 30,000 inhabitants are obliged to implement an urban transportation plan. In the last few years, several Italian towns and cities in the Alps have implemented a number of measures like parking space management, traffic restrictions in the town and city centres, pedestrian zones, bicycle lanes or programmes for the development of innovative vehicles (Alpenkonvention 2004). For details see chapter D4.1.

As data about passengers are not available for the whole Alpine Convention perimeter, only the examples for the French Alps (see box) and Switzerland as a whole can be given.

Case study: Passenger transport by rail in French provinces

For the Alpine space, there are only a few data about the usage of the railway system. Most data refer to the relevant countries as a whole. National data show a general increase in passenger transport by train in the last few years, with the exception of Slovenia.

There is one example which shows an increase in passenger transport by rail: in the French Provence-Alpes-Côte-d'Azur and the Rhône-Alpes regions, rail passenger transport volumes have risen by about 38 – 54%.

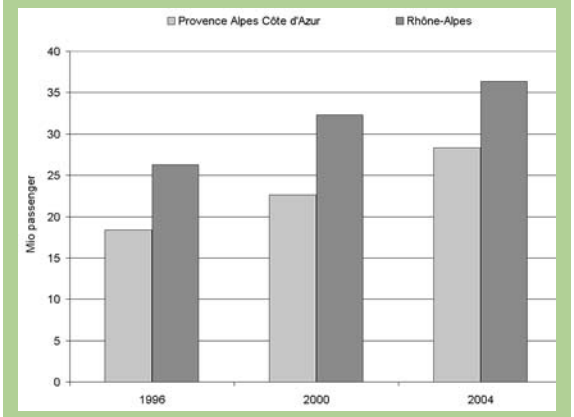

Fig. A3-8: Development of passenger transport by rail in France (Source: DAEI/SESP).

The Swiss railroad company SBB reports raising passenger numbers and also passenger kilometres over the last years. The number of passengers transported rose from 275.9 Mio passengers in 2005 to 285.1 Mio in 2006; at the same time the passenger kilometres rose from 13,830 Mio to 14,267 Mio.

To compensate for the lack of passenger data, the numbers of local trains and long-distance-trains per day of selected 65 track sections were examined by the UBA Wien.

From	To	Local trains	Long distance trains	Sum
Chambéry	Torino	0	3	**3**
Villach	Trieste	1	5	**6**
Graz	Maribor	1	7	**8**
Grenoble	Gap	8	0	**8**
Villach	Ljubljana	7	2	**9**
.	.	.	.	**.**
München	Rosenheim	34	18	**52**
Luzern	Bern	32	21	**53**
Bregenz	Feldkirch	45	9	**54**
Zürich	Bern	5	54	**59**
Genève	Lausanne	22	71	**93**

Tab. A3-1: The least and most frequented rail connections presented as trains per day for 2006 (Source: UBA Wien 2006).

The five least and the five most frequented rail connections from these selected tracks are shown in table A3-1. They point up the range of use, from only three train journeys on the Chambéry-Torino section, up to 93 journeys per day on the section between Genève and Lausanne – most of them long-distance connections. In total on the 65 railway sections, 1,725 trains are available per day, of which 811 local trains and 914 long-distance trains.

A3.4.2 Bus transport and local transport systems

In Alpine regions, bus transport is an important – sometimes even the only – public transport system, connecting peripheral regions with the central facilities. Because of the morphology (relief) in mountainous regions, bus services are often easier and more flexible to provide than railways for local passenger transport outside the agglomerations.

Due to the trend towards transport by privately owned cars, bus transport systems run the risk of being reduced to a minimum service, e.g. for school transport, as there are not enough passengers and some bus services are then no longer cost-effective. The consequence is an increasingly unattractive public transport system in peripheral areas and therefore fewer passengers – a vicious circle.

However, in most countries in the Alps, efforts have been made to stop this negative development. There are at least some national examples of effective regional bus systems offering attractive public transport.

Alpine passenger transport (Source: Postbus Austria).

Some regional and national bus companies developed historically from post buses, e.g. the Austrian "Postbus" company founded in 1907 originally for post- and telegraph matters, or the Swiss PostBus Ltd. founded in 1906.

Indicator B7-5: Passengers conveyed by regional bus
Indicator B7-6: Number of municipalities with regular or on-demand services

For the Alpine space there are no coherent data on the development and status of passenger transport by bus or on-demand systems. But the situation can be highlighted by some case studies for Austria, Switzerland and Italy, which are presented below.

Postbus in Austria

The Postbus company in Austria is organised in seven regional managements. In total Austria the Postbus company has a market share of approx. 70% of regional bus transportation, approx. 50% of the entire bus transportation and approx. 20% of the entire local public passenger transportation (ÖPNV). The buses serve almost all municipalities in Austria with about 20,000 bus stops, travel in total 120 million km/year and have 235 Mio passengers/year. Fig. A3-9 shows the km/year driven by Postbus for each region, data only for the area of the Alpine Convention were not available.

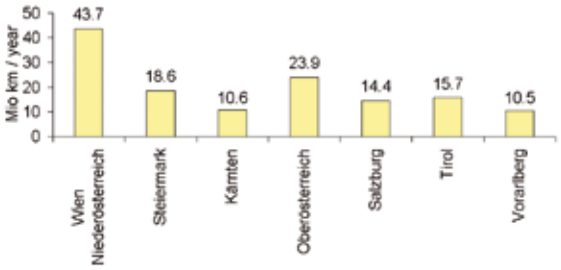

Fig A3-9: Total distance driven yearly by Postbus in Mio km per year (Source: ÖBB-Postbus GmbH 2006).

PostAuto in Switzerland

The Swiss PostAuto Ltd. delivers roughly 50% of overall carrying capacity in regional public transport. Its network consists of over 10,450 km (three times as large as the Swiss Federal Railway's system with 3,034 km). Over 100 Mio passengers travelled 94 Mio km in 2006. As well as the regional and local lines it also serves several so-called "Route Express Lines" in the Swiss Alps, leading over passes and connecting as far as Meran in Italy (Swiss PostBus Ltd.n.d.).

A new policy concerns the expansion in the neighbouring countries, especially in the niche markets with fewer than 150,000 inhabitants. Some regions in France are already served, like the Bourg-en-Bresse area in the French Alpes, where since 2006, 75,000 inhabitants have travelled 1,450,000 km/year in 30 buses. This can be interpreted as an encouraging sign for a development towards a more sustainable mobility, particularly as this service has to be cost-effective in economic terms (Source: http://www.post.ch/fr/pag_nat_carpostal_france_sarl?jsdimA=13863&jsdimB=1, accessed 11 April 2007).

Dolomiti Bus in Italy

A case study describing a good regional bus system is the "Dolomiti Bus" in the province of Belluno (Italy). The Dolomiti Bus network connects 67 communities and covers 3,612 square kilometres. More than 7.1 Mio kilometres are travelled by the Dolomiti Bus in one year and about 8 million passengers are transported (www.dolomitibus.it).

On-demand systems

A new form of public transportation is the on-demand system. This is a transport system which runs only when required. It is especially suitable for peripheral areas where the operation of a regular bus service is not economic. On-demand systems include shared taxis or buses with a fixed timetable, but which run only if a customer calls and books this service.

Case study: Shared taxis in Austria

In some parts of the federal provinces of Niederösterreich, Salzburg, Tirol, Kärnten and Vorarlberg, shared taxis are part of the public transport system. They are in use especially on the outskirts of the regional capitals. The on-demand system substitutes for the common public transport systems. The main target groups are women and young people.

There are four types, fulfilling slightly different functions. The first type is a shared taxi on demand ("Anrufsammeltaxi"), practised as a mixture of line operation and non-scheduled traffic. There is a timetable and fixed stations, but the station is only serviced if a passenger is announced. The second type is a city taxi, which differs from normal taxis only in the fixed price; it also offers subsidised prices for kids and teenagers. An example of this system is the night-taxi in Villach, which serves the whole urban area between 9.00 p.m. and 5.00 a.m. There are three different price-zones (3, 6 or 9 km), the passengers pay with vouchers bought from the municipality. Each voucher is subsidised by the municipality. In 2003 more than 45,000 vouchers were sold.

Another variant of normal taxis are those which connect to the terminal stations of public transport services (bus or rail) which can be shared by several passengers. The last type are line taxis which fill the gaps of conventional public transport. An example of this type is the bus taxi in Salzburg, which was conceived as a substitute for public buses and runs at night-time between 11.30 p.m. and 1.30 a.m. There are defined departure stations in Salzburg and 12 routes are served. They run every half hour and take from one to four people. There are fixed prices of 3 € per person and ride. About 4.000 people per month are using it (WKO n.d.).

The advantages of this kind of on-demand system are flexibility and customer orientation.

A3.4.3 Soft measures

Soft measures aim to increase more sustainable transport modes and to reduce energy consumption by motivating people to use their cars less. This aim can be achieved by several types of measures, sometimes called soft measures, sometimes called smart measures. Some of these options are (Cairns et al. 2004):

- increased awareness from better information on the impacts of motorised traffic,
- travel awareness campaigns,
- information and marketing of public transport possibilities,
- new patterns of car use like car sharing,
- implementation of travel plans for workplace and school, and
- new ways of organising activities like home-shopping, video-conferencing and teleworking.

Main findings

Status

The private car still is the most commonly used mode of passenger transport, and it is expected to remain as such. Alpine transit routes, as well as peripheral routes providing access to tourist destinations and urban access roads, face high individual motorised traffic loads.

Frequent public transport services offering a dense network are mainly available in agglomerations. Peripheral areas face the risk that bus services and light rail links cannot be operated economically and may decline.

But the examples of the Austrian Postbus and the Swiss PostAuto show that bus services are still in demand and available. The successful expansion of the Swiss PostAuto in France could serve as a model for public passenger transport and mobility for other regions.

Most regions have developed transport plans focusing on sustainability and the use of public means of transport.

Trends

There will be an increase of passenger transport in general, both on rail and road. Traffic to leisure and tourist destinations will play an increasing role in the traffic volumes.

Depending on the attractiveness of the service, a shift of modal split towards rail may also be achievable, as the Swiss example proves.

Amendments to and substitutions for traditional public transport will further develop, such as on-demand systems. Soft measures may additionally provide further options for developing sustainable passenger transport.

Hot issues

Individual motorised traffic will continue to increase in the future, and it is likely that transport infrastructures will be overburdened by this growth. Therefore intelligent traffic management as well as appropriate infrastructure will become crucial. The successful implementation of other transport modes such as attractive public transport, on-demand systems, etc. will be also a question of timeliness.

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B Driving Forces of Mobility and Transport

The human being: in the focus of the system

One of the main objectives of a modern transport policy is to ensure sustainable mobility on a national as well as on a regional level. In this context, it is necessary to satisfy the need for mobility of all population groups and of different regional segments in a manner that is economically sustainable and efficient as well as environmentally sensible. Therefore, human beings are the main focus of the transport issue, because they are the originators and the beneficiaries, as well as those who suffer because of the transport system; in the end they are the standard of assessment. The differences between these roles may disappear from time to time. Depending on the region and the point in time, human beings may play one role or quite often even several roles simultaneously. A population group living close to a motorway, for instance, will have a different opinion on the traffic passing in front of its windows than will tourists travelling to their holiday resort. If the above-mentioned residents drive to their holiday resort or to work themselves, the roles are reversed.

Chapter B1 addresses the most important factor within this system: the geographical distribution of the population and its demographic development within the region. These factors give information on the potential demand for mobility and traffic and their respective distribution. It can be safely assumed that in highly-populated regions and their catchment areas a great deal of traffic is going back and forth from and to workplaces, schools and businesses. The population density similarly plays an important role with regard to the equipment of infrastructures (leisure time, professional education, employment) and the supply of public services (medical care, public transport). The distribution of these infrastructures has an influence on both the amount of traffic and the supply of the traffic infrastructure, as well as the means of transportation.

Within the Alpine arc, regions exist with both a high, concentrated population and a low, dispersed population. Offering reasonably-priced transport services in regions with a low, dispersed demand poses quite a challenge with regard to the development of an infrastructure that is socially compatible and as environmentally friendly as possible. For this reason, regional development authorities are confronted with the crucial task of setting up the framework conditions to ensure an adequate basic supply as well as sufficient employment opportunities.

The location: a sensitive area

The region in which traffic movements occur is equally of special importance. Due to its special characteristics, the Alpine region in particular can be considered as one of the most sensitive regions in Europe. Therefore, the EU had good reasons for including this region in the "sensitive areas" and listing it in its Road Charging Directive 2006/38/EC, which was adopted on 17 May 2006. Among other things, this mountain region is characterised by the high risk potential of its natural space and its steep landscape. Only a small part of the region is suitable for year-round settlement.

In the valleys or the accessible terraces, where most of the region's population lives, different intentions for using the scarce commodity of "space" are competing with each other. In this context, traffic becomes even more important, especially since its effects (spread of noise, pollutants etc.) extend beyond the area concerned. Chapter B3 deals with the actual land-use changes of the regions.

The economy: a motor

Sometimes, economic development and traffic are closely linked. Thus, the economic development of a region also depends on its accessibility and, consequently, on the opportunities for exchanging goods and services. Accessibility defines the quality of a geographic location with regard to potential opportunities for establishing contacts, making visits or exchanging goods and services. It is also a standard for the benefits that resident citizens or companies theoretically derive from the quality of a location's accessibility. Good accessibility may be an essential criterion for the survival of certain economic sectors depending on additional income from other sectors. It may create economic benefits both within and outside the Alpine region.

At the same time it needs to be emphasised that a vital mountain region cannot depend on accessibility alone. In fact, several surveys found that an improvement of the accessibility led neither to a relocation of jobs to the periphery nor to a stop of the population decline (Institut für Länderkunde 2001).

Where accessibility affects economic development, the economy will become the primary source of influence for goods traffic. Furthermore, logistic development and traffic policy also have a great impact on the development of goods traffic (ARE 2004). In this context, the development surrounding the Alpine arc is just as crucial as the development within it: division of labour, economic growth, consumption patterns and the single market are just a few key factors that play a role with regard to the extent of traffic movement caused by the economy. Chapter B2 addresses the economy as a motor for traffic development.

In this context, tourism plays a special role. Due to the trend of more frequent but shorter stays prevailing in this sector, individuals travelling by car attach even greater importance to a comfortable and fast access to their destination. At the same time, this sector in particular depends on a peaceful and scenic landscape which is free of traffic-related nuisance (see chapter B4).

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B1 Population in the Alps

The demand for transport is derived from people's requirements to earn a living, enjoy leisure activities, consume goods and utilise services. Thus, demographic, economic and social factors create demand for mobility and also for traffic. On the other hand, transport influences these three factors, making some places more desirable than others for living in, or for starting up and carrying on an economic activity and bringing development.

Public accessibility to places, services, goods and places of work is one of the main factors that influence the vitality of the Alpine arc. In the most peripheral areas the average accessibility of services in general is more difficult and the demand for it is harder to satisfy. Thus, these areas are less attractive for living in, and dependency on individual car transport is high.

In contrast to peripheral areas, the densely populated areas are the sources and causes of pollution and traffic. These are also areas that offer more opportunities to develop the public transport system.

Representing a crucial driver for transport and mobility, demographic development, population distribution and migration as well as the special issue of population density in the Alpine area are presented in this chapter.

B1.1 Demographic development

The present provisional delineation of the Alpine Convention area comprises 190,558 km² (Ruffini et al. 2004). In 2004 about 14 Mio people were living in this area.

Today the population in the Alpine Convention area is twice as many as it was at the end of 19th century (BMU 2004). Austria and Italy together with 55.5% represent the largest share in the Alpine Convention area. More than half of the Alpine population (53.5%) is concentrated in these two parts of the Alps.

B1.1.1 Population change since the end of the 20th century

During the 1990s the population increased in the Alpine Convention area by 7.8% (see Tab. B1-1). The demographic process is not homogeneously spread across the Alpine regions. Areas with growth and decline are located closely together. The highest population growth was registered in Germany and in Liechtenstein. In contrast, the lowest was recorded in the Slovenian Alps.

It has to be noted that a cluster of municipalities along the Italian Alpine sector which includes the area from Liguria to Lago di Garda is facing a steady decrease in population (Map B1-1). Also several municipalities in the provinces of Belluno and Udine have recorded a decline in population. The same tendency is observed in the Slovenian Alpine region and in Austria throughout eastern Steiermark and in the southern parts of Niederösterreich too. Even in the Swiss Cantons of Uri, Bern and in the northern part of Ticino the population has decreased.

In contrast, population growth is observed in the Central Alpine regions. The provinces of Oberbayern, Salzburg, Tirol, Vorarlberg, Alto Adige, Trentino, the majority of Cantons in the western parts of Switzerland and Liechtenstein have all recorded an increase in population.

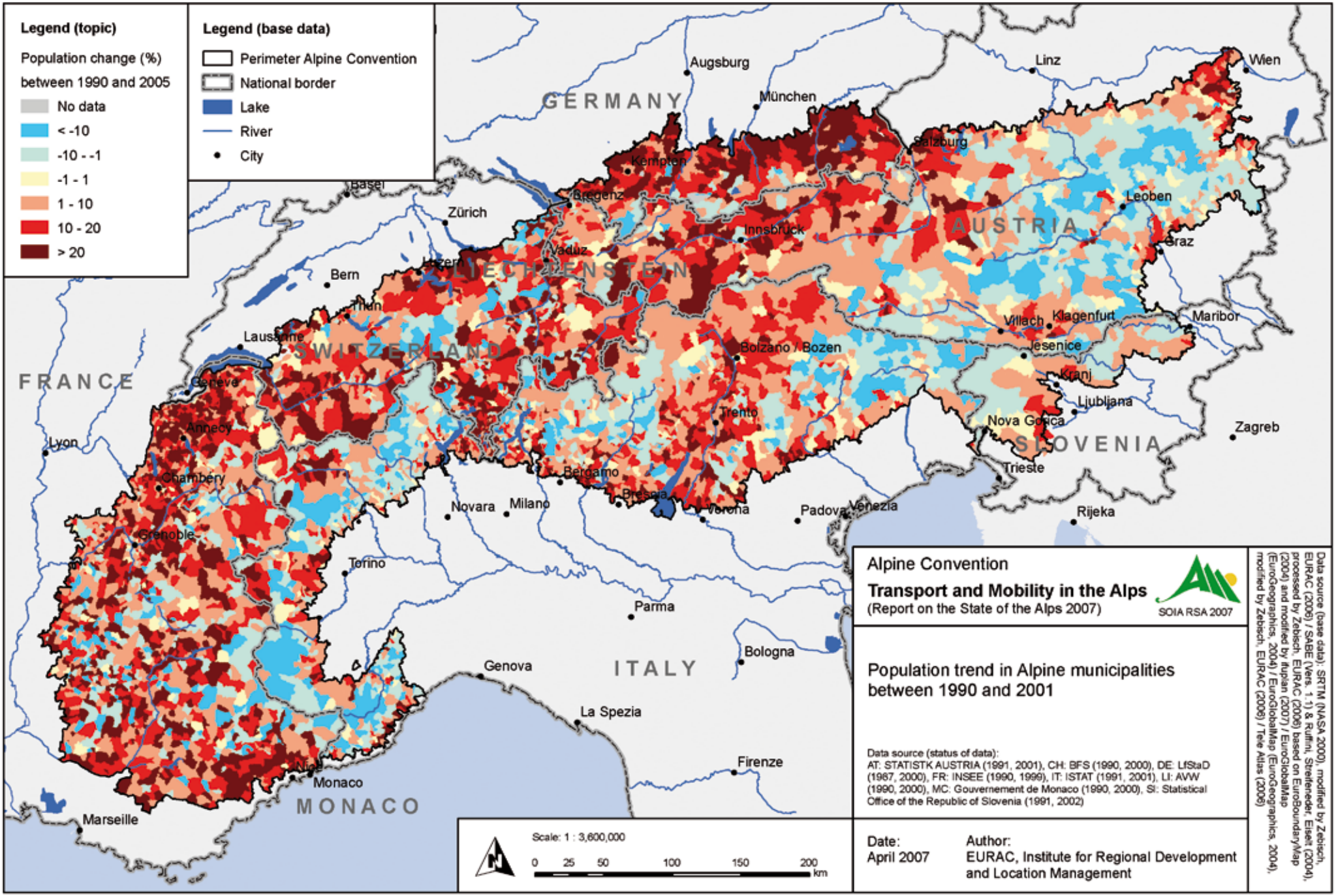
In these prospering regions of the Alps an increase in urbanisation of the valleys' centres has been registered. Due to the influence of booming tourism the population has even increased in remote municipalities that are not easily accessible, e.g. touristic centres in the Swiss Alps, French Alps etc. (StMWIVT 2004, Hornung & Röthlisberger 2005).

In fact the French Alps show a heterogeneous demographical pattern, where depopulated regions and dynamic regions alternate within a narrow space. A large number of municipalities have achieved a high relative population growth of more than 25%. In contrast, the south Alpine areas and the regions close to the main Alpine ridge are characterised by a distinctive population decrease.

Country	Area [km²]	Municipalities	Inhabitants[1]	Change in inhabitants[2] [%]	Population density [inhabitants/km²]
1	**2**	**3**	**4**	**5**	**6**
Austria	54,620	1,148	3,255,201	+4.8	60
France	40,804	1,749	2,453,605	+9.2	60
Germany	11,072[3]	285[3]	1,473,881	+15.7	133
Italy	51,184	1,756	4,210,256	+5.7	82
Liechtenstein	160	11	34,600	+13.2	229
Monaco	2	1	32,020	+6.8	16,010
Slovenia	7,864	60	661,135	+1.2	84
Switzerland	24,862	944	1,827,754	+13.1	74
Alps	**190,568**	**5,954**	**13,948,452**	**+7.8**	**73**

Tab. B1-1: Population change and density in the Alpine Convention area during the 1990s (Sources: AT (UBA), FR (IFEN), DE (LfStaD), IT (ISTAT), LI (AVW), SI (Statistical Office of the Republic of Slovenia), CH (FSO).

1) Date of survey: AT: 2005, DE, IT, LI, SI and CH: 2004, MC: 2000, FR: 1999.
2) Due to data availability the reference year varies between 1987 and 2001: MC: 1990/2000, AT: 1991/2001, FR: 1990/1999, DE: 1987/2000, IT: 1990/2000, LI: 1990/2000, SI: 1991/2000, CH: 1990/2000.
3) Not included 10 municipality-free areas.



Map B1-1: Population trend in Alpine municipalities between 1990 and 2001.

Development of the Alpine Convention municipalities

The trends of the Alpine-wide population change at municipality level between 1990 and 2000 can be summed up as follows:

- 25.7% (1,535) of municipalities suffer a population decrease of more than 1%,
- 6.6% (395) are stagnating as their population change ranged between ±1%,
- 57.8% (3,448) had a population growth between 1 and 25%, whereas for 9.6% (574) an even higher increase was recorded.

In 2000 4,547 (76.4%) of all municipalities counted fewer than 2,500 inhabitants. These municipalities cover only 27.1% of the Alpine population. One third of all Alpine municipalities were inhabited by fewer than 500 people (Tab. B1-2). In less than 0.2% of all municipalities more than 5,000 inhabitants were registered.

A high percentage of the Alpine population (20.1%) is concentrated in municipalities with 2,500 to 5,000 people. About 35.7% of the people live in urban centres of between 5,000 and 25,000 inhabitants. And another 17.1% live in cities with more than 25,000 inhabitants.

However the analysis of the population decrease in the 1990s shows that the smallest and the largest municipalities in terms of population are more often affected by a reduction in the number of inhabitants. In other words, those municipalities with between 2,500 and 25,000 inhabitants are less affected by a population decrease.

The smallest municipality in the Alps is Rochefourchat (Drôme) with only one inhabitant. In 1870, 150 people lived in this municipality. The small municipalities are those which register the highest relative population change. For example, in Monestier-d'Ambel/Isère a decrease from 65 inhabitants in 1990 to just 20 (–69.2%) has been recorded.

On the other hand, strongly rising rates are also possible. For example, Aucelon/Drôme recorded a growth from 18 to 41 inhabitants, an increase of 128%. Consequently the smaller the municipalities are, the higher the relative rate of change could be. These large relative changes in small municipalities are obviously also a statistical phenomenon.

B1.1.2 The large centres of the Alpine arc

The development of the centres and agglomerations is very important both for trans- and intra-Alpine transport. The centres and the agglomerations (see box on Periurbanisation) constitute a living space for a large number of people with specific mobility requirements. Moreover they are connected with the economies outside the Alpine arc, host tourist attractions and offer a wide range of services and jobs. Last but not least they create a high number of commuters.

In the Alpine arc a large share of the population is concentrated in cities and larger municipalities (Perlik & Debarbieux 2001). Those municipalities that, in the European context, are nothing but "small municipalities", are considered as "centres" in the Alpine arc. About 55% of the Alpine population lives in municipalities with more than 5,000 inhabitants (Tab. B1-2), whereas 35% of the people are concentrated in cities with more than 10,000 residents. These small urban centres play a major role in the surrounding communities. Hence the establishment of urban centres within the Alps and the ongoing process of periurbanisation has led to a change in living standards. The Alps no longer constitute a rural area with a rural population. They have become the preferred residence for people who want to combine the advantages of urban infrastructure with the attractiveness of unspoilt countryside.

Population classes[1]	Number of municipalities	Share on total number of municipalities [%]	Number of inhabitants[1]	Share on total population [%]	Number of municipalities with decreasing inhabitants during the 1990s[2]	Share of municipalities with decreasing inhabitants during the 1990s[2] on relative municipalities of population class [%]
1	**2**	**3**	**4**	**5**	**6**	**7**
< 500	1,876	31.5	445,588	3.2	684	36.5
500 – < 1,000	1,099	18.5	797,585	5.7	309	28.2
1,000 – < 2,500	1,572	26.4	2,551,301	18.2	419	26.5
2,500 – < 5,000	816	13.7	2,810,900	20.1	168	20.5
5,000 – < 10,000	367	6.2	2,476,149	17.7	67	18.6
10,000 – < 25,000	175	2.9	2,522,397	18.0	42	23.6
25,000 – < 50,000	35	0.6	1,166,367	8.3	13	38.2
≥ 50,000	14	0.2	1,228,738	8.8	5	35.7
Total Alps	**5,954**	**100.0**	**13,989,025**	**100.0**	**1,707**	**28.7**

Tab. B1-2: Overview of municipality types and the population structure [Source: AT (UBA), FR (IFEN), DE (LfStaD), IT (ISTAT), LI (AVW), SI (Statistical Office of the Republic of Slovenia), CH (FSO)].

1) Date of survey: AT: 2005, DE, IT, LI, SI and CH: 2004, MC: 2000, FR: 1999. Does not include the ten German municipality-free areas.
2) Due to data availability the reference year varies between 1987 and 2001: MC: 1990/2000, AT: 1991/2001, FR: 1990/1999, DE: 1987/2000, IT: 1990/2000, LI: 1990/2000, SI: 1991/2000, CH: 1990/2000.

Periurbanisation..

..is a spatial process of expansion of a town towards more and more distant areas to form an urban continuum.

According to Perlik (1999), periurbanisation in the Alps shows the same tendency as observed in non-Alpine towns: the urban centres stagnate whereas the peripheral municipalities grow. The growth of the urban area is thus basically due to the growth of the municipalities surrounding the centre.

In the work of Perlik, on the basis of the available data, agglomerations have been determined for all the major Alpine cities with 50,000 inhabitants or more. Based on the centroids of the municipalities, all the municipalities within a radius of 10 km of the major cities have been assigned to the respective agglomeration. For every agglomeration the total population has been determined.

Case study: Switzerland

The structural change of the Alpine areas in Switzerland can be illustrated as a practical example of rural development. The Swiss urban centres and those municipalities situated closely to these cities have a meaningful population increase, whereas the rural areas are suffering from a significant population decrease. While in 1930 only one third of the population (36%) lived in urban areas, this proportion had more than doubled by 2003 (73%). Since the mid 1960s the urbanisation process has been concentrated on small centres and on the agglomeration belts. Consequently even for larger centres a population decrease was partly detected. Due to the improved infrastructure services the number of regions with declining population has diminished in recent years. Hence since the 1990s the population in rural areas has been growing a little more strongly compared to the urban centres (Swiss Federal Statistical Office 2004).

According to the delineation of agglomerations in Switzerland, the number of urban agglomerations rose from 24 to 50 between 1950 and 2000 (ARE 2003).

Furthermore, it was pointed out that about 71% of the jobs in the whole Alpine area are already concentrated in these centres (Favry et al. 2004). Therefore these centres are important places for the economic and demographic development of Alpine regions. Many of these municipalities are located on the Alpine fringe, where they are affected by the large metropolises bordering the Alps like Milano, Torino, Lyon, München or Wien (Perlik & Debarbieux 2001). These metropolises located close to the Alpine arc have a strong impact on the settlement activities at the Alpine fringe. As the concentration in the periurbanisation area is still continuing traditional intra-Alpine centres will lose their former importance (Pfefferkorn et al. 2005).

The larger centres within the Alpine arc are located mainly in the river basins and large intra-Alpine valleys (Etsch, Rhône, Inn, Aosta, Isère). Thus external and internal accessibility play a significant role. Moreover, all big intra-Alpine cities with more than 50,000 inhabitants are very easily accessible from the outer-alpine area by highways, railways etc. (see Map B1-2) (Torricelli 1996).

Concerning the development of large “Alpine metropolises“, a decrease in population can be observed in six of these municipalities (cp. Tab. B1-3). As these centres are closely interlinked with their surrounding hinterland it is not sufficient to analyse them exclusively. Because of their socioeconomic and cultural importance and their influence on the surrounding hinterland, the Alpine metropolises and their periurbanisation areas are destined to be a dynamic development area.

The comparison of the population development between the metropolises and their bordering agglomeration belts shows a higher growth rate in the belts than in the metropolises themselves. The tendency towards periurbanisation seems to be increasing in the Alpine regions.

Thus a remarkable population growth in the agglomeration belts becomes apparent, whereas the growth rate of the urban centres is decreasing (cp. Tab. B1-3). This extraordinary dynamic development in the agglomeration belts is the reason for the less significant growth and stagnation in the Alpine metropolises.

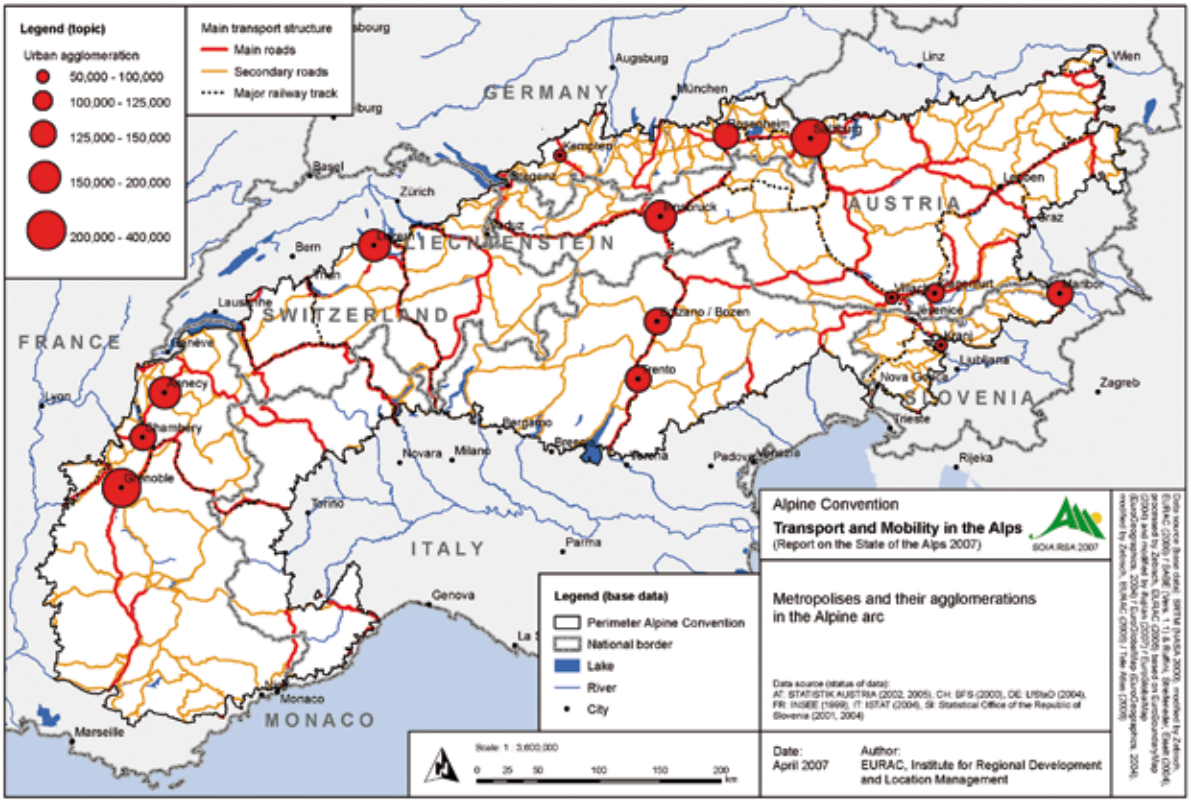
The urbanisation process has had an important impact on the spatial structure of land use in the Alpine arc. Centres with favourable local conditions have achieved a higher population growth and the establishment of new enterprises, as well as the strengthening of existing enterprises. And, as commuting plays a fundamental role in these areas, the transport infrastructure is of great importance.

Urbanisation in Pfronten / Germany (Photo: S. Marzelli).

Municipalities	State	Inhabitants 2000	Inhabitants 1990	Change [%]	Agglomeration 2000	Agglomeration 1990	Change [%]
Annecy	France	52,100	51,143	1.9	156,727	142,252	10.2
Chambéry	France	57,592	55,603	3.6	131,547	119,208	10.4
Grenoble	France	156,203	153,973	1.4	394,787	384,086	2.8
Bolzano/Bozen	Italy	97,236	98,158	**-0.9**	139,152	133,744	4.0
Trento	Italy	110,142	101,545	8.5	136,591	123,750	10.4
Klagenfurt	Austria	91,723	89,415	2.6	117,003	111,949	4.5
Innsbruck	Austria	115,498	118,112	**-2.2**	171,554	170,020	0.9
Salzburg (city)	Austria	142,662	143,978	**-0.9**	211,229	199,317	6.0
Villach	Austria	57,829	54,640	5.8	78,544	74,034	6.1
Maribor [1]	Slovenia	114,436	132,860	**-13.9**	127,931	134,742	-5.1
Kranj [1]	Slovenia	52,689	52,043	1.2	78,834	76,251	3.4
Luzern	Switzerland	59,904	61,034	**-1.9**	176,821	166,436	6.2
Kempten	Germany	61,576	61,906	**-0.5**	93,583	83,411	12.2
Rosenheim	Germany	60,108	56,340	6.7	145,345	120,508	20.6

Tab. B1-3: Overview of the growth of the Alpine metropolises (municipalities > 50,000 inhabitants) and their agglomerations in the Alpine Convention area. [Source: AT (Statistik Austria: Volkszählung 1991, 2001), DE (LfStaD: Bayerische Gemeinde- und Kreisstatistik Strukturdaten aus der Volkszählung 1987, Bevölkerungsstatistik 2000), IT (ISTAT: Censimento generale della popolazione 1991, 2001), SI (Statistical Office of the Republic of Slovenia: Population Census 1991, 2002), FR (INSEE: Recensement de la population 1990, 1999), MC (Gouvernement de Monaco: Recensement général de la population 2000 (incl. data of 1990)), LI (AVW: Volkszählung 1990, 2000), CH (FSO: Volkszählung 1990, 2000).]

[1] After achieving independence from the former Yugoslavia in 1991 a major reform of municipalities/municipality structure took place in Slovenia. For this reason the year 1996 has been selected as the reference year for this study.



Map B1-2: Metropolises and their agglomerations in the Alpine arc.

B1.2 Population density and area of permanent settlement

Population density

Population density is a basic indicator in evaluating the human pressure on space and in distinguishing between rural and urban areas (OECD 1994). Using this indicator it is possible to depict processes of agglomeration and urbanisation.

Throughout the whole Alpine Convention area the average density is 73 people per km² (see Tab. B1-1). Compared to the national values (e.g. Germany: 231.1 Inh./km², Italy: 197.1 Inh./km²; EUROSTAT 2004), the Alps are one of the less populated regions in Europe. In this analysis the Principality of Monaco was not considered as this city state has the highest population density worldwide, which is not representative of the situation in the Alps.

Map B1-3 shows the distribution of the population density in the Alpine Convention area which significantly reflects the topographical situation. Higher population densities occur along the Alpine fringe and the foothills of the Alps. Numerous small centres have developed there. Due to the favourable site conditions the settlement comes into conflict with agricultural land use.

Many commuters, who work outside the Alpine arc at a nearby agglomeration centre, live in these bordering municipalities (Bätzing 1998) or in the broad and easily accessible Alpine valleys. In these valleys, municipalities with high population densities are found along the main Alpine ridge (valleys of Rhine, Etsch, Inn and Aosta). There is also a high population density in the nearer vicinity of the large centres of the Alpine arc.

In contrast to the large intra-Alpine valleys the peripheral Alpine areas with poor accessibility are characterised by municipalities with low population density. These were found in areas close to the central mountain chain. This population pattern was observed in particular in the western parts of the Alps: Maritime Alps, Provencal Alps, Cottian Alps, Southern Dauphiné and Ticino Alps.

As already mentioned, topography plays a key role in analysing the reasons for the observed population density pattern in mountainous regions. Many parts of the Alps must be considered as unsuitable for human settlements. In Austria, for example, only 40% of the cadastral area can be considered as an area of permanent settlement (BMVIT 2002). To give a more realistic and comparable picture of the population density, the area of permanent settlement, as the most appropriate indicator, should be taken into account. If the area of permanent settlement is the basis of the calculation, this results in higher values for the population density of the Alpine regions. Some valleys even reach values similar to those in densely populated urban centres.

A closer look at the distribution of Alpine area according to different altitude levels reveals the interdependency of population density and permanently settled area. Large areas of the Alps are located in altitudes where no permanent settlement is possible any more (Fig. B1-1). The considerable differences between the two ways of calculating the population density are shown in Tab. B1-4. Of particular interest in this respect are the figures from German and Swiss Alpine regions, because they were available for the entire Alpine Convention area. Considering the area of permanent settlement and not the whole area in Germany, the population density in the Alpine Convention area has almost doubled. In Switzerland the density value raised seven times, assuming the area of permanent settlement. In general the intra-Alpine regions, Tirol, Vorarlberg and the Autonomous Province of Bolzano/Bozen, experience a multiple increase when relating the population to the permanently settled area.

Population density..

..is the average number of persons per unit of area for a certain territory. Normally it is specified as inhabitants per square kilometre. But the significance of the value is limited and may lead to false conclusions, particularly in mountain areas because normally this value does not take into account the geographical and ecological particularities (area for permanent settlements, glaciers, steep slopes, hazard zones etc.).

Area of permanent settlement..

..is the area which is inhabited or used continuously throughout the whole year (ASTAT 2004); in other words, where the majority of human activities is concentrated. This area includes intensively used agricultural areas, settlements and transport infrastructures, but does not include forests, pastures, bare rocks, wasteland and water surfaces.

Due to the requirements of the respective spatial planning, the relevant administrative and political definition of the area of permanent settlements differs in the individual countries.

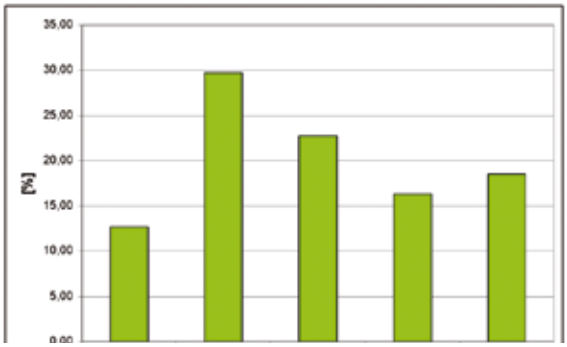
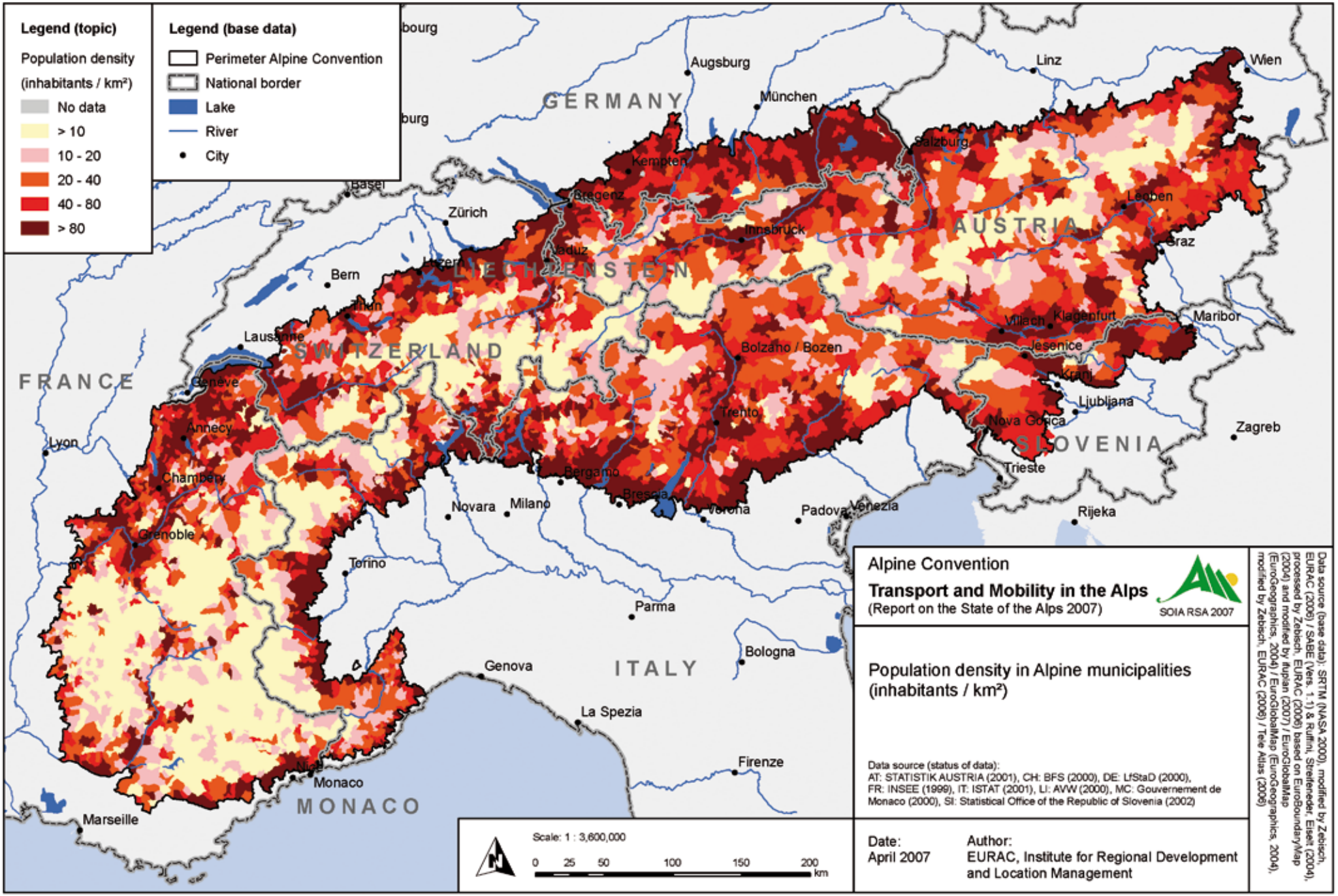


Fig. B1-1: Relative area distribution in the Alps at different altitudes (AMSL).

Map B1-3: Population density in Alpine municipalities (inhabitants per km²).



Region	Inhabitants (2005)	Area [km²]	Population density [inhabitants/km²]	Area of permanent settlement [km²]	Population density [inhabitants/km²]
1	2	3	2/3	4	2/4
Tirol	692,281	12,648	54.7	1,542	449.0
Vorarlberg	363,237	2,601	139.7	621	583.0
Salzburg*	524,400	7,154	73.3	1,540	340.5
Styria*	1,183,303	16,392	72.2	4,948	239.1
Germany – Area of the Alpine Convention	1,473,881	11,072	133.1	5,650	260.9
Autonomous Province of Bolzano/Bozen	477,067	7,400	64.5	612	779.5
Switzerland – Area of the Alpine Convention	1,827,754	24,862	73.5	3,475	525.8

Tab. B1-4: Population density in some Alpine regions [Source: Salzburg (Amt der Salzburger Landesregierung 2004), Vorarlberg (BMVIT 2005), Styria (Amt der Steirischen Landesregierung 2001), Tirol (Amt der Tiroler Landesregierung 2004), Bolzano/Bozen (Autonome Provinz Bozen-Südtirol 2004), DE (LfStaD 2004), CH (FSO 1985)].

* belongs partially to the AC area.

B1.3 Migration

For about 30 years the whole Alpine region registered a positive migration balance (Bätzing 1996 and 2003, Birkenhauer 2002). Since the 1980s the migration process has mainly been concentrated on the larger cities and their surroundings (Bähr 2004, Herfert 2001). This process concerns the cities within the Alpine arc as well as the large urban areas at the fringe of the Alps (Milano, München, Wien, Lyon) (Perlik 1998, Perlik & Debarbieux 2001).

As a consequence of the economic disparities between urban and rural areas and of the improved infrastructure services in the last decades, a rising internal migration within the Alps, comparable to non-mountainous regions, was recorded.

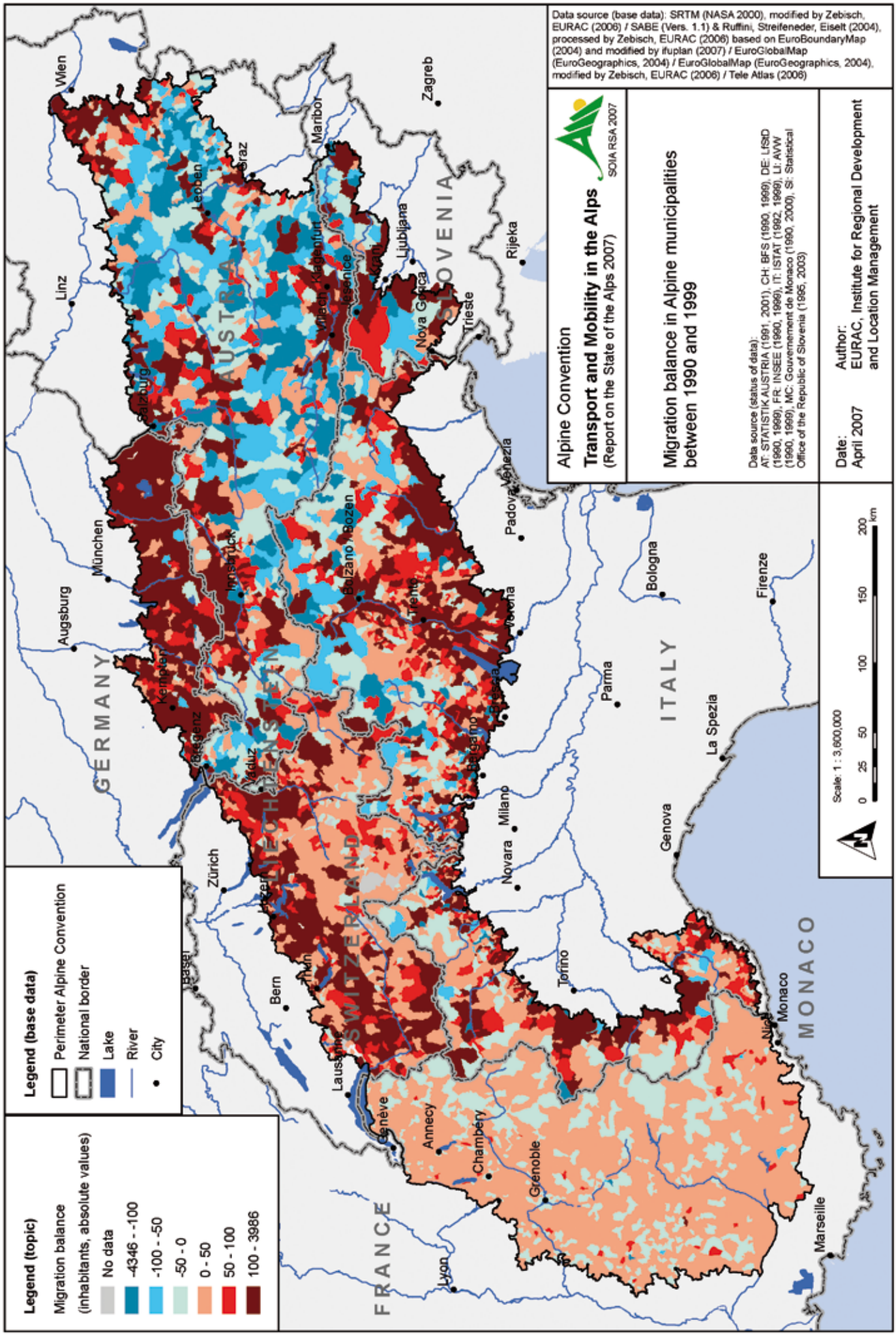
Periurbanisation and the development of commuter cities are restricted to favourable locations situated close to rural or urban centres. Accordingly the striking shift between peripheral areas and dynamic, booming centres has led to structural challenges concerning demographic, social and economical development as well as the regional volume of traffic (Perlik & Debarbieux 2001, Birkenhauer 2002).

Generally, the rural areas located close to the large cities at the Alpine fringe, especially in Switzerland and Bavaria at the northern border and all southern borders of the Alpine arc, have the highest positive migration balance. These locations are very attractive for working people (commuters). Moreover, these Alpine landscapes (Tirol, Oberbayern and surroundings of Alpine lakes) attract older people, who have chosen these locations for their retirement (StMWIVT 2004, INSEE 2001). In contrast to these attractive areas, certain peripheral Alpine regions close to the main Alpine chain with low population density and far from the large valleys suffer from population decrease (e.g. Italian Alps) (Varotto 2004).

The development of migration in the 1990s shows a relatively heterogeneous structure (Map B1-4). A more negative migration balance can be observed in the internal areas, while the areas near the borders have registered a positive migration rate.

In the French Alps there were only small changes and in comparison with other Alpine regions the migration rates turned out to be stable, as municipalities have few inhabitants and therefore can show low absolute but high relative changes.

While almost all municipalities in the German Alps show a high positive migration balance, many Austrian municipalities in most of the federal states suffer from population decrease. Following the significant restructuring of the local industries in Obersteiermark, the northern Alpine districts of Mürzzuschlag, Bruck an der Mur and Leoben were hit by a deep crisis (Regionalmanagement Obersteiermark Ost 2000). The district of Leoben, for example, had to face a population decrease of 15% between 1981 and 2001. Only those municipalities situated close to the larger cities of Innsbruck, Klagenfurt, Salzburg and Wien were not affected by the population decrease.



Map B1-4: The migration balance in Alpine municipalities between 1990 and 1999.

Main findings

Status

55.8% of the population is concentrated in small centres with 2,500 to 25,000 inhabitants. In 57.8% of the municipalities the population has increased between 1990 and 2000.

In the big urban centres the demographic development and periurbanisation are similar to those of the centres outside the Alpine arc.

The population density calculated considering the permanent settlement areas can be compared to that of the metropolises located outside the Alpine arc.

The migration balance is positive especially in the municipalities located at the northern German and Swiss border of the Alpine arc and in the southern border in the Adige Valley.

Trends

The Alpine arc is characterized by a dynamic but rather heterogeneous population growth.

The population growth in the Alpine Convention area is clearly higher than the EU-15 average.

Hot issues

Demographic development is not equally distributed over the Alpine arc (contrary to objectives of the Alpine Convention) and the heterogeneous distribution of factors such as economic growth, public service availability or life style makes a further polarisation of this effect likely.

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B2 The Alpine and European Economy

Transport and economic development are closely related in our modern and globalised world. The transport of people, goods, services and information in itself are some of the driving forces of globalisation. While accessibility contributes to economic development, economic aspects like economic growth, internal European market, consumer attitudes, comparative cost advantages, division of labour, sector structure in as well as outside the Alps also have a remarkable influence on the quantity and quality of traffic.

The direct economic advantages of a region based on transport are easy to define. There are direct economic effects where goods are being loaded and unloaded, sold or bought and where people get the opportunity to spend their money (Knoflacher 1998). Several Alpine regions, particularly those located along the most important passes and traffic-junctions, have profited from this strategic advantage. Thus they registered a significant economic upturn. As time becomes a minimum factor, passengers and the transport velocity are rising, while often traditional economic benefits for regions along transit corridors are diminishing. Consequently those transit regions which are situated along the international and national road networks can suffer from a rising traffic volume.

B2.1 Accessibility and economic development: a complex relationship

Rising traffic volume is not only the result of the development of enterprises and labour markets. The prosperity and welfare development of a region and of society as a whole also contribute to increasing traffic loads in the Alps (ASTRA 2004).

The transport system is able to directly affect the accessibility of a location and the spatial structure meaningfully. It influences the progressive separation of working and living environments as well as the site-selection of certain services. Furthermore, the access to mobility gives individuals the opportunity to fulfil their needs concerning shopping, working, lifestyle, leisure or entrepreneurial behaviour (distribution, production, storage).

In the framework of the European research project REGALP (5th EU Framework Research Program), the accessibility of NUTS-3 regions was analysed (cp. Fig. B2-1). This analysis is based on the accessibility of inhabitants as an indicator of different action opportunities or socioeconomic potential. The calculations were carried out considering the number of people who are accessible within the defined time-frame of one hour. The one-hour time limit is typical for daily commuting and shopping traffic. The one-hour-accessibility is thus

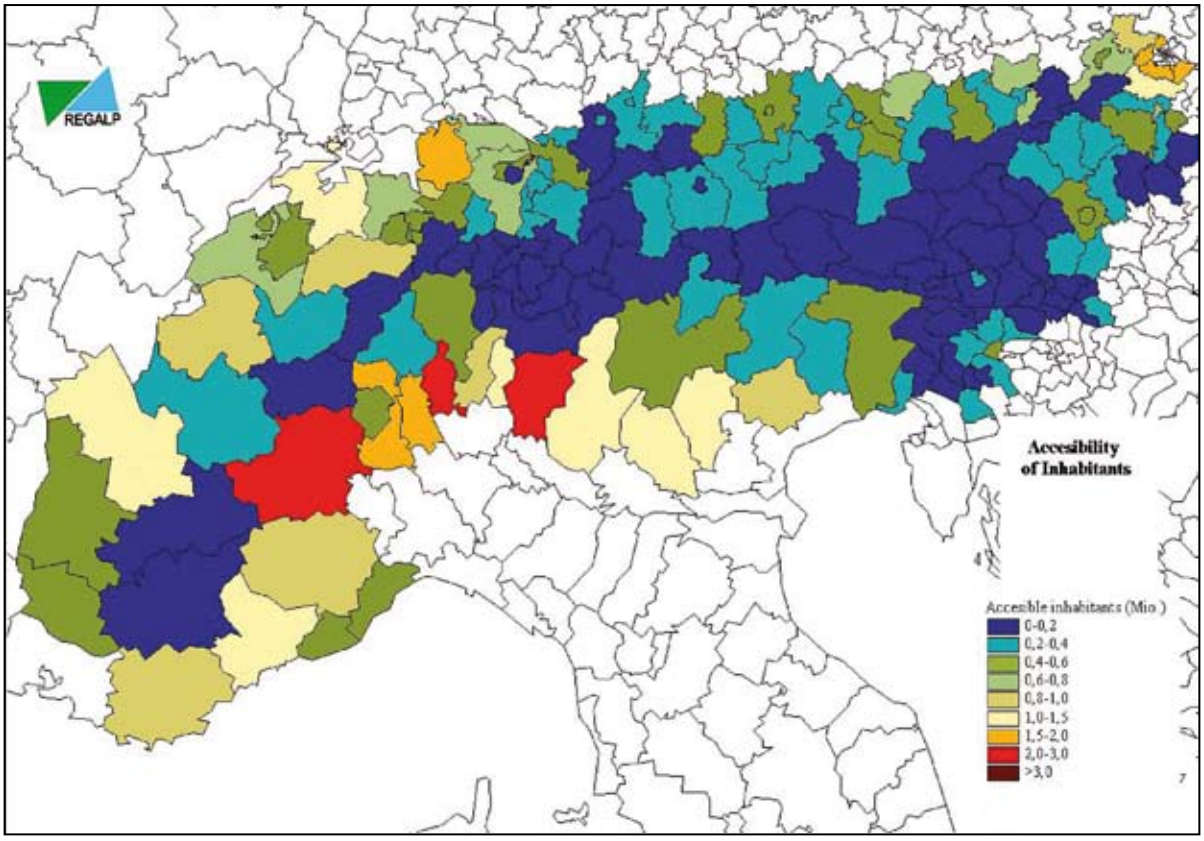


Fig. B2-1: The number of inhabitants accessible within the time-frame of one hour in the Alps (Favry & Pfefferkorn 2005).

calculated from the town which is the central node of a certain administration unit (NUTS-3) by considering all other central nodes that can be reached within one hour (Favry & Pfefferkorn 2005).

As expected the results confirm that the one-hour-accessibility is generally higher in Alpine border regions than in the inner areas of the Alps. In the eastern part of the Alps, accessibility is lower and much more homogenous than in the western part. The regions with the highest accessibility are in the southern Italian Alps, between Torino and Verona (Favry & Pfefferkorn 2005).

Without doubt, accessibility is an important location factor for achieving a dynamic economic development (ESPON 2006). It is a key indicator for the relationship between transport system, mobility and spatial structure. The spatial structure determines the distribution of activities in a specific area. Locations with a high accessibility are more attractive for economic investments (Ackermann et al. 2006). Regions located close to the main traffic axes make it easier for commuter traffic and short journeys. Because of their good accessibility it is obvious that these locations receive more economic investments than peripheral regions, which are not connected with a national or international transport net (Dieters et al. 2001).

Also for the Alpine arc, direct correlations between the regional level of accessibility and selected economic indicators have been observed (Pfefferkorn et al. 2005). Two main results were derivable from these correlations (see chap. B1):

- Mainly those areas with a reduced accessibility tend to be structurally weak regions. Consequently they are less competitive and are thus in danger of facing economic degradation and depopulation.
- In contrast, those areas with excellent accessibility – usually located along a national road network in longitudinal or transversal extended valleys – are places which feature a stable demographic development and economic growth. Additionally their bordering regions are predestined to attain prosperity, too.

However, good accessibility through the connection to the national traffic network alone does not guarantee economic success in a mountainous region (Favry et al. 2004). An improvement of the traffic network between weak regions and centres is thus not sufficient to mobilise the potential of structurally weak regions. In fact, in some cases an improved accessibility between prospering and weak areas may even lead to spatial polarisation and strong dependencies between centres and peripheries. Thus new infrastructures can give rise to new disparities among the regions and increase energy consumption. Furthermore remoteness can even become a success factor: tourist resorts profit from the reduced traffic-related noise and pollution.

B2.2 The economic progress in the Alpine arc

The Alpine arc is intensively integrated in the development and policies of the European Union. Its regions benefit from this in various ways. Currently the European development is characterised by an increasing functional and spatial division of labour. This facilitates higher productivity, efficient production and the necessity to access new markets. Consequently an increase of mobility is also taking place (Perlik 2005).

Increasing mobility is certainly one of the main reasons for the increased prosperity and for the social and cultural changes in Europe and in the Alps. Therefore a further increase of traffic will be expected, which will not only affect freight traffic (Prognos 2002, ARE 2004 and 2006).

Recent historic development

The industrial development of the Alpine arc was initiated rather late in comparison with other parts of Europe. Until the end of the 1970s, industrial production was the dominant sector in the Alps, with the highest share of employees. All urban and semi-urban areas experienced a high demographic and economic dynamic (Birkenhauer 2002). It was in the early 1980s all industrial regions were confronted with an economic crisis (Bätzing 2005).

In the course of globalisation, the industrial sector slightly lost its relevance for the Alpine economy. The share of employed people in the industrial sector is decreasing while in the service sector it has been rising since the 1980s. However, industrial production is still important in the Alps. In the early 2000s it accounted for about 36% of the working places (Perlik & Debarbieux 2001) with some regional variations, e.g. in the Autonomous Province of Bolzano, Tirol and in the Swiss Canton of Fribourg the employed in the industrial sector amounted to 26% (Office de Statistique 2004) while it accounted for 29% in Trentino (ASTAT 2005).

Considering the amount of GDP generated, some of the main drivers of economic growth (BAK 2005) are:

- the *urban sector*, which consists of services that fulfil everyday requirements such as commerce, hotels and restaurants, real estate, transport, financial services, etc. It generates the biggest part of the GDP in all Alpine regions and it is of minor importance only in the region of Bern, in Nordwestschweiz and in Ostschweiz,
- the *political sector*, which covers basically public administration, health care and education. It is very important in all Alpine Space regions, especially in the Bern area and in the French regions,
- the '*new' economy sector*, based on IT and telecommunications. It is rather marginal in the Alpine Space regions and concentrated in a few specialised regions such as Oberbayern, Rhône-Alpes and Provence-Alpes-Côte d´Azur,
- the *high value added 'old' economy sector* that includes the chemical-pharmaceutical industry, the automotive industry, medical engineering and the production of pre-

cision instruments, is developed above all in Nordwestschweiz while it is shrinking in the Italian Alpine regions, and

- the *traditional economic sector*, composed of food, textiles, refined petroleum products, metal products and construction, shows negative growth rates in many regions, except Slovenia.

A traditionally strong sector is the dairy industry (see subchap. B 2.6). Within the service sector, tourism plays a key role. Bätzing (2000) proved that the intensity of tourism is not distributed equally in the Alps. On an Alpine-wide scale, larger tourist areas are concentrated especially in the central part of the Alps (e.g. Province of Bolzano/Bozen, Salzburg, Tirol, Vorarlberg and Bayern). In many other Alpine regions, tourism is just appearing at selected locations (see chap. B4).

Table B2-1 shows the employees per sector within the NUTS-3 (aggregated on NUTS-2 level)[1] units which are part of the Alpine Convention area. In many parts of the Alps, the share of employees in the primary sector is higher than the national average. The Austrian regions in particular are strongly characterised by agriculture. In some Alpine regions the industrial sector still plays a relevant role. Industry is comparatively more important in the Italian regions of Lombardia and Veneto as well as in the Austrian regions of Vorarlberg and Oberösterreich.

Service sector

Generally the service sector is the dominating one (non-market and market services). Its importance, however, varies from one region to another. While 80% of the active population in the French region of Provence-Alpes-Côte d'Azur and 76% in the Italian region of Liguria are employed in services, almost half of the active population in the Austrian regions of Oberösterreich and Burgenland and in the Italian regions of Veneto and Lombardia work in this sector.

Transport sector

Considering the number of employees, the transport sector is another important branch in the Alps. Fig. B2-2 points out the employees in the transport sector in relation to all employees. The highest percentages were recorded along the European North-South axis in Tirol, Salzburg and Verona. This also applies to the western Alpine provinces of Torino, Aosta, Verbania-Cusio-Ossola.

Nowadays there are several modern poly-structured economic centres in which about 70% of the Alpine population are concentrated. The symbiosis of tourism, electric power generation, traffic, industry and agriculture is the basis of sound economic development. These regions, like Alto Adige/Südtirol, benefit from their diversified economic structure and thus they are able to attain high regional GDPs (see Map B2-1) (Birkenhauer 2002).

[1] It means that only NUTS-3 units that are at least partly included in the Alpine Convention perimeter have been aggregated. For instance, as for the NUTS-2 region Lombardia, only its NUTS-3 provinces of Bergamo, Brescia, Como, Lecco, Sondrio and Varese were included in the computation, while Milano, Pavia, Lodi, Mantova and Cremona were excluded because they are located entirely outside the Alpine Convention area.

Area (NUTS-2 unit)	Agriculture	Industry	Market and non-market* services
Austria	5.5	27.5	66.9
Burgenland	25.0	21.6	53.4
Steiermark	20.0	24.2	55.7
Oberösterreich	16.8	35.7	47.5
Niederösterreich	14.1	24.6	61.3
Kärnten	14.0	19.8	66.2
Tirol	13.3	22.4	64.2
Salzburg	11.0	20.9	68.1
Vorarlberg	6.6	30.9	62.5
France	3.8	24.3	71.9
Provence-Alpes-Côte d'Azur	3.3	16.6	80.1
Rhône-Alpes	2.6	27.7	69.8
Germany	2.4	29.8	67.8
Schwaben	4.4	30.5	65.1
Oberbayern	4.4	28.3	67.3
Italy	4.2	30.8	65.0
Provincia Autonoma di Bolzano/Bozen	8.2	25.1	74.8
Provincia Autonoma di Trento	6.4	28.4	65.2
Liguria	6.3	17.9	75.8
Valle d'Aosta	5.1	23.8	71.1
Friuli Venezia Giulia	3.9	33.4	62.7
Veneto	3.9	43.3	52.8
Piemonte	3.0	33.8	63.2
Lombardia	1.6	44.1	54.3
Slovenia	9.1	37.1	53.9
Slovenian AC area	9.5	35.6	54.9
Switzerland	4.0	23.0	73.0

Tab. B2-1: Share of employed persons aged 15 and over by economic activity 2005: comparison between national values and the respective aggregations at NUTS-2 level of NUTS-3 units partly included in the Alpine Convention area (EUROSTAT 2006).

* Market services: wholesale and retail trade, repair of motor vehicles, motorcycles and personal and household goods; hotels and restaurants; transport, storage and communication, financial intermediation; real estate, renting and business activities; Non-market services: public administration and defence, compulsory social security; education; health and social work; other community, social and personal service activities; private households with employed persons; extra-territorial organisations and bodies.

Two thirds of the goods that are transported on the roads of the Alpine arc are not bulk products but products with a high added value such as manufactured and half-manufactured goods, chemical products (mainly pharmaceuticals) and food (Ickert 2006). This high added value makes transport time expensive (the longer goods are in transit, the more revenue is lost due to foregone interest) and a crucial factor that has to be minimised. Therefore it is not surprising that in many Alpine regions production is mainly concentrated in the large and easily accessible centres or valleys, which are mostly located at the fringes of the Alps. Only individual industrial plants are situated in remote locations (Pfefferkorn

et al. 2005). Areas with better access to locations of source materials and markets are generally more productive, more competitive and more successful than remote areas.

Agricultural sector

The analysis shows that for several reasons (e.g. economic factors, cultural and social importance, conservation of the landscape) the agricultural sector is still important (see sub-chap. B.2.6). However, also in mountain areas more and more people work in non-primary sectors (Buchli & Kopainsky 2005). Furthermore, the Alpine arc shows a trend towards higher rates of employment in the tertiary sector. This development, which is comparable with the trend in the rest of Europe, inevitable influences the quality and the quantity of traffic.

With increasing values and decreasing weight of transported goods, the quality of traffic in terms of reliability and flexibility becomes more important than the costs. Furthermore in certain cases telecommunications replace transport thus can help to limit transport volume. On the other side they can also be the source of new traffic.

Also, "soft" factors (e.g. quality of life, leisure, culture and environment, services) tend to become more important than the traditional "hard" factors (payment, infrastructures) when considering the site conditions for setting up new enterprises with a high-quality labour force.

B2.3 Disparities in economic development

Economic performance is normally measured by Gross Domestic Product (GDP, see box)[2]. As with many other national-economic indicators, this aggregated value is restricted to a given administrative unit. In this analysis the considered GDP data was only available for the entire NUTS-3 regions (provinces). It has to be kept in mind that for some regions these data only partly reflect the situation within the Alpine Convention area. Hence it was not possible to restrict the analysis just to the Alpine Convention area. In fact, the economic disparities limited to the Alpine arc could not be detected as the economically vital areas are bordering the perimeter of the Alpine Convention and are part of the Alpine NUTS-3 level (e.g. cities of Torino, Verona, Bergamo, Brescia).

However, the distribution of the per-capita GDP in the Alpine arc on NUTS-3 level (Map B2-1) depicts significant disparities between the central parts and the eastern and western foothills of the Alpine arc and also within the same country. Interestingly, the southern foothills in Italy are generally characterised by a quite high per-capita GDP. Considering the aforementioned, these NUTS-3 regions that only partly cover the perimeter of the Alpine Convention territory attain one of the highest values (Tab. B2-2). A similar phenomenon

[2] For Switzerland the GDP is not available at cantonal level. Therefore national income has been used as proxy of GDP.

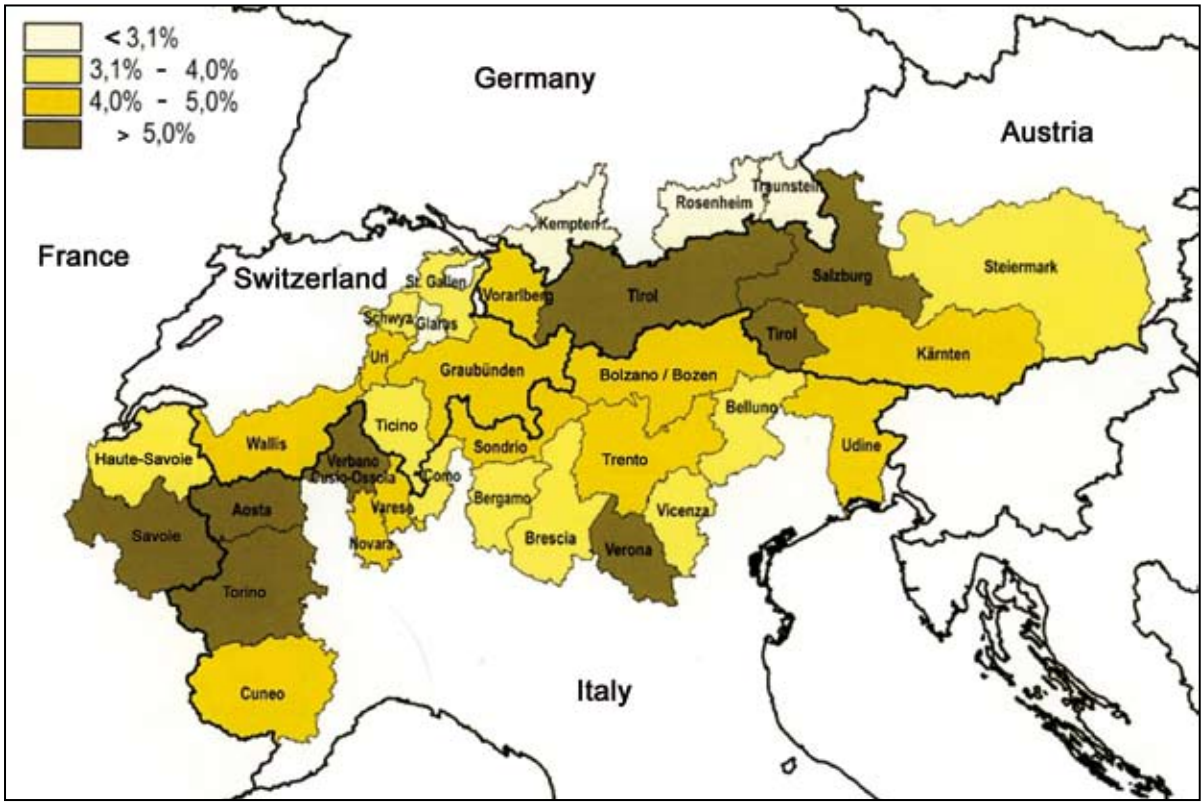


Fig. B2-2: The relation of employees in the transport sector to all employees (Source: Wirtschaftsforschungsinstitut Bolzano 2004).

can be observed at the northern Alpine fringes (Germany, Switzerland). The respective regions of Oberbayern and the cantons of Glarus, Nidwalden as well as Salzburg and Liechtenstein are attaining minimum average per-capita GDPs above 30,000 EUR.

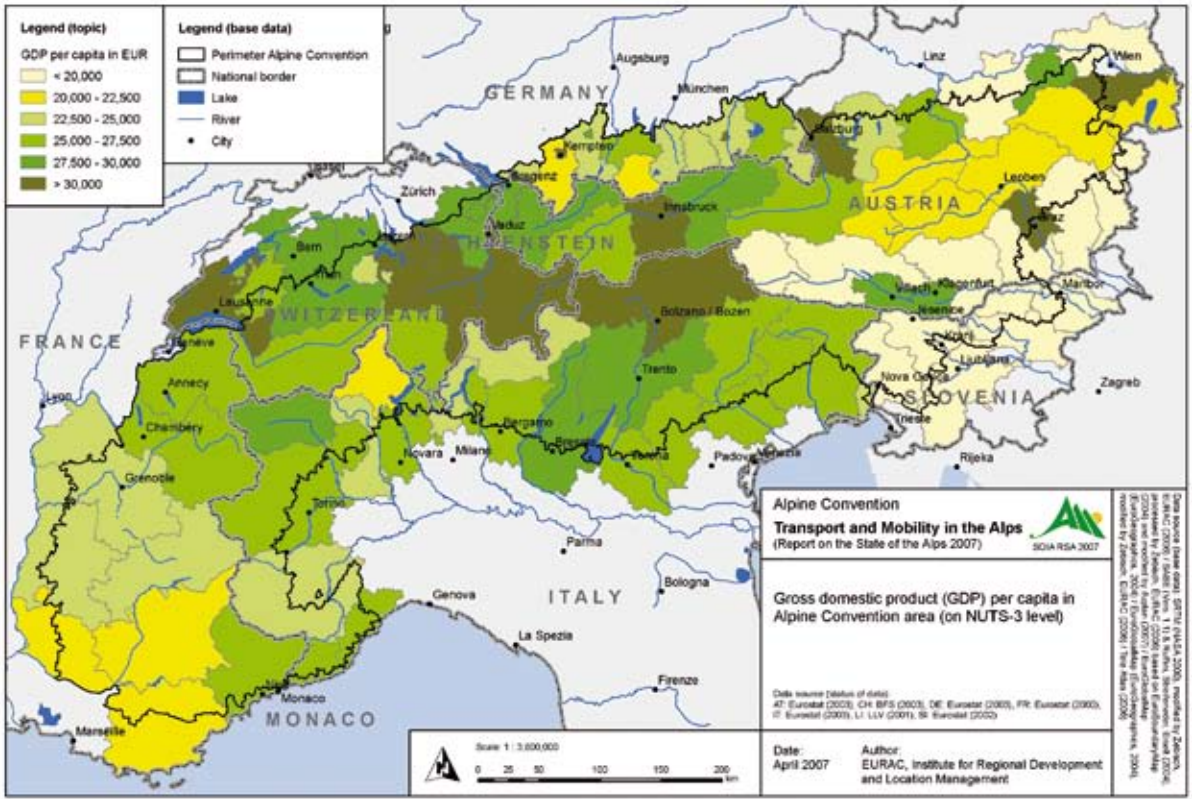
Besides the absolute values, Tab. B2-2 also highlights those regions with the highest per-capita GDP in the Alpine arc. With a per-capita GDP of over 80,000 EUR, Liechtenstein represents one of the richest regions worldwide. The NUTS-3 regions Kempten, Rosenheim (both Germany), Glarus, Nidwalden, Waadt (all Switzerland) and Salzburg (Austria), are attaining higher GDPs than the national averages. As Map B2-1 and Fig. B2-3 shows, there are also significant disparities in the per-capita GDP within the same country: the per-capita GDP of the Autonomous Province of Bolzano-Bozen[3] (34,395 EUR) is significantly higher than that of Verbano-Cusio-Ossola (22,000 EUR). The same phenomena can be observed in the case of Salzburg and surroundings (33,972 EUR) in comparison with the per-capita GDP of Südburgenland (16,271 EUR) and the one of Kempten (38,580 EUR) in comparison with the one of Oberallgäu (20,854 EUR). Despite the wide disparities between and within the regions of the Alpine countries, the average per-capita GDP of the Alpine Convention is slightly higher than the European average. However, the national average per-capita GDP is higher in every (except Italy and Slovenia) than the average per-capita GDP country of the Alpine region.

Gross Domestic Product (GDP) and per-capita GDP

The GDP is equivalent to the market value of all final products and services (without double counting products used in other outputs) produced within a certain country or region over a specific time period, usually one year. It is a very important indicator measuring economic performance. Within the EU's Lisbon Growth and Jobs Strategy this indicator plays a key role. This is also the case when evaluating the effective economic convergence within Europe's Member States in the context of a policy with the objective of balancing economic differences (EUROSTAT 2006b).

Per-capita GDP is calculated by dividing GDP for a given year by the total registered population in that year. It is a proxy for the prosperity of the resident population.

[3] A recently published news release of EUROSTAT (2006) places the Autonomous Province of Bolzano/Bozen in the 8th position in the European ranking of the NUTS-2 regions with the highest per-capita income.



Map B2-1: Gross domestic product (GDP) per capita in the Alpine Convention area (on NUTS-3 level).

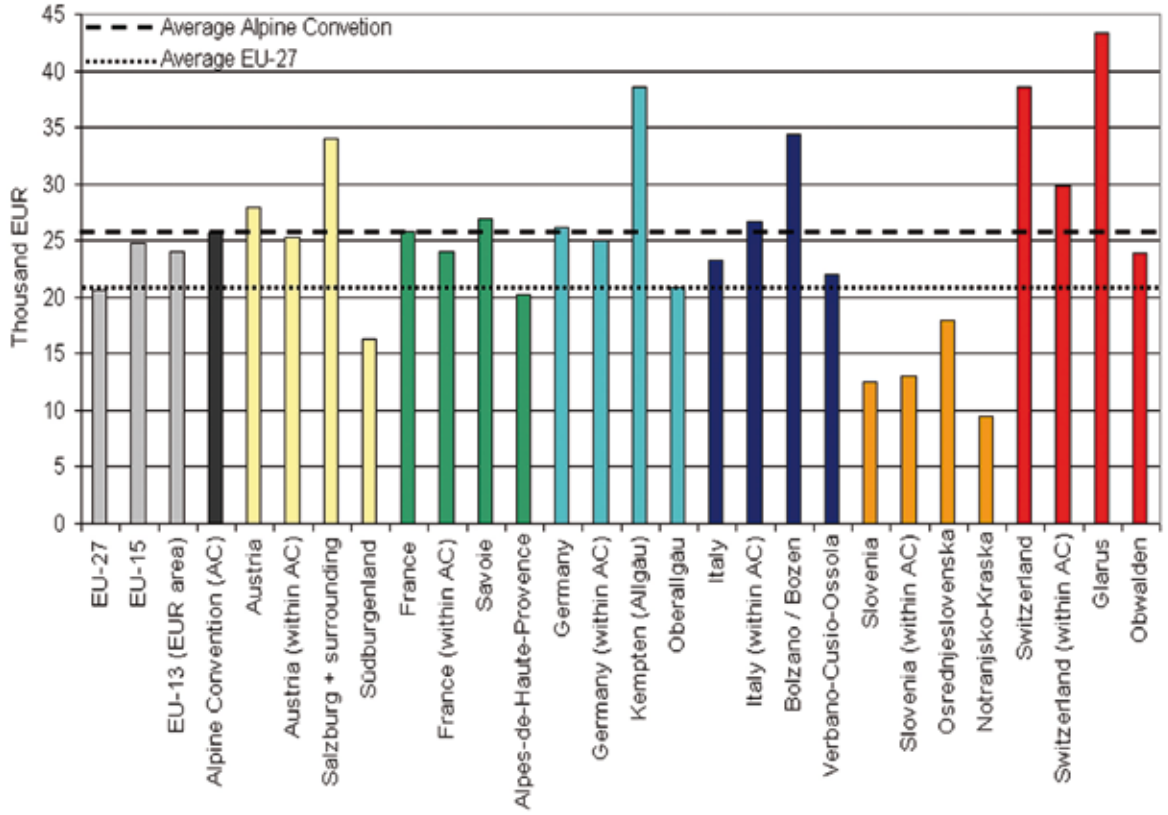


Fig. B2-3: Per capita Gross Domestic Product (GDP) of selected regions in the Alpine Convention area (Source: See Map B2 -1; Liechtenstein was not included in the graph as with its per-capita GDP of 83,610 EUR it constitutes an outlier).

NUTS-3	Share of region within AC area (%)	GDP for the whole NUTS-3 level area (Mio EUR)	NUTS-3	Share of region within AC area (%)	GDP/capita for the whole NUTS-3 level area (EUR)
Torino (IT)	61	59,811	Liechtenstein	100	83,610
Brescia (IT)	59	31,474	Glarus (CH)	100	43,556
Bern (CH)	53	27,957	Nidwalden (CH)	100	41,941
Isère (FR)	67	27,812	Kempten (Allgäu), Kreisfreie Stadt (DE)	100	38,580
Alpes-Maritimes (FR)	90	26,859	Rosenheim, Kreisfreie Stadt (DE)	100	35,533
Bergamo (IT)	70	26,380	Waadt (CH)	22	34,762
Waadt (CH)	22	22,543	Salzburg und Umgebung (AT)	78	33,798
Verona (IT)	29	22,202	Graz (AT)	57	33,085
Vicenza (IT)	54	21,895	Schwyz (CH)	100	31,622
Varese (IT)	38	21,097	Wiener Umland/Südteil (AT)	28	31,475

Tab. B2-2: The ten regions with the highest Gross Domestic Product (GDP) in the Alpine Convention area. [Source: France (Eurostat, 2000); Liechtenstein (Landesverwaltung Liechtenstein 2001, http://www.llv.li/pdf-llv-avw-statistik-fliz-07-2005-national_economy); Slovenia (Eurostat, 2002); Austria (Eurostat, 2003); Germany (Eurostat, 2003); Italy (Eurostat, 2003); Switzerland (BFS, Volkswirtschaftliche Gesamtrechnung und die Volkswirtschaft, 2003), Monaco (Central Intelligence Agency, 2006, https://www.cia.gov/cia/publications/factbook/index.html). For Switzerland national income has been used as proxy of GDP.]

NUTS-3	Share of region within AC area (%)	GDP for the whole NUTS-3 area (Mio EUR)	NUTS-3	Share of region within AC area (%)	GDP/ capita for the whole NUTS-3 area (EUR)
Appenzell I.Rh. (CH)	100	423.9	Notranjsko-kraska (SI)	10	9,515
Lungau (AT)	100	452.3	Koroska (SI)	100	9,708
Notranjsko-kraska (SI)	10	483.9	Podravska (SI)	26	10,366
Mittelburgenland (AT)	23	702.4	Gorenjska (SI)	88	10,826
Koroska (SI)	100	717.4	Savinjska (SI)	30	11,072
Obwalden (CH)	100	790.3	Goriska (SI)	89	11,870
Außerfern (AT)	100	920.2	Südburgenland (AT)	14	16,150
Osttirol (AT)	100	978.0	Oststeiermark (AT)	41	17,809
Uri (CH)	100	1,073.3	Osrednjeslovenska (SI)	17	17,928
Kaufbeuren, Kreisfreie Stadt (DE)	100	1,194.4	Mittelburgenland	23	18,049

Tab. B2-3: The ten regions with the lowest Gross Domestic Product (GDP) in the Alpine Convention area. [Source: France (Eurostat 2000); Liechtenstein (Landesverwaltung Liechtenstein 2001, http://www.llv.li/pdf-llv-avw-statistik-fliz-07-2005-national_economy); Slovenia (Eurostat 2002); Austria (Eurostat 2003); Germany (Eurostat 2003); Italy (Eurostat 2003); Switzerland (Swiss Federal Statistical Office 2003), Monaco (Central Intelligence Agency 2006, https://www.cia.gov/cia/publications/factbook/index.html). For Switzerland national income has been used as proxy of GDP.]

Tab. B2-3 lists those regions with relatively low GDPs and per-capita GDPs on NUTS-3 level (e.g. in Slovenia). The lowest Alpine-wide GDP is marked by the sparsely populated cantons of Appenzell/CH. Lungau, another sparsely populated Austrian region, is next. Seven of the ten regions of the Alpine arc with the lowest per-capita GDP are located in Slovenia.

The average annual growth rate of the real GDP within the total Alpine area attained an increase of 1.5% during 1990 and 2003 (BAK 2005). This economic growth is not equally distributed among the regions of the Alpine arc (Fig. B2-4). It has been particularly strong in Austria, while the Swiss cantons have been affected by the generally low national growth rate of Switzerland. The Alpine regions of Slovenia always achieved average growth rates, even if the reference period was extended. Slovenia's annual growth rate, however, has always ranked among Europe's leading regions since 1996 (BAK 2005) and will make up for what it lags behind the EU average economic condition in due time.

The detected economic trend was also reflected significantly in the labour market. The analysis proved the expected relationship between economically weak regions with a low GDP and regions facing high unemployment. The distribution of the unemployment rates confirms a concentration of economic welfare close to the well-developed and easily accessible intra-Alpine areas.

A clear demarcation between the Alpine fringe and the Alpine centres is observable (Map B2-2): the regions with the highest unemployment rates are situated on the peripheral western and eastern fringes of the Alps, while those with moderate rates are located in the central parts of the Alps.

Recent developments show that Alpine cities maintain close economic interrelationships with adjacent perialpine metropolises (e.g. München, Milano, Torino) (Perlik & Debarbieux 2001; BFS 1997). In this context the aspect of "commuters" becomes relevant. Particularly, the regions along Italy's Alpine foothills such as Verona, Bergamo, Brescia, Torino, and Udine as well as the areas close to Wien, Graz, Linz, Bern, Maribor, Ljubljana, and München are facing this changed demand (Perlik & Debarbieux 2001). The dynamic development outside the Alpine fringe (where cities become increasingly important for labour and commercial opportunities) accentuates the gap with the peripheral regions within the alpine fringe, where conditions for economic development are less favourable.

The unemployment rate in the Alpine arc amounted to almost 6% in 2003 (BAK 2005) and is lower than the average value of the EU-15 which amounted to 8% in the same year (EUROSTAT 2004). It varies regional between 14.2% in Podravska/Slovenia and 1.2% in the Swiss Canton of Uri. 13 NUTS-3 regions out of 99 are attaining an unemployment rate below the 3% threshold. Besides eight Swiss cantons and Liechtenstein also four Italian provinces (Cuneo, Bolzano, Lecco, Belluno) are below that threshold.

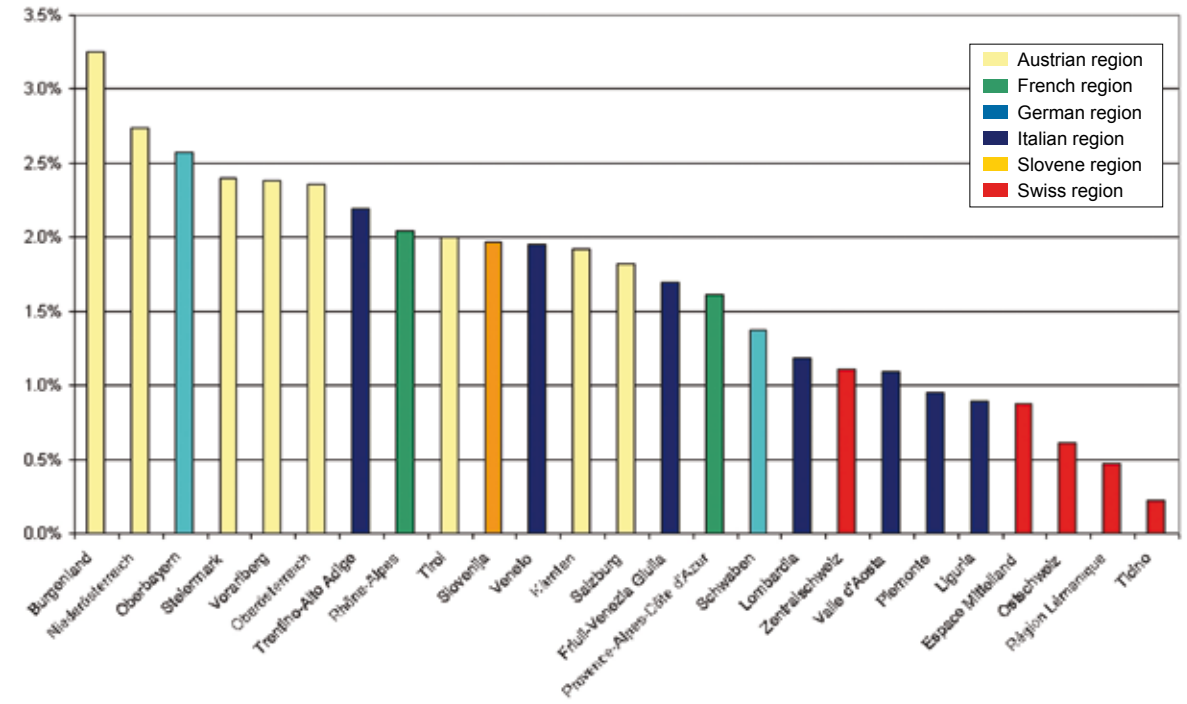
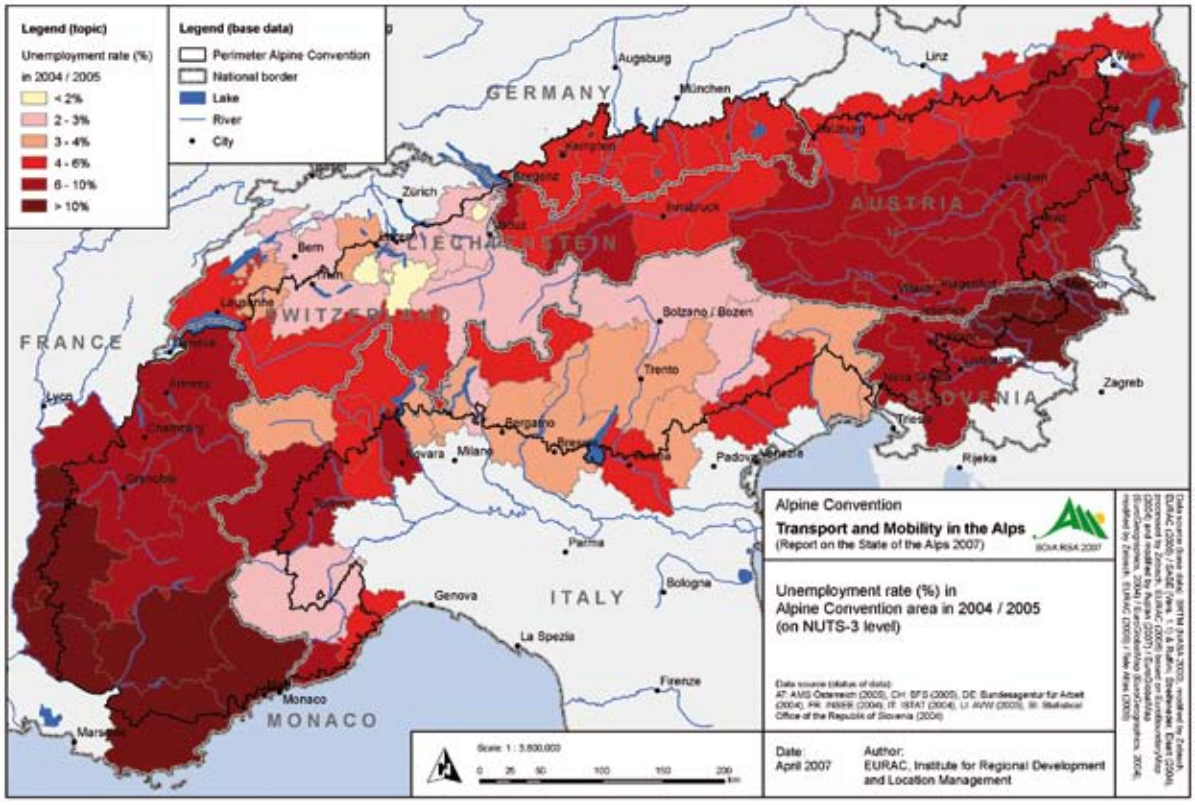


Fig. B2-4: Growth of real GDP in the regions of the Alpine arc (Source: BAK 2005). 1990-2003, annual average growth rate based on EUR 1995 prices and 1997 Purchasing Power Parity.



Map B2-2: Unemployment rate in the Alpine Convention area in 2004/2005 (on NUTS-3 level)*.

* The relatively high rate of unemployment of Austrian Tirol is probably due to seasonal variations caused by tourism and the reason is probably the same for the Berchtesgaden area. The Rosenheim area has one of the highest unemployment rates in Oberbayern.

B2.4 The situation of agriculture

Role of accessibility for agriculture

A good transport network for goods as well as easy accessibility to wholesale and processing enterprises is elemental for agriculture to function. The need to supply markets with fresh products as well as the broad range of production factors (e.g. machines, fertilisers etc.) necessary in modern agriculture makes this obvious. Although products from Alpine agriculture can hardly compete with those of the lowlands in terms of quantity, improvements in transport can help to reduce the gap, making the former cheaper and thus more competitive.

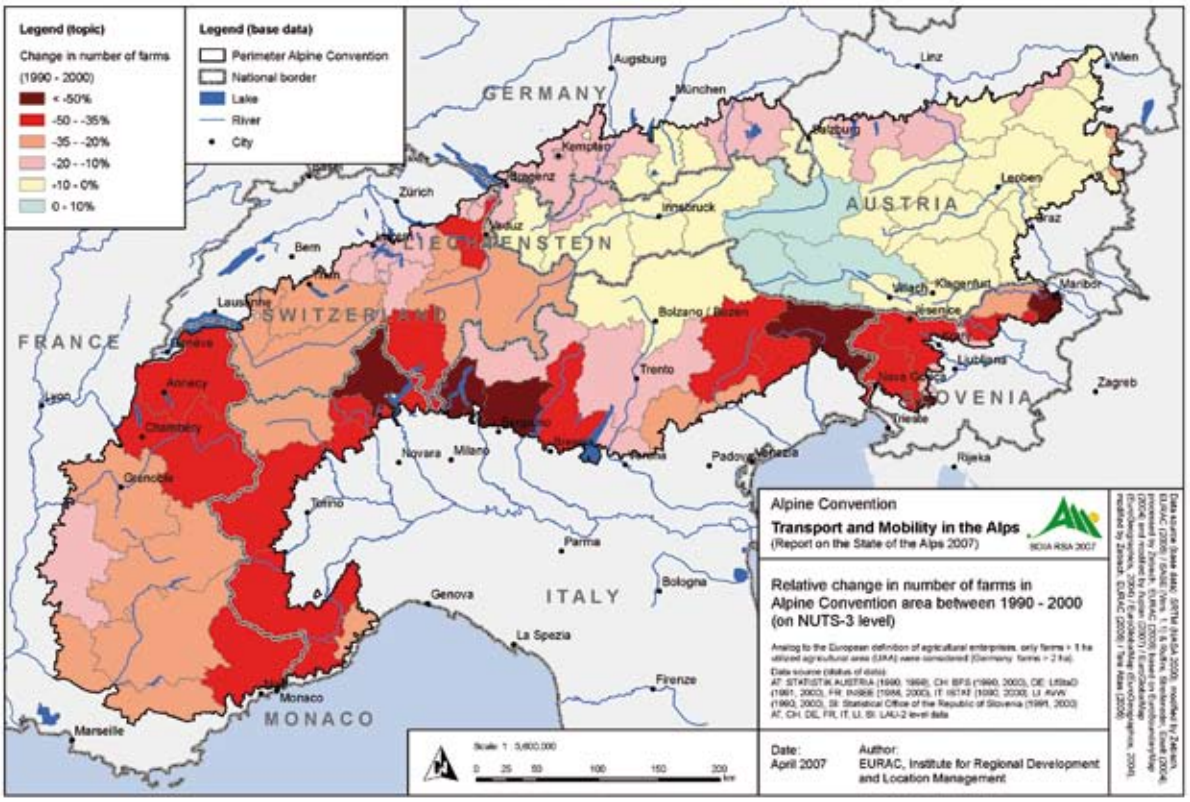
Another important aspect concerns the relationship between accessibility and the time-management of farms. Even if several studies of the Alps show that there is no general relationship between accessibility, agricultural intensity (e.g. livestock density) and type of operation (regular or sideline basis), other experts are convinced that there is a concentration of part-time farming in regions where there is good access to the local road network as they have better access to non-agricultural employment opportunities (UBA 2005). This may contribute to sustaining agricultural activity. Without doubt a good accessibility leads to operational advantages. However, the development of agricultural structures is driven by a complex system of different regional economic conditions (Schweizer Berghilfe 2000).

Structural changes in agriculture

Due to the high share of land under agricultural and forest use and their multifunctional services (e.g. preservation of the cultural landscape) within the Alpine bow, the primary sector is of particular importance. However, the structure of agriculture has largely changed in the Alpine Convention area over the last decades. Larger structural changes have seen an increasing number of farms throughout the Alpine area, with part-time farming and an increasing farm size (EURAC 2006).

These changes, however, are in line with the developments outside the Alps: because of the income gap between farming and non-farming activities, more and more farms are being reorganised to become farms with part-time farming. In general, only very large farms are still managed full-time. The reasons for this development are various and depend on local, regional, national and international economic and policy processes (Krausmann et al. 2003; Mann 2003; Weiss 2006).

The change in farms between 1990 and 2000 (see Map B2-3) shows regions with a relatively stable or moderate agricultural change such as Alto Adige/Südtirol, Central Switzerland and the German Alps, which stand out distinctly from the regions with a strong decrease in agriculture of more than 40%, particularly in the Italian Alps (EURAC 2006). In most cases this is due to the lack of possible successors and heirs who left to look for alternative employment opportuni-



Map B2-3: Relative change in the number of farms in Alpine Convention area between 1990 and 2000 (on NUTS-3 level).

ties in other sectors (Baur 2000; Buchli et al. 2002; Schmitt & Burose 1995). Land use changed with a clear tendency towards intensification in favourable areas and extensification or even abandonment in disadvantaged areas (Tappeiner et al. 2003; Taillefumier & Piégay 2003). These changes may endanger the balance of the mountainous environment and the vitality of life in rural areas (Piorr 2003; Hietala-Koivu 2002; Perner & Malt 2003; Varotto 2004; Varotto & Psenner 2003).

Main findings

Status

The Alpine Space is one of the most competitive areas in Europe. Interestingly, this is particularly the case for regions located in the central part of the Alpine arc, while the eastern and western fringes display rather low per capita GDP. Even without the outlier Liechtenstein, data on per capita GDP reveal the polarisation within the Alpine bow. Regions with the highest and regions with the lowest per capita income differ by a factor of five. Not surprisingly, regions with lower GDP also show an above-average level of unemployment.

Development within the Alpine arc is influenced to a high degree by the division of labour, the establishment of the European common market and other processes that take place across the whole of Europe, which is why the transport sector cannot be assessed without considering the development taking place beyond the Alpine region.

Trends

In terms of economic sectors, the Alpine primary and secondary sector are losing shares, while the tertiary sector with market and non-market services is increasing in importance. The volume of transported high-value goods is increasing and consequently, the quality of transport in terms of punctuality and reliability become more important than transport costs themselves.

The structural change of agriculture is continuously progressing. In the Italian Alps an outstandingly high level of change was registered. Data reveal that in regions with a high share of part-time farming, good accessibility can help to sustain farming.

Hot issues

Good accessibility is an expression of a favourable site condition, which is of great importance for regional development. At the same time it becomes obvious that the vitality of a region does not depend only on accessibility.

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B3 The Change in Land Use

Land use and its change are indicators of spatial development trends. Spatial structures and development have an influence on land use and vice versa. Therefore land-use change is closely connected to the development of transport needs and infrastructure.

This chapter describes the present situation of land use and how it has changed from the mid-1990s to around 2003 in the Alpine arc. The focus is on the three land-use classes of forest area, agricultural area, and settlement including traffic infrastructure. The area shares of these classes are depicted on different levels: following an overview at national level the regional differences are displayed at NUTS-2 and NUTS-3 level.

B3.1 Spatial development processes in the Alps

The change in land use in the Alpine arc is evident in two main trends: some regions – mainly the large valleys and basins with urban centres – show a dynamic development, with a high and fast-growing population density (see chap.B1), and a large and growing share of built-up area. Agricultural landscapes are transformed into periurban settlements and transport facilities are concentrated in these areas. An important network of roads and railways connects them. In contrast, other regions show strong trends towards marginalisation, with decreasing population and abandonment of agriculture, leading to afforestation, in a continuous cycle. In some cases strong tourism activity or the influence of conurbations bordering the Alpine Convention area may change this pattern, but in general a concentration process of people and infrastructure is continuing.

Land use and transport infrastructure – a close relation

The change in land use is often initially seen as a secondary effect of the development of transport infrastructure and settlement activities. Transport and settlements are necessary requirements to support the life of the local population. The development of transport infrastructure uses area resources directly, but indirectly it also leads to changes in land use through changes in accessibility and income possibilities. On the other hand, land-use changes also influence the need for infrastructure development. Growing settlement areas and periurbanisation of large areas require good transport facilities and high degrees of mobility and thus accelerate the land-take process.

Economic and population growth are important links between the development processes of transport and land use:

- When the population grows, there will be an increasing need for transport and for mobility (cp. chap. B1). Where good accessibility to goods, services, workplaces and other facilities is provided, population numbers will probably increase. Thus good transport infrastructure can lead to a prosperous region.
- Nevertheless there is also the potential for a draining effect towards central regions, because people can easily move away from their remote and marginal location. A spatial separation between housing and business / working areas can take place, producing commuter traffic, often combined with environmental and social problems.

The direction of these possible effects is steered by the amount of different needs, which can be satisfied at local or intra-regional basis, which defines quality of life and the attractiveness of a region. Any attempt to influence the processes of transport and land use has to take into account the different aspects of economics, welfare, resource management, and life quality. Successful management will be possible only with an integrated approach to regional development.

Land use and accessibility

Two accumulating effects form the impact of transport infrastructure on land use:

- A direct effect is the land take. The actual area of the line-shaped features may be not the most important indicator. The effects of noise, pollution and fragmentation influence a much larger area than the actual space covered. The special topographic situation in the Alpine valleys, where the roads and railroad lines are usually concentrated and situated close to populated areas, increases the impact on the environment and people.
- A second effect on land use results indirectly from the development of the transport infrastructure: improved accessibility (see subchap. B2.2) offers new possibilities for business activities, better supplies for needs and easier market access. Depending on different factors this can lead to periurbanisation (see subchap. B1.2.2) of rural areas but also to marginalisation and depopulation.

Accessibility (for a definition see Introduction part A) is an important factor in the development of urban and peripheral regions. Opposite trends of economic, structural and land use evolution are indicators for these development types. The level of accessibility is determined in turn by the type of transport infrastructure as well as by the distance that has to be travelled to supply the needs of the population.

Land use is connected to accessibility through the potential added value of the kind of land use:

- Highly profitable types of land use (i.e. settlement, containing housing areas, business, industrial production, but also tourist centres and others) can support the lives of many people. The population density generated by this development requires increasing transport facilities and easy accessibility of goods and services.
- In contrast, extensive land-use forms like forestry require large areas to make a living and thus support only low population densities. In consequence the infrastructure density required by this type of land use and its accessibility often remains low.

In this sense land-use change is a driver for development in traffic and transport: employment and productivity migrates from rural areas towards urban areas, with, in consequence, an increase in commuting or even abandonment of rural areas. A decreasing share of subsistence and local/regional economic relations increases the need for transport.

Linked with land-use change are the effects of the loss of natural habitat, the loss of productive agricultural areas, fragmentation, the loss of land to roads and buildings, and a change in the appearance of the landscape.

As the currently available data describe local situations, this data can only be linked with local traffic phenomena. Transit traffic hardly influences land-use change and therefore cannot be analysed.

Indicators used

Indicators used for the change of land use are:

B6-1 Settlement and traffic area,
B3-5 Cultivated land, and
B4-1 Forest area.

Data sources

The data used were provided via the Permanent Secretariat of the Alpine Convention from national statistical offices and contain statistics on agriculture (A), forestry (F), settlement and infrastructure (S):

Austria	*Cadastral data from UBA (A, F, S)*
Switzerland	*Areal statistics (A, F, S)*
Germany	*Areal statistics (A, F, S)*
Liechtenstein	*Areal statistics (A, F, S)*
France	*Corine landcover (F;S); Agriculture statistics (A)*
Italy	*Forest statistics (F); National statistics (A)*
Slovenia	*Landsat Satellite data (A, F, S)*

More details on the data are provided in Annex B3.

It is known, that area statistics derived from Corine Landcover data are inaccurate in particular for settlement and infrastructure values, as areas of less than 25 hectares are not identified as a separate area class. This different data quality leads to restricted comparability between countries.

B3.2 Development of areas for settlement and transport infrastructure at national level

The countries which to date have provided data on the area of settlement have collected and aggregated this data in different spatial resolutions. Summed up according to the national level, considering the area of the Alpine Convention only, there is an increase in settlement area of between 0.47% per year in France and 1.29% in Switzerland and Liechtenstein and 1.32% per year in Germany.

These mean values are based on different lengths of the period under review. In Fig. B3-1 the change is given relative to the settlement area in the first year of observation. Thus the different time period of observations becomes obvious. The remarkably low increase in France is partly due to the methodological limitations of data sampling from Corine Landcover data (see textbox on indicators).

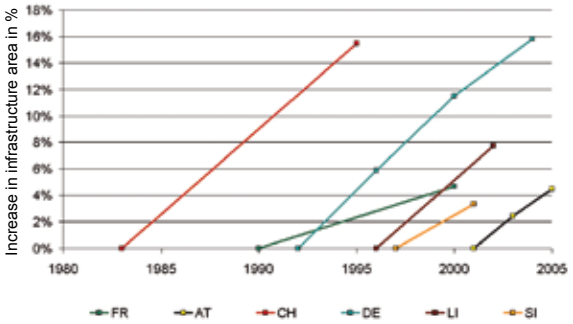


Fig. B3-1: Relative change in settlement and traffic infrastructure area (Source: National Statistics see Annex B3).

Special aspects in the Alps – the area of permanent settlement

The area of permanent settlement (PSA) is a concept to better consider land suitable for human settlement in order of altitude, slope aspect and other constraints. This is of great importance in the Alpine area as here natural constraints play a major role compared with the lowlands. The definition of PSA is given in subchap. B1.2.3. In Alpine municipalities the PSA is often only about 20% of the total area.

In relation to the PSA, values are more impressive: calculated as national mean, between 12% and more than 30% of the PSA is “settlements and traffic infrastructure”. The national mean rates of change fall by between 0.1% (SL) and 0.37% (LI) per year, calculated over different national periods.

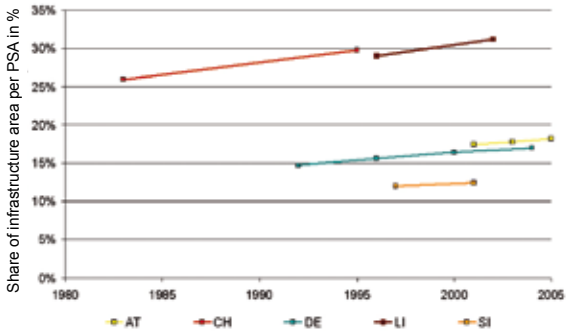


Fig. B3-2: Settlement and traffic infrastructure area per PSA (Source: National statistics, see Annex B3).

Switzerland and Liechtenstein have the highest values for status as well as in change rates. They seem to perform the most dynamic construction development on an already high level within the five compared countries (for France no PSA data is available).

B3.3 Regional differences in land-use development

Further analysis in this chapter focuses on different regional changes, considering different causes for land-use changes in different types of regions.

B3.3.1 Changes of settlement area in LAU-2[1] level

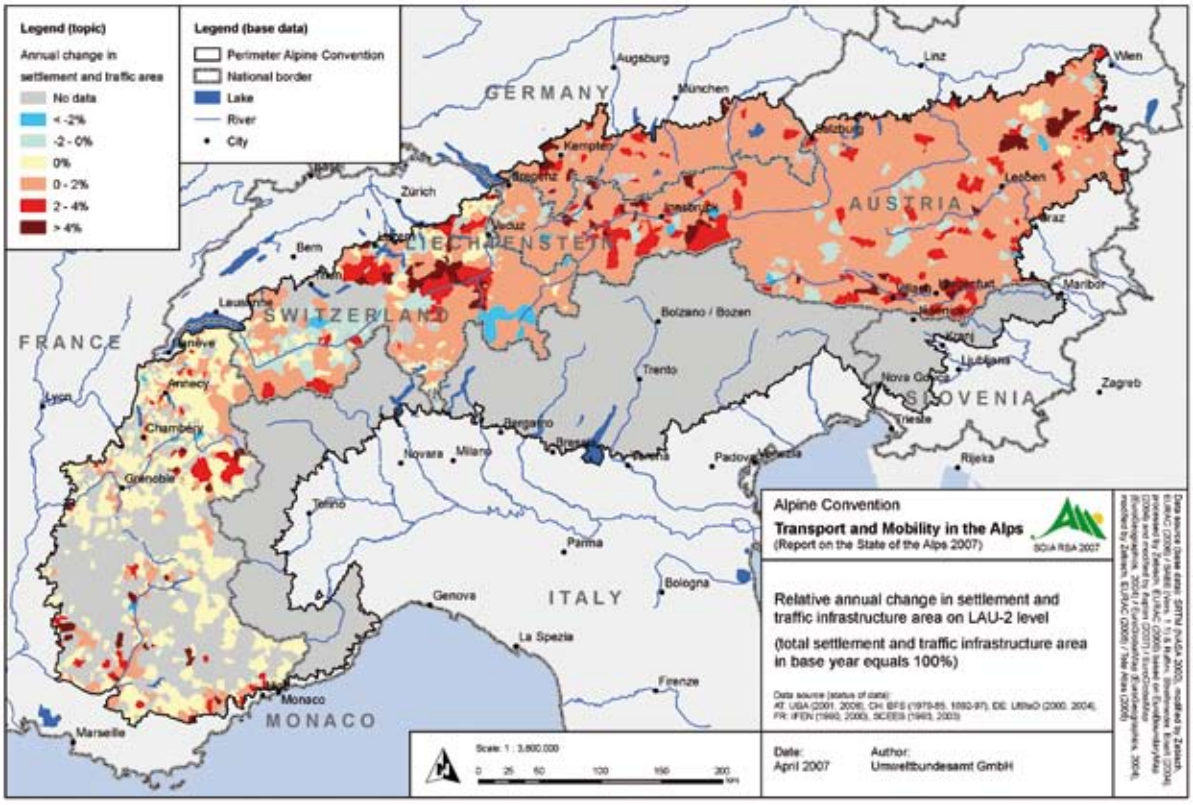
Due to the data available for this report, only France, Switzerland, Germany and Austria could be analysed. For those countries data was available for the development of built-up area on LAU-2 level for at least two points in time. However this data does not allow a distinction between different types of built-up area (settlement, industry, traffic infrastructure etc.), therefore the interpretation is rather limited. It must be stressed when displaying the data that comparison between countries is almost impossible, because of the various origins of the data (see textbox on indicators). Thus interpretation has to focus on differences within the countries.

[1] The abbreviation LAU means "Local Administrative Unit"; LAU-2, formerly known as NUTS-5, refers to all municipalities, municipality free areas or respective units in the EU Member States.

One hot spot of built-up area development seems to be the central region of Switzerland (parts of Glarus, Uri). This region shows the highest values in both growth dimensions (absolute and relative).

In Austria the highest relative increments of built-up area are mainly connected to tourist areas. It does not mean that all tourist areas show a significant increase of built-up area, but if there is a significant relative increase of built-up area, it is mostly in a tourist area. Regarding the opposite image of absolute areas of settlement increase, i.e. lower values in tourist areas, the following interpretation is given: built-up development in tourist areas is low, but as tourism prefers regions with a lower degree of existing built-up area, the relative change may appear higher (few changes in relation to small existing areas).

On average the German and Austrian communities show higher relative increases than Switzerland. France appears to be a quite stable country, but one has to note that the French data result from Corine Land Cover, with the inherent underestimation of both urban areas and urban changes.



Map B3-1: Relative annual change in settlement and traffic infrastructure area on LAU-2 level (Sources: National statistics, see Annex B3).

Negative values of change indicating shrinking areas of settlement (see Graubünden, CH) probably result more from data inconsistency than from an actual decrease in area.

B3.3.2 Changes in cultivated, forest, and settlement areas in NUTS-3-regions[2]

Cultivated areas

The "cultivated areas", which are areas used for agriculture, including grassland, are characterised by a general negative trend in the territory of the Alpine Convention: The only province with an increase in cultivated area is Torino (Italy).

According to the results of the national flow analysis in chapter B3.4 in the Eastern and Central Alps (Austria, Slovenia, Germany, Switzerland) the regional decrease is only small or even "0". In the western and southern Alps (France, Italy) the decrease per year in cultivated area exceeds 2% to 4% of the reference year. The highest losses are registered in the French departments Savoie, Haute-Alpes and Alpes-Maritime. Higher losses in the Eastern Alps are reported for the south of Kärnten and Innsbruck (both Austria) and in Italy for parts of the provinces of Liguria, Piemonte, Lombardia, Veneto and Friuli Venetia-Giulia.

The highest relative decrease in cultivated area is reported in France. This is quite astonishing, considering that changes in France are only recorded in areas larger than 5 ha, as they rely on the Corine Land Cover data. In general the decrease is higher in the central areas of the French Alps. It seems to be the case that less cultivated area is lost in those regions which border the Alps.

Switzerland and Austria show relatively constant low decrease values all over the country, whereas regional differences in close neighbourhood are highest in France. This corresponds to the mix of communities with increasing and decreasing population which is shown for France in chap. B1.

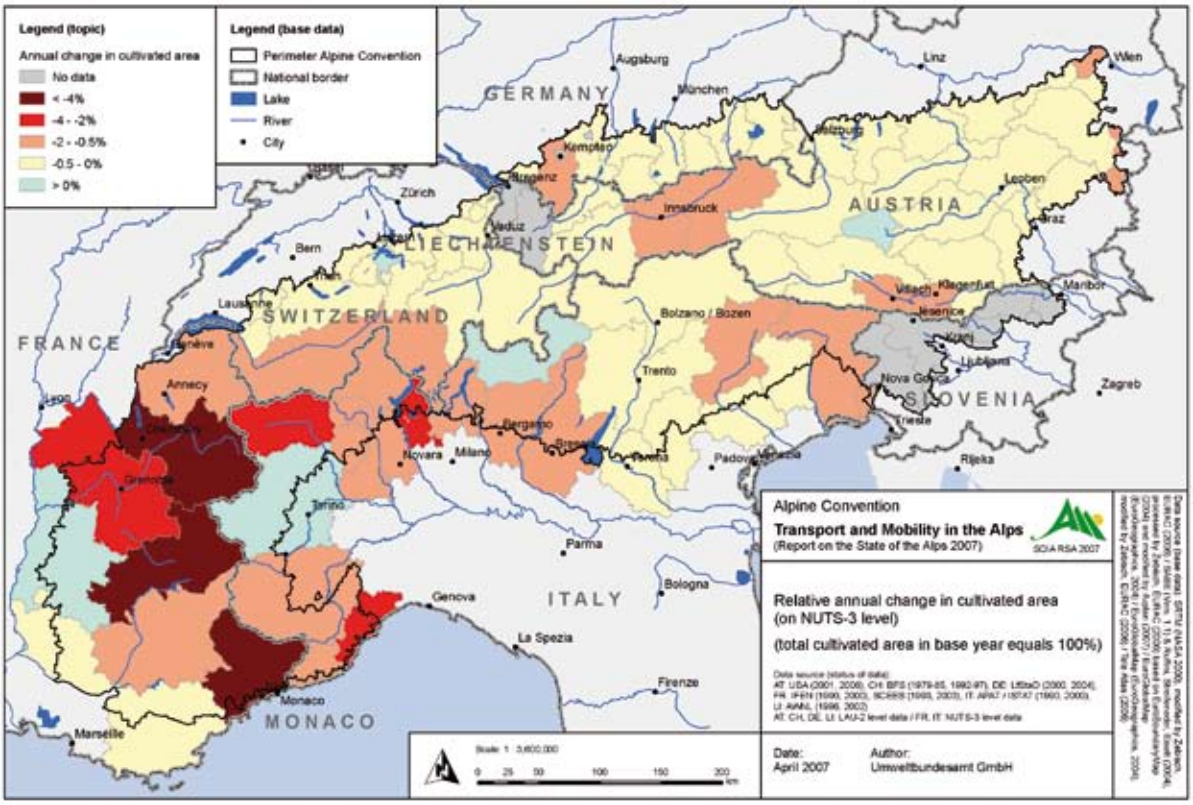
Forests

Forest areas appear to be stable in most regions of Austria, Germany, Switzerland and France. In relative terms, little forest increase can be observed in Slovenia and the Italian Province of Trentino. Italy is the only country where a high decrease in forest has occurred, in particular in the areas of Piemonte, Sondrio/Bergamo and Udine. The order of magnitude of loss of forest is about the same as the changes in cultivated area.

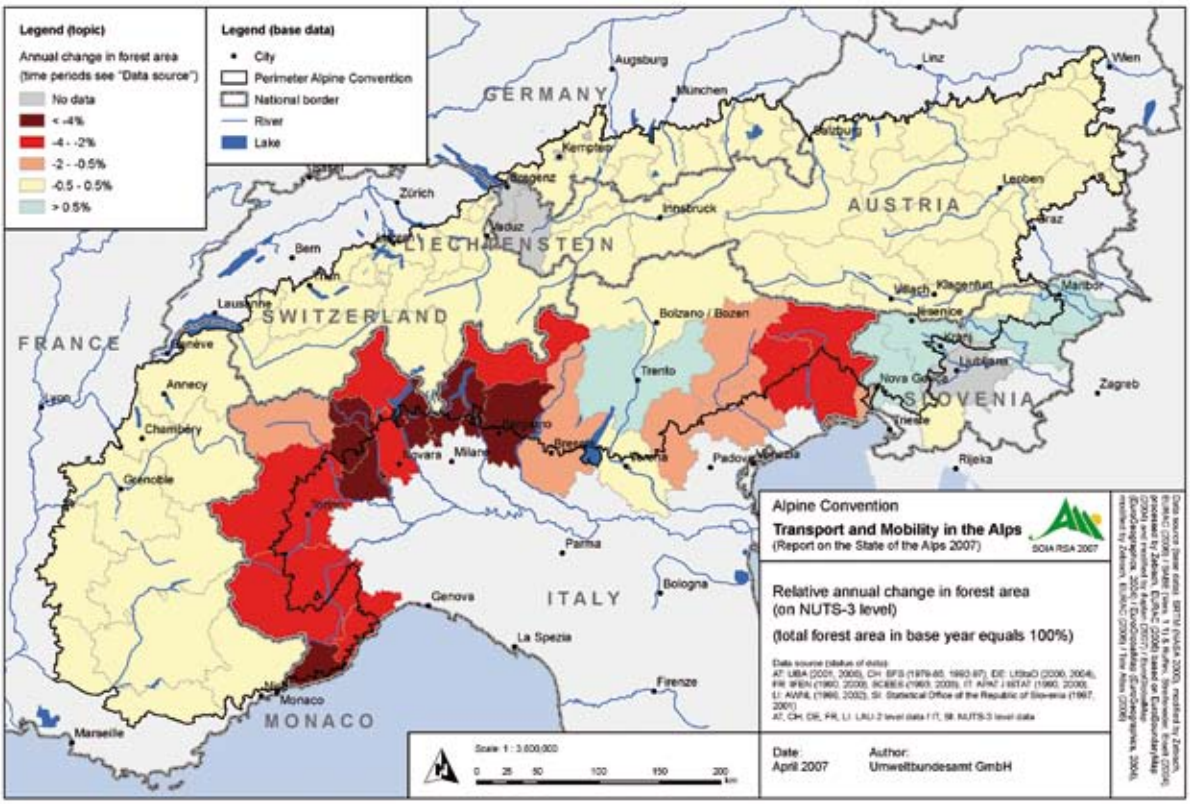
As forest covers mostly large areas within NUTS-3 regions the relative changes in area are often expressed only in small percentages.

The main areas of loss of agricultural area and increase in forest area (in general parts of the western and the southern Alps) correspond to the areas with less transport infrastructure: the main road network is less dense in those regions (see chap. A1.3). This may support an indication of the mu-

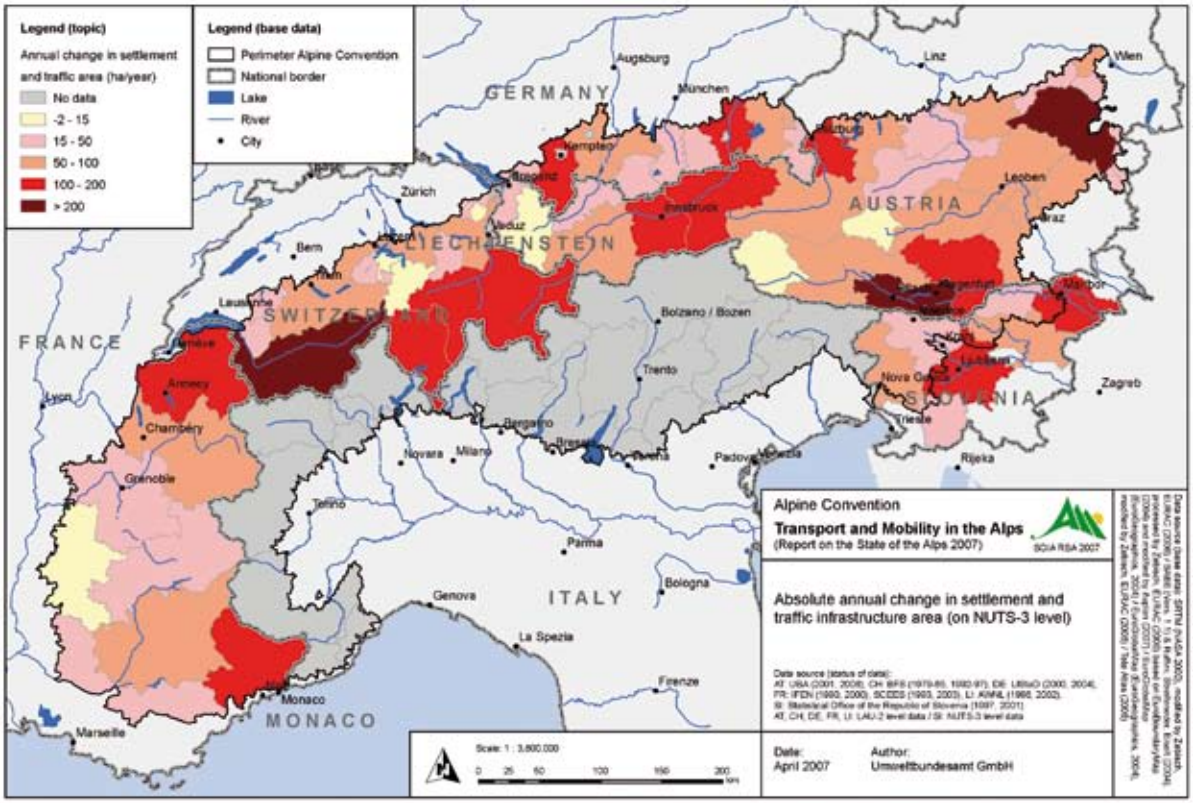
[2] If between the two time stamps of sampling, a province has been split into two or more provinces, then the old "common" province is displayed. This is the case in two Italian provinces (Novara, Vercelli). Bergamo, Como and Lecco were summed up as "Como+Bergamo".



Map B3-2: Relative annual change in cultivated area (on NUTS-3 level) (Sources: National statistics, see annex B3).



Map B3-3: Relative annual change in forest area (on NUTS-3 level). Time periods considered for each country are shown in the legend: data source (Sources: National statistics, see Annex B3).



Map B3-4: Absolute annual change in settlement and traffic infrastructure area change (on NUTS-3 level) (Sources: National statistics, see Annex B3).

Settlement and transport infrastructure

The amount of change in settlement and transport area is by a factor of more than 100 lower than the other land uses. It ranges from several to a few hundred hectares per year in NUTS-3-regions.

In Austria, the regions with high increasing settlement and traffic infrastructure correspond to densely populated municipalities (Tirol/Inntal, Salzburg with its surroundings, Klagenfurt-Villach, southern part of Niederösterreich), whereas Germany has much more densely populated municipalities, but less increase in settlement area. In Switzerland the highest activity is seen in the southern cantons (Graubünden, Ticino, Valais), and in France in the Department Haut-Savoie around Annecy and in the South (Alpes-Maritimes).

The total increase in settlement area does not always correspond with high relative changes in relation to a reference year. In Haute-Savoie (FR), for example, the "hectare increase" is high but the "percentage of reference year" value is much lower. In those regions where a high share of settlement areas is already present in the reference year, the percentage increase seems fairly low. Nevertheless, absolute values indicate high activity in land-use change.

Switzerland shows a high increase in settlement area in hectares, but when displayed as relative to the reference year, it is less marked (cp. Map B3-1). This accords with the high increase on an already high level.

B3.4 Land-use transformation to the detriment of agricultural area

A deeper insight into land-use change processes offers an analysis of land-use transformation. This investigates which land-use classes increase on the cost of which class. An analysis of land-use transformation requires spatially exact data. Land-use change has to be documented for each spot within the area under investigation. Because in most cases only aggregated data is available, a real land use transformation can often not be compiled. For the land use classification Corine Land Cover data, as provided by France, are not very precise. Therefore this calculation has been carried out only for selected countries (Germany, Austria, Switzerland).

As a workaround method, but nevertheless much more exact than pure statistical aggregation, for this report simplified land use transformation tables have been constructed (see box "land use transformation matrices" in Annex B3).

The analysed classes of land use are

- agricultural area also referenced as cultivated area, comprises farming area including horticulture, grassland and pastures (the detailed definition may vary from country to country),
- forest area, and
- area of settlement and traffic infrastructure (mainly a self-contained built-up area, including traffic).

The change per year reveals the same trends in the three countries (see Tab. B3-1). Agricultural areas are being lost to forest on one side and to settlement on the other (cp. chap. B2.4). Other land-use changes are not notable. However when interpreting the values in the tables one has to take into account that due to the underlying assumptions, the changes are systematically underestimated. But they give the verified minimal change rate. In reality the change rate is larger.

Switzerland (12 years run-time)					
	ha in start year (1982)	**A**	**F**	**S**	**Total loss in %**
		change/year in % of start year			
A	251,351		0.11	0.18	0.29
F	609,303			0.00	
S	75,411		0.01		
Total	936,065				
Germany (4 years run-time)					
	ha in start year (2000)	**A**	**F**	**S**	**Total loss in %**
		change/year in % of start year			
A	508,983		0.15	0.14	0.29
F	428,626			0.01	
S	75,443	0.01	0.01		
Total	1,013,053				
Austria (5 years run-time)					
	ha in start year (2001)	**A**	**F**	**S**	**Total loss in %**
		change/year in % of start year			
A	932,661		0.10	0.17	0.27
F	2,771,929			0.01	
S	179,042	0.02	0.03		
Total	3,883,632				

Tab. B3-1: Land-use change per year in percent of initial area of the start year. A= agriculture, F=Forest, S=settlement and traffic infrastructure; red and green colour indicate loss and increase of agricultural and forest area respectively (Sources: Alpine Convention, see Annex B3).

Of major interest is the result that in all three countries agricultural areas are being transformed at the same rate of almost 0.3% per year of the initial area. This may seem low, but is based on trends over several years and, in these countries, on cadastral data. As mentioned, the change is systematically underestimated, so that it seems a valid conclusion that a trend of loss of agricultural area is present. The main type of agricultural area that is being lost is presumed to be grassland, which is very important for conservation issues.

Whereas agricultural area in Switzerland and Austria is lost at higher rates to settlement areas, in Germany the losses to forest and to settlement are almost equal.

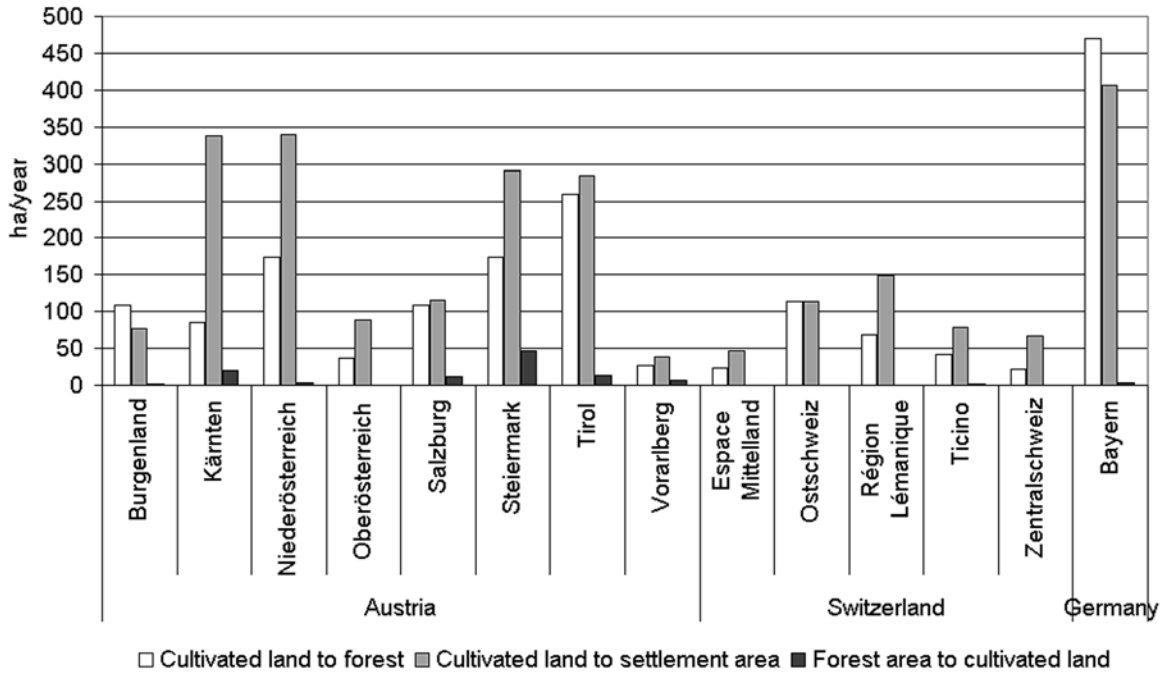


Fig. B3-3: Land use change in NUTS-2 regions (Sources: National statistics, see Annex B3).

Loss of cultivated area partly corresponds to an increase in settlement and traffic (Tiroler Unterland, Innsbruck, Haute-Savoie). But such a loss is also possible in other regions. Flow analysis shows that the absolute value of hectares transforming from agriculture to settlement is equivalent in magnitude to the transformation to forest (on NUTS-2 level). That means "agricultural land" is the category from which in some regions the main area is being lost to forest, and in other regions to settlement. In Austria and Switzerland, the main flow seems to go towards settlement (partly double that of forest-targeted, and especially in NUTS-2 regions with high settlement activity like Tiroler Unterland, Villach-Klagenfurt), whereas in Germany the flow towards forest is higher.

Main findings

Status

The area of settlement and transport infrastructure is increasing generally in all Alpine countries. In most cases these increases occur on agricultural land.

Trends

There is a fast increase in settlement and transport infrastructure area in Switzerland (and Liechtenstein), based on an already high level.

Cultivated area serves as area resource for forest or settlement and transport infrastructure in rural or densely settled areas, respectively.

Area loss of cultivated land is high in France and Italy and southern parts of Switzerland, lower in Austria, Germany, and in central Switzerland.

Hot issues

Development of settlements and traffic infrastructure is concentrated to existing infrastructure. A concentration process of population and built-up area is ongoing.

The mutual dependency of infrastructure development and land-use changes requires an integrated approach for regional development. In order to increase the accessibility for peripheral regions it is more important to develop opportunities to earn a living than to increase the transport infrastructure.

B4 Tourism and Transport

Over 60 Mio holiday guests, another 60 Mio day tourists and about 370 Mio tourist nights spent make the Alps the largest holiday region in Central Europe (Bätzing 2003). Regarding the whole of Europe, only the Mediterranean region is a more favoured tourist destination (EEA 2003).

Although the economic importance of tourism in the Alps is sometimes overestimated, it is a key industry for many Alpine areas. About 10% of the Alpine municipalities feature a touristic monostructure (Bätzing 2003). Based on good natural and infrastructural conditions (i.e. concerning sufficient snow cover), tourism here dominates the whole local or regional economy.

The majority of tourist nights spent are counted during the summer. Nevertheless winter tourism is economically more important in many places due to the higher financial expenditure of winter tourists (Bartaletti 1998).

The economic role of tourism in the Alps is dependent on and connected to the provision of transport infrastructures and capacities. These are needed to allow tourists to reach their destination in a reasonable time. They are also necessary to deliver goods and services to the tourist municipalities. Dependence on well-established transport connections increases with the remoteness of a municipality.

The chapter outlines the role of tourism as one of the driving forces for traffic development. The tourism intensity in the Alps and the development of tourism demand gives an overview of the general development in the Alps. The relation between tourism and traffic is then investigated for some case studies in Austria.

B4.1 A driving force behind traffic

In general, changing leisure and tourism trends affect passenger transport. Within the Alps, the growth of leisure and tourism demands is expected to generate an increase in individual motorised transport, in particular. This is the most common form of transport used by tourists in many parts of the Alps, where public transport suited for tourists / tourist requirements is crucially lacking. The European Environment Agency estimates that up to 80% of all tourist journeys to the Alps are by car (EEA 2003). In Austria the number of tourist arrivals by car amounts to 85% (Rauh et al. 1998). In addition, once tourists have arrived at their destination, they frequently use the car during their holiday stays.

***Tourism transport** is all transport related to vacations and holidays. It comprises the distances travelled to and from holiday destinations as well as the journeys taken during the holiday stay.*

According to the WTO definition "tourism" includes also business journeys. However "tourism transport" here refers only to transport undertaken for vacation reasons.

Only a few figures exist that describe explicitly the share of tourism transport in comparison to other forms of passenger transport. European and German studies estimate that approximately 9% of all passenger-km travelled in the respective regions are for tourism purposes (EEA 2003, IFO 2000).

Day tourism

Economic growth and social changes lead to growing personal incomes, to an increasing amount of leisure time as well as to a growing demand for leisure activities outside the home (Meier n.d.). As the Alps are also a destination for day tourism and short trips connected to a multitude of sport and other leisure activities, these are also an important source of transport pressures. Detailed figures do not exist. But some conclusions can be drawn from the development of the whole segment of leisure transport, which comprises all forms of transport connected to sport or cultural activities, short trips, events or the visits of families and friends.

In Germany and Switzerland, about 40% of all journeys (and 45% of all distances covered) are for leisure purposes. In the near future, leisure transport in Germany is expected to increase by 30%. As the majority of leisure journeys are made by cars, this will lead to an increase in individual motorised transport in particular (IFO 2000, DIW & INFAS 2004, BMVIT 2002, ARE & BFS 2001).

From an environmental point of view, cars – after planes – cause the highest pressures on the environment (Peeters 2006). So – for the Alpine space – the developments outlined above imply, for example, a risk of growing emissions of air pollutants and noise as well as a risk of an increasing land take for infrastructures.

B4.2 Measuring tourism, traffic and their interrelations

This chapter intends to analyse the interrelations between the tourism sector on the one side and the transport infrastructures and traffic volumes on the other.

The first part focuses on the spatial situation and distribution of tourism centres in the context of transport infrastructures. The indicator "tourism intensity" will be used to identify those tourism centres.

The intensity of tourism is usually defined by the number of beds in accommodation businesses per resident population. In France not only the "official" tourist sector is of importance, as a high share of tourist accommodation is offered by private second homes. In the whole of France, almost 335,000 new second homes were built during the past two decades. Second homes here represent 73% of the total tourist lodging capacity, and 18% of all nights spent by French residents in 1999 were in their second home (EEA 2003). In Switzerland and Italy also, beds in second homes are supposed to play a role in considering tourism intensity (Bätzing 2003). But respective data to describe the situations were not delivered.

Secondly an overview about the recent development of the tourism sector based on statistical data will be given.

An analysis of tourist arrivals, tourist nights spent and the duration of tourist stays (number of tourist nights by number of tourist arrivals) aims to show changes in tourism demand within the Alps, which may have strong influences on the traffic development.

Finally the influences of leisure and tourism on transport volumes will be highlighted. As this cannot be explained only by using tourism statistics, respective insights will be drawn from the interpretation of data on traffic volumes. For this purpose, data from the Brenner Pass as well as from selected traffic measuring points in the vicinity of tourism centres in Austria will be used.

Data limitations

Several factors restrict the usage and the comparability of tourism data. First of all, the object of statistics differs between the different countries, as the following examples show: In Switzerland and Liechtenstein, only beds in hotels are counted. German statistics do not include businesses of fewer than nine beds. In Austria, only municipalities with more than 3,000 tourist nights spent report to the tourism statistics.

In Germany, confidentiality obligations also restrict the use of statistical data on tourism. The calculation of tourism intensity is only possible for about 65% of the municipalities. In the context of this chapter, this is acceptable as further analysis of the tourism sector will place special focus on tourism centres. Here the number of accommodation businesses is usually above the critical values.

Other figures such as the number of tourist arrivals and nights and the thereby calculated average duration of tourist stays can only be displayed on a higher level of statistical spatial units (NUTS-3), i.e. districts etc. This refers to Fig. B4-3 in particular. At this spatial level, confidentiality obligations are only applied in exceptional cases. However, the problem with using data on level NUTS-3 is that these units do not wholly correspond with the boundaries of the Alpine Convention area.

The interpretation of data is partly limited, as availability of data differs in terms of time-scale. Coherent time series describing long-term developments, both for tourism and transport, were only delivered for a few countries.

B4.3 Tourism centres and transport infrastructures in the Alps

Municipalities with a tourism intensity higher than 1 are regarded as tourism centres. As Fig. B4-1 shows, about 9% of Alpine municipalities exceed this value. In other words, these municipalities offer more tourist beds than they have resident population. In another 8% of municipalities tourism intensity amounts to between 0.5 and 1 tourist beds per inhabitant.

These figures reveal great differences between the Alpine municipalities, as they reveal that tourism is of no or low importance in about 80% of Alpine municipalities.

What is tourism intensity?

Tourism intensity is defined as the number of tourist beds per resident population. It is rather commonly used as a measure of provision of tourist facilities. The tourism intensity of the whole Alpine region, including beds in second homes and in the parahotellery sector, is estimated to be about 0.5 beds/inhabitant for 1991 (Bätzing 2003). The calculated tourism intensity based on current data amounts to 0.33 beds per inhabitant, however this does not include beds in second homes. Due to the relation to the resident population, the indicator tends to overvalue small municipalities and in turn to underestimate larger ones.

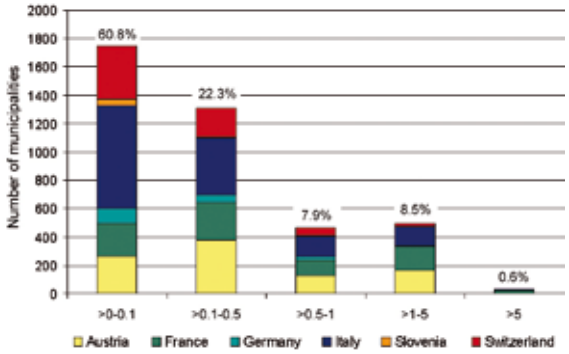


Fig. B4-1: Tourism intensity in Alpine municipalities (FR: 2002, IT: 2003; DE, SI: 2004; AT, CH: 2005).

Role of second homes

In French municipalities the number of beds in second homes adds to a large extent to the number of commercial tourist beds. Although these types of accommodation are not used as frequently as beds in hotel businesses (cp. EEA 2003), they have to be considered in the context of tourism intensity. For this reason, the second home intensity, i.e. the number of beds in second homes per inhabitant of French municipalities, was considered in addition to the tourism intensity (see Fig. B4-2). Map B4-1 displays the highest class in either tourism or second home intensity.

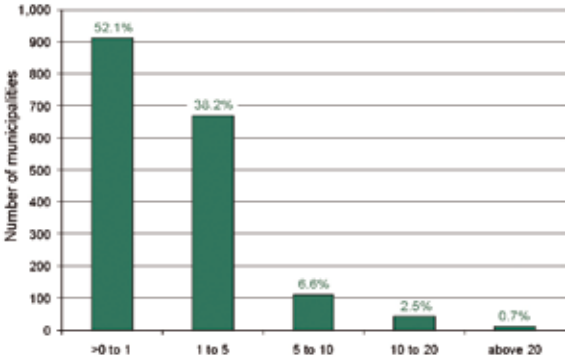
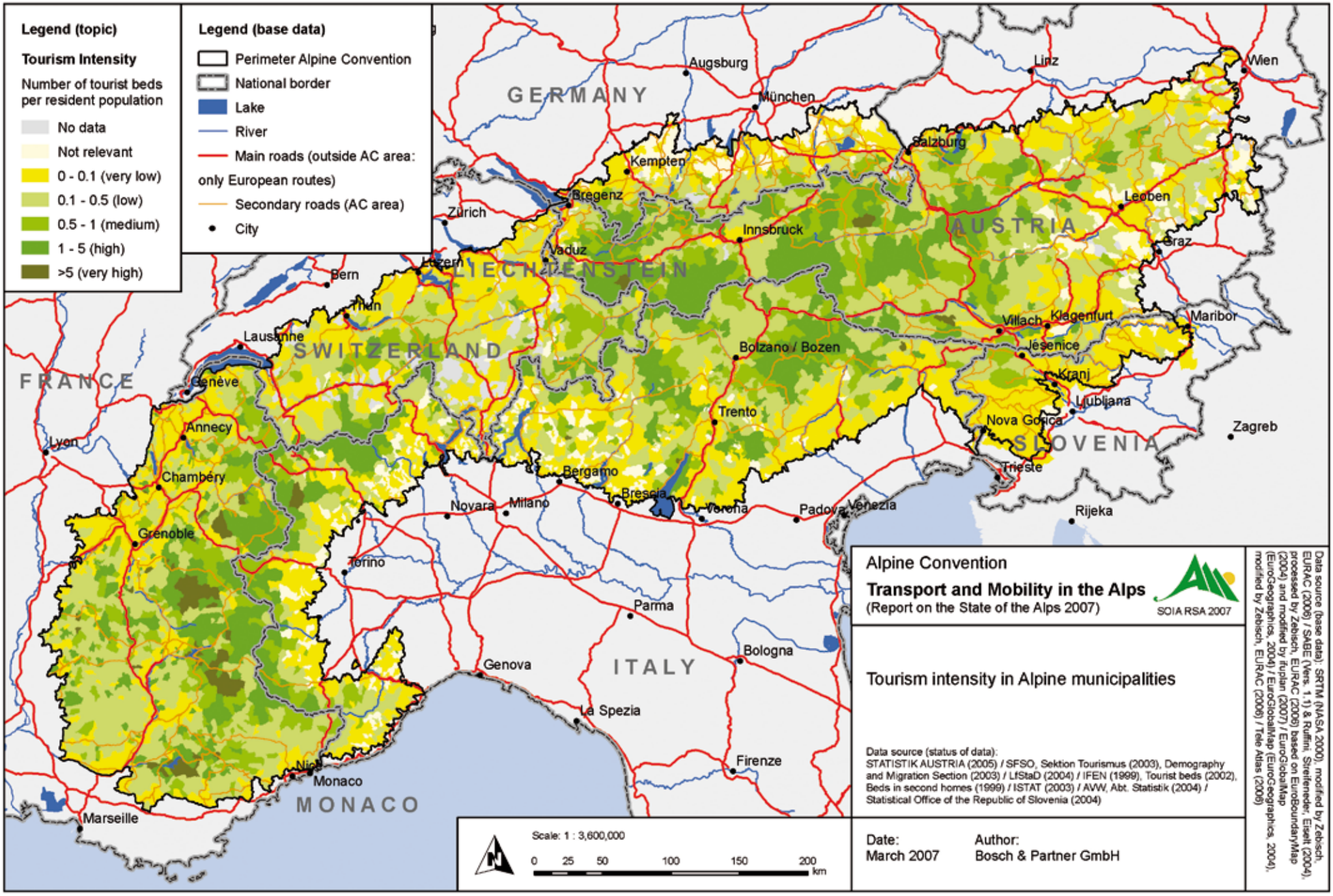


Fig. B4-2: Second home intensity (beds/inhabitant) in French Alpine municipalities in 1999.



Map B4-1: Tourism intensity (number of tourist beds per resident population) in Alpine municipalities. For France the number of beds in second homes per inhabitant were considered in addition to the tourism intensity.

Tourism centres and transport infrastructure

The spatial distribution of the tourism centres in the Alps follows the topography (see map B4-1). They are often close to the main Alpine ridge. Municipalities in the lower Alpine regions are generally of low tourism intensity.

Not surprisingly, regions of very high tourism intensity are mostly skiing areas. In Austria, this applies to well-known skiing destinations in the Alps, e.g. Ischgl or Saalbach-Hinterglemm, Kitzbühel, Zillertal, Stubai or Ötztal and to the Hohe and Niedere Tauern ridge. In France, where some of the skiing resorts are only sparsely populated, municipalities near ski resorts such as Tignes, Val d'Isère or Alpe d'Huez are characterised by a high or very high tourism intensity. The Dolomite mountain ridge and the Valle d'Aosta are respective examples for Italy. Here, Lago di Garda is one important non-skiing tourist destination.

In Switzerland the tourism centres with the highest intensities are also connected to high Alpine areas, e.g. Adelboden or Lauterbrunn in the Berner Oberland or St. Moritz. As only beds in hotel businesses are statistically registered, tourism intensity is not as distinct here. The few places in German Alpine regions with high tourism intensity are Bad Hindelang and Oberstdorf in Oberallgäu as well as Ramsau near Berchtesgaden. In Slovenia, Kranjska Gora, the Triglav National Park area and the Cerkljansko area are the most important tourist destinations within the Alps.

The main transport infrastructures are tied to the longitudinal valleys or – when crossing the main Alpine ridge – to corridors where geographical obstacles are relatively easy to overcome. This contrasts with the location of the tourism centres, the majority of which are not situated close to transport infrastructures. On the contrary, some tourism centres are situated in rather remote and not easily accessible areas (see also: Wrbka et al. 2002, Pfefferkorn & Musović 2003).

B4.4 Development of tourism demand

The importance of tourism demand in the Alps, described by absolute figures of tourist nights spent in tourist accommodations, varies rather strongly between the Alpine countries. However, in order to draw conclusions on the development of traffic, the relative description of tourism demand is more meaningful.

In the following Fig. B4-3 France does not appear because data were only delivered for a single year. For Austria, the presentation of a graph showing the long-term development was rejected as data were only delivered for the years 1991, 2001 and 2005.

Generally speaking, the statistics show an increase in the number of tourist nights spent and tourist arrivals between 1996 and 2005. In this period, tourist nights spent were declining only in Germany and Liechtenstein. The only country facing a decline in tourist arrivals is Liechtenstein. The recovery of the tourism sector in the Alps at the end of the 1990s has been slowed down or even halted in most countries by the economic recession following the years 2000 and 2001.

Regarding the average duration of tourist stays, a tendency towards shorter holidays is to be observed (cp. Fig. B4-3c). This trend is seen very strongly in Germany, where it reflects the decline in tourist nights spent. But it is also rather distinct in Italy and Switzerland, where the number of tourist arrivals is growing faster than the number of tourist nights spent.

So in the Alps a weak trend towards shorter but more frequent holidays is visible between 1996 and 2003. This is in line with the developments observed by the European Environment Agency for the whole of Europe. People tend to use the increased length of their vacations for multiple holiday stays instead of extending one main holiday (EEA 2003).

In terms of transport, tourists travelling more often to Alpine destinations and staying for shorter visits imply a growth in traffic volumes. Since tourists in the Alps arrive mostly by car, this applies in particular to individual motorised transport (see subchap. B4.1).

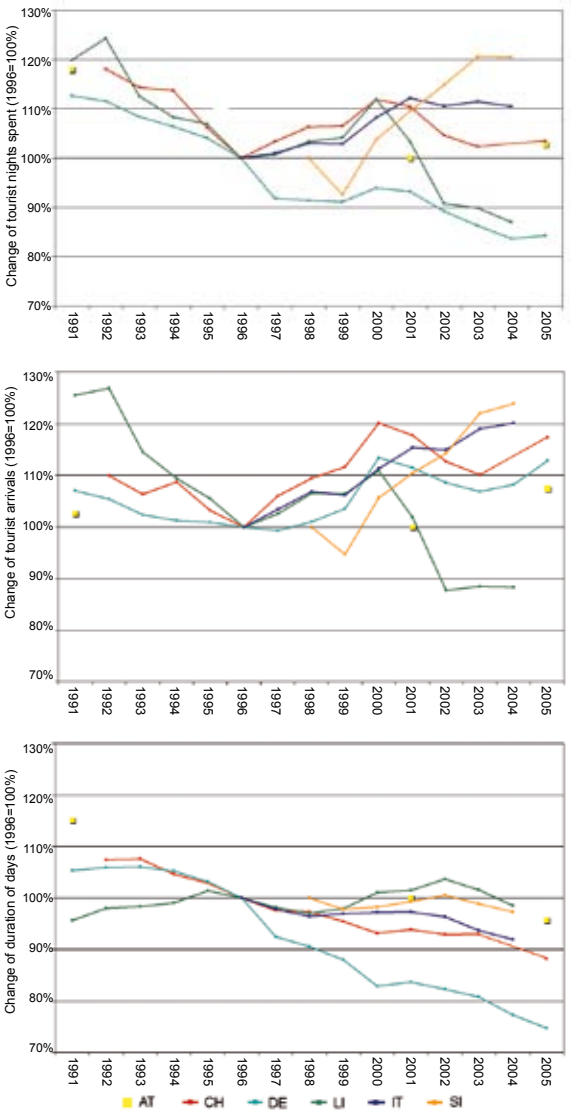


Fig. B4-3a-c: Development of tourist nights spent, arrivals and duration of tourist stays.

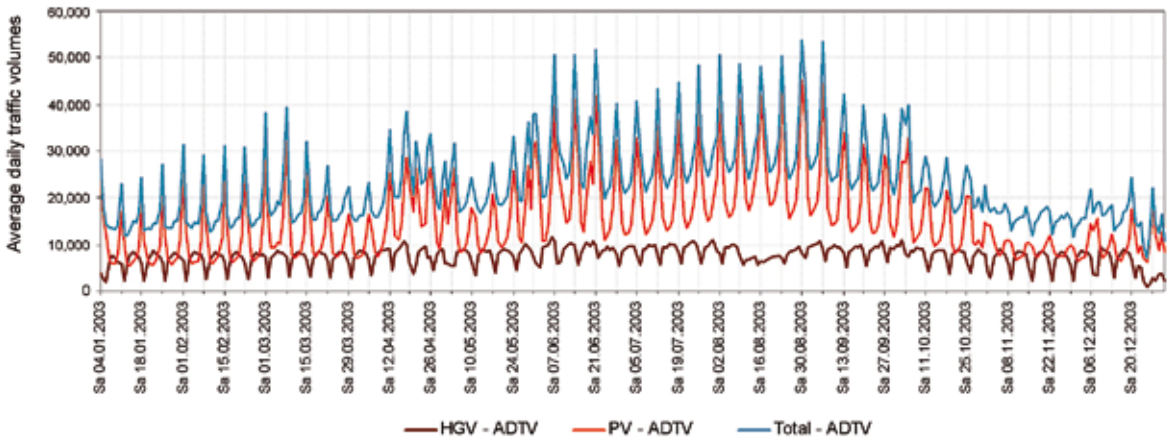


Fig. B4-4: Average daily traffic volumes (ADTV) in 2003 at the Brenner Pass (Measuring Point Vipiteno, both directions aggregated; HGV – Heavy Goods Vehicles, PV – Passenger Vehicles).

B4.5 Tourism and traffic volumes

Although less than 10% of all distances covered are for tourism reasons (see subchap. B4.1), tourism travel can cause extensive traffic volumes on certain routes. For instance, about 55% of all journeys at trans-alpine roads in Switzerland are interrelated to holidays and vacations. An additional 29% of the journeys are for leisure purposes, including among others day and short tourist trips (ARE 2003).

Respective results of interviews and surveys are not available for the whole Alpine region. But the importance of tourism- and leisure-related transport can also be interpreted by figures on traffic volumes from the transport sector, in particular by their seasonality and the occurrence of peak volumes.

Traffic volumes at the Brenner Pass

As an example, the traffic volumes at the Brenner motorway at Vipiteno will be examined (see Fig. B4-4). The rather constant traffic volumes of Heavy Goods Vehicles on weekdays form a baseline for the total traffic volumes. The peak traffic volumes are clearly linked to passenger transport and have a strong interrelation to weekends, in particular to Saturdays. One main reason is journeys to and from holiday destinations, as Saturdays are still the usual day of tourist arrivals and departures. Another reason is day tourists taking short trips to the mountains at weekends.

Furthermore, in 2003 the peak traffic volumes on the Brenner Pass were obviously related to holiday seasons in the adjacent countries. The first peak at the beginning of March corresponds with the carnival days, the second to the Easter holidays, with Easter Sunday the 20th April. Throughout the summer season, traffic volumes are frequently high, starting from the beginning of June (Pentecost) until the end of the summer holidays in early September in e.g. Alto Adige, Austria and the German federal states of Bayern, Nordrhein-Westfalen and Baden-Württemberg. Relatively lower traffic volumes occur between October and January.

Both observations underline the importance of tourism and leisure as sources of high traffic volumes. But as the Brenner Pass is one of the main trans-alpine transport corridors, the traffic volumes to a large extent reflect the journeys to and from destinations outside the Alpine area.

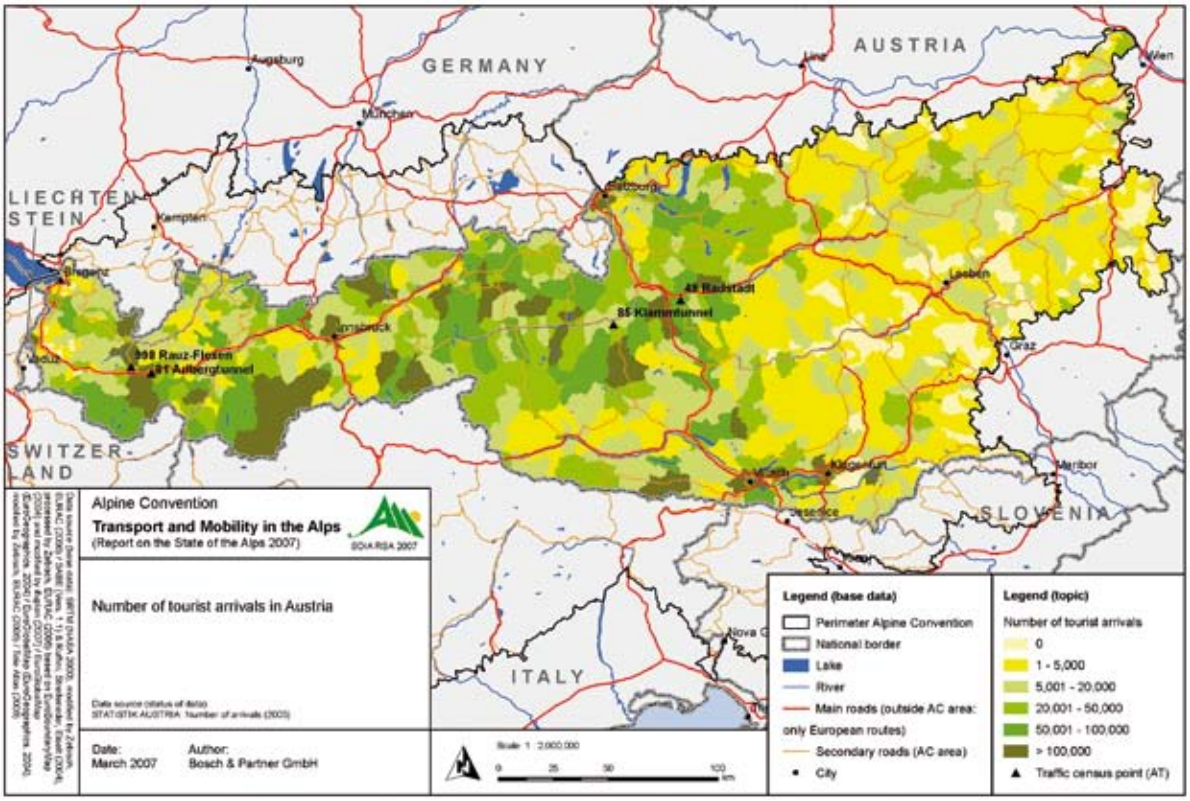
Case study: Climate change and tourism demand

Climate, a key location factor of the Alpine tourism sector is changing. The rising snow line, melting glaciers and a shortening of the season in particular affect winter tourism. Current measures such as artificial snow, ground adjustments or covering glaciers are short-term-strategies (Elsasser & Bürki 2005).

Cover sheetings to retard the melting of glaciers at vulnerable places (Elsasser & Bürki 2005).

The IXth Alpine Conference emphasised the need to develop suitable strategies and activities to adapt to the consequences of climate change – regarding also single economic sectors and regional peculiarities. Urgent sustainable measures are to be developed for branches such as tourism which are particularly affected by the ongoing changes (Alpine Conference 2006).

In terms of tourism transport, the changing climate can subsequently lead to a concentration of traffic towards tourism centres at higher altitudes and of guaranteed snow. In the long term, the development of tourism-related traffic volumes will depend on the ability of tourism centres to adapt to the changing conditions.



Map B4-2: Number of tourist arrivals in Austria.

Traffic volumes near tourism centres

In order to describe intra-Alpine leisure and tourism transport, the traffic situation in the vicinity of tourism centres within the Alps was analysed in a more detailed way. For this purpose, traffic volumes on access roads towards four Austrian tourism centres were analysed.

The indicator "tourism intensity" identified tourism centres marked by a high provision of tourism facilities (see Map B4-1). However, in the context of transport, the use of tourism facilities is of importance. For this reason, absolute numbers of arrivals were taken into account. These figures picture municipalities most likely to induce high volumes of tourism-related traffic (see Map B4-2).

The following measuring stations are situated on access roads to tourism centres. As far as numbers of tourist nights are mentioned in the text below, they refer to all associated municipalities listed in Tab. B4-1.

Measuring stations	Road	Rationale
81 Arlbergtunnel	S416	Connection between Vorarlberg and Tirol, gateway to Ischgl and St. Anton / Arlberg
49 Radstadt	B99	Gateway to the Niedere Tauern ridge and the skiing areas in Untertauern
85 Klammtunnel (Dorfgastein)	B167	Gateway to Obertauern, Bad Gastein, Bad Hofgastein
998 Rauz-Flexen	B198	Gateway to skiing areas in Lech, Klösterle

Tab. B4-1: Selected transport measuring stations.

All the centres that were studied have their majority of tourist nights during the winter season (see Fig. B4-5). The tourism regions adjacent to the Arlberg, Radstadt and Rauz-Flexen focus strongly on winter tourism; only in the Gastein municipalities (Klammtunnel) does summer tourism play a more important role.

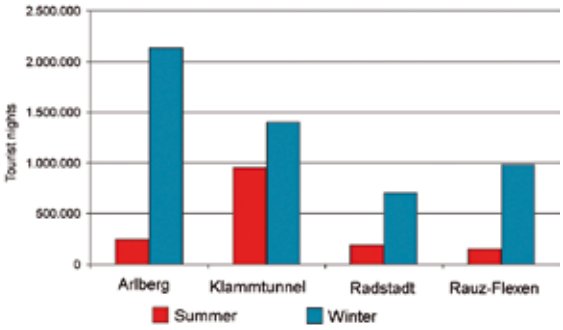


Fig. B4-5: Seasonality of selected tourism centres in 2005.

As already observed at the example of the Brenner Pass, all the measuring stations show peaks on Saturdays during the holiday seasons in winter and summer. The main reasons are journeys to and from holiday destinations. The specialisation on winter tourism may explain the very marked peak on winter Saturdays. Tourist arrivals and departures within the region coincide with day-tourist traffic visiting the regional winter sport facilities.

The measuring stations at Radstadt, Arlberg and the Klammtunnel also count (tourism) transport across the Alps, though at alternative routes. For instance, the very distinct peak at the Radstadt measuring station emanates from traffic by-passing the Katschberg tunnel. Again, this is augmented by day-tourist traffic activities such as hiking, climbing or even driving.

Furthermore the summer peaks on weekdays at the selected measuring stations and in the Tirol average indicate that mobility during the holiday is of higher importance for tourists in the summer season. They are more dependent on their car and use it more frequently to visit attractions, leisure facilities or for sightseeing.

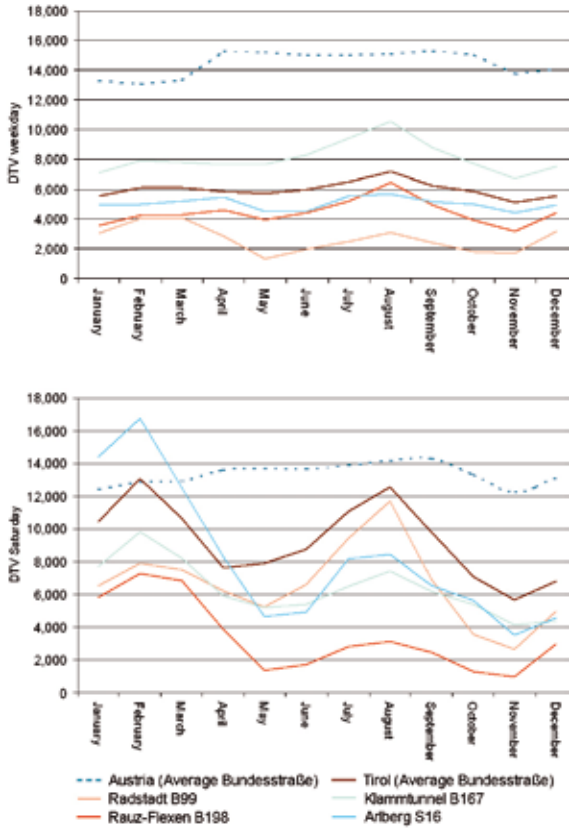


Fig. B4-6: Average daily traffic volumes (ADTV) of passenger transport in 2004 at selected measuring points in Austria (weekdays and Saturdays).

Main findings

Status

Traffic related to tourism and day tourism has a strong influence on traffic volumes within the Alps, in particular with respect to peak situations. Alpine roads suffer from high traffic volumes connected with the journeys to and from tourism destinations within and outside the Alps – both in winter and in summer.

Trends

The trend towards shorter but more frequent holidays can also be observed in the Alps. This implies a growth of individual motorised transport.

The main tourism centres in the Alps are not solely dependent on the close vicinity of major transport infrastructures. On the contrary, some tourism centres are even situated in rather remote areas.

Hot issue

Measures need to be taken to increase the use of public transport for journeys to and from tourism destinations as well as in particular the use of public transport during the time spent at the holiday destination.

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C Effects of Transport and Mobility in the Alps

The impacts of transport are manifold, and much has been written about them. However, when looking for figures and hard facts, and especially for data which allow for international and inter-regional generalisations and comparisons, it becomes difficult to draw a broad picture covering all dimensions of sustainable development. Nevertheless this report tries to stick to this ambition by deliberately selecting some representative aspects from the broad range of pertinent issues. Therefore, part C is not a comprehensive overview on all relevant impacts of transport.

Accordingly, the structure of part C corresponds to the three main pillars of sustainable development: chapter C1 deals with the impact on the economy, chapter C2 with the social impacts and chapter C3 with some selected environmental and health issues.

While starting from the impacts of transport on the economy providing evidence on positive and negative effects despite the difficulties of quantification in this field, part C1 is inevitably confronted with the feedback of the economy on transport: the challenging question of how transport growth and economic growth are linked or can somehow be separated is a central issue which has also been touched on in previous parts of the report. The end of the chapter deals with the concept of external costs and economic instruments in transport policy based on this approach.

Chapter C2 deliberately focuses on the issues of accessibility and social equity and on the ageing of the population. It shows how strongly transport needs to be considered as an element of a complex system ensuring the provision of essential services to the population: transport is essential for access to services, but more transport is not the solution to all accessibility problems – other measures need to be considered too.

Chapter C3, finally, deals with the issues which have raised the most controversial debates on transport in the Alps: the environmental and health effects. However, in order to give a valuable insight into specifically Alpine problems, here it focuses on the two most sensitive issues: air quality and noise. In both cases the specific Alpine topography, where important transport corridors are located at the bottom of densely populated and rather deep, long valleys, leads to conditions in which transport causes much more severe impacts than elsewhere.

The impacts of transport are manifold, they affect economic, social and environmental issues (Photo: S. Marzelli).

Overall, this part of the report devoted to the effects of transport shows again the necessity for a specific Alpine approach to the issue and makes the case that transport policy needs to be integrated into a comprehensive development approach. In this spirit it is also essential to see the Alpine transport system in a larger European context – an important aspect which has been dealt with in more detail in previous chapters.

C1 Economic Effects

All economic activity requires a certain amount of transport. This is why the demand for transport is seen as a derived demand both in the case of passenger and freight. According to economic and behavioural theories people wish to travel so that some benefit can be obtained at the final destination. The trip itself is to be as short as possible (Button 2003).

Transport has always played a strategic role in the economic development of spatial entities. Easy access and proximity to main transport infrastructure such as roads, rivers and seaports has for ages given rise to important and commercially successful cities (Blauwens et al. 2002). This is true for the main Alpine centres too, which can be found in the most accessible valleys and in the Alpine foothills. However in some Alpine locations accessibility *per se* is not a sufficient condition for good economic performance.

This chapter introduces the role of transport and mobility in view of a growing trade volume within and across the Alpine Space. The positive, supporting effects of transport and mobility for economy and development are addressed as well as the adverse effects of transport. Therefore the main question of the interrelation of transport and economic growth is considered and consequently questions on the internalisation of external transport costs are raised.

C1.1 Trends of inter-regional trade in the Alpine space

In the Alpine space – as already shown in chapter A2 and confirmed by EU data – a high level of international and inter-regional trade has been registered in recent years and is expected to continue to rise in the future.

It is estimated that the volume of goods transported overland will increase by 70% between now and 2020 in the EU-15 and by up to 95% in the ten new Member States (European Commission DG TREN 2004).

For the Alpine area, the trend is confirmed: Between 1994 and 2004 road transport increased by 300% while rail transport increased by 25%. Provided that no substantial changes take place in business and technology, the OECD has estimated a growth in freight transport of 76% between 1990 and 2030, of which the trans-Alpine traffic alone would increase by almost 3 times. Passenger traffic too would grow by 76%, of which the trans-Alpine traffic alone would rise by 2.4 times. Roads would capture more than 90% of the passenger-traffic increase, and nearly 80% of the freight-traffic increase. One of the main reasons for such a growth is the central geographical position of the Alps with respect to Mediterranean and Central European trade (OECD 2001).

For the case of road transport, Tab. C1-1 shows the main origin and destination centres in the Alpine space and their GDP, where a higher level of trade and transport can be found. These regions can be considered to host the main Alpine interregional markets.

Region (NUTS-2)	Originated road vehicles/ year	Road Vehicles per year attracted	GDP in EUR per capita 2002	Development of GDP in EUR per capita 1998–2002 [%]
Steiermark	854,000	926,000	22,913	15.2
Lombardia	851,000	925,000	28,691	16.4
Veneto	450,000	396,000	24,945	15.7
Piemonte	433,000	417,000	25,230	14.8
Niederösterreich	379,000	350,000	21,759	11.6
Oberösterreich	269,000	249,000	25,230	14.8
Kärnten	236,000	221,000	22,359	12.9
Provence-Alpes-Côte d'Azur	220,000	188,000	22,858	17.7
Tirol	204,000	190,000	27,735	16.2
Rhône-Alpes	204,000	210,000	25,194	13.6
Oberbayern	190,000	175,000	37,141	12.3

Tab. C1-1: Main Alpine origins and destinations for road transport of freight and GDP (Source: CAFT 2004, analysis BMVIT; ESPON 2003).

Aggregated data for the whole Alpine space result in an average per capita GDP of € 22,859 and an economic growth of 15.1% between 1995 and 2003 (MARS 2005); these values are in line with the reported data.

C1.2 Effects of transport enhancing development and economy

In modern economies effective transport systems have often been a catalyst in extending local markets, connecting separate regions and fostering market openness. They shifted a variety of goods and services to places where they were neither produced nor available before. Therefore, transport can bring economic advantages to consumers, who can reach more goods and services at lower prices.

Good accessibility, efficient transport infrastructures and modern mobility concepts can induce employment and consumer wellbeing (and GDP) convergence (AlpenCorS 2005).

Despite uncertainty about their specific effects, infrastructures have often been used to foster local employment, enhance regional development and encourage local industry in certain areas (Blauwens et al. 2002). The decision to create an infrastructure results in both direct and indirect effects.

- A direct effect on GDP can be measured in terms of increased employment rate (see PAN-EUROSTAR 2003 and box on the Torino-Lyon and Gotthard tunnels below) and convergence in economic growth (AlpenCorS 2005).
- Indirect effects of infrastructures are on the other hand mainly linked to their use. They can reduce journey times and bring about a reduction in transport costs, sometimes resulting in consequences in the fields of consumption, movement of people and income distribution (Quinet & Vickermann 2004).

C1.2.1 Transport infrastructure effects

When a new infrastructure is planned some regions are usually advantaged, whereas others may be disadvantaged. Within the framework of a redistribution of economic activities in an inter-regional perspective (where some regions specialise in certain production), the presence of efficient transport infrastructures can lead to sector specialisation and relocation of firms in the long run (Armstrong & Taylor 2000).

As an example of large infrastructure investments the main ongoing and projected Alpine tunnel projects and their respective costs are listed below (cp. Tab. C1-2).

Investments in the main Alpine tunnels	Tunnel length [km]	EUR
Lyon-St.Jean de Maurienne (Source: LTF)	65*	6.7 billion
Gotthard tunnel (Source: Alptransit)	57	5.1 billion
Brenner Tunnel (Source: BBT SE)	55	4.5 billion
Lötschberg tunnel (Source: BLS Alptransit)	34.4	2.1 billion

Tab. C1-2: List of main Alpine tunnel projects and costs (the amounts reported for the Gotthard and Lötschberg tunnels correspond to 8.035 and 3.22 billions CHF approximately). *St. Jean de Maurienne – Venaus: 53 km, Bussoleno: 12 km.

Case study: Torino-Lyon and Gotthard tunnel employment effects

The employment generated during the construction period of the French-Italian common section has been calculated by the Committee for the Liaison Européenne LyonTurin (LTF).

Once construction has started on both the basis tunnel and the Bussoleno tunnel, the employment of nearly 3,500 workforce is envisaged.

At the peak of the total activity on the construction of the new Lyon-Turin link, between 6,200 and 6,500 people will be recruited on the French side (including approximately 4,000 people for the sites depending on the Réseau Ferré de France).

For the Italian section whose owner is RFI, nearly 1,500 people should be recruited by the trans-Alpine sites at the peak of the activity.

Until now, during all the phases of the Gotthard tunnel construction nearly 2,250 people have been recruited.

When evaluating the construction-related employment effects of these infrastructure projects, one has to bear in mind that only a small proportion of labour is recruited at a regional level and thus effects on regional employment are rather small. Furthermore, the working conditions of these tunnel projects are difficult and hazardous.

Sources: LTF 2006, ALPTRANSIT (n. d.)

Cost reduction due to better transport infrastructure

The reduction of the cost of transport leads to reduced production costs and to a modification in the level of output within a certain region. This cost reduction can also lead to an improvement in inter-regional trade: on the one hand because reduced transport costs make it easier to export, on the other because the rise in output leads to an improvement in the availability of exportable goods (Anderson & Wincoop 2004, Kopp 2006).

In a free market this would lead to lower prices and to an advantage for the consumers. The difference in prices in the two regions should be equal to the price of transport (Quinet & Vickerman 2004). The existence of several transport subsidies in the Alpine countries, together with the decreasing share of transport costs in pricing, however, tends to reduce the benefits deriving from a reduction of transport costs for inter-regional trade.

Spatial dimension of economic effects

The distributional effects of a reduction in transport costs – that is, how a cost reduction influences the allocation of economic advantages among the parties living within a specific region – due to improved infrastructure are often not taken into consideration by policy makers.

Different consequences can derive from such a cost reduction and relative advantages can affect different parties such as enterprises, consumers or employees. Enterprises can profit from increasing revenues if the reduction does not result in lower prices. Consumers can benefit from lower market prices and larger supply of goods available on the local market. Employees can get either higher or lower wages, because of the increased labour force competition induced by higher accessibility standards (potentially leading to a wider supply of labour force and to lower wages) and the reduced distance-related costs they incur which can result in lower transport costs for employees living out of the region. Additionally, it must be kept in mind that transport costs are continuously becoming less significant in overall price calculations.

All of these aspects and the complexity of assessing the whole effect of an infrastructure on the Alpine space have to be carefully considered. There is a common tendency to underestimate the scope of the economic effects of an infrastructure.

It is essential to keep in mind that inter-regional trade through the Alpine space induces economic consequences beyond the Alpine region. Often outer regions can attain even higher economic advantages from good transport infrastructure and services than those in close proximity to the Alpine area. This happens because outer and formerly isolated regions can gain substantial marginal advantages from reduced transport and time costs connected to an infrastructure, even though it is situated relatively far from them.

This consequence can also be drawn from the consideration of the extra-European array of the TEN corridors, which – from an economic point of view – is much larger than it could seem if only the physical networks are considered (see Chapter B2).

Case study: Effects of infrastructure investments on spatial planning and regional economy (Switzerland)

It is questioned if transport infrastructures induce local development or merely help to accommodate a situation that would have occurred anyway. Regions that already have a relatively good traffic infrastructure seem to gain limited marginal advantages from the construction of new infrastructure.

This is why higher effects on GDP are usually found where the infrastructure system is in an early development stage (Rietveld & Nijkamp 2001). A large increase in accessibility in mountain regions sometimes translates into only small changes in economic activities (MONTESPON 2006).

These findings are confirmed by a study launched by the Swiss Federal Office for Spatial Development (ARE) in 2003 (ARE 2007). In four case-studies (three of them dealt with infrastructure-investments in mountainous regions) the spatial and economic effects of new transport infrastructure investments have been investigated. The three case studies focused on the territorial effects of transport infrastructures on the Alpine territory (Vereina tunnel; Vue-des-Alps tunnel; transport infrastructure in "Piano di Magadino").

One of the outcomes of the study was indeed that the economical effects of these investments cannot be easily isolated, as locational processes are slow and influenced by a multitude of constantly changing parameters. According to the study, infrastructure projects have the potential to accelerate or slow down ongoing spatial processes, but they rarely contribute to a turnaround of spatial development. Furthermore, new Alpine infrastructures are often embedded in an already existing dense transport network and therefore often create redundancies in the system. In a country with a less dense transport network the outcome might have been different.

C1.2.2 Effects of improved mobility on Alpine living standards

Good transport services seem to play a substantial role in determining the endogenous path of growth of a region (Quinet & Vickermann 2004). In addition to the Keynesian approach that was already experimented with in the pioneering railway developments since the 19th century, with the clear intention of fostering local employment and shortening the distance from peripheral regions to locations where trade took place, some other more substantial effects have also been recognised.

It has been argued that transport has a "public good" aspect and is able to produce not only negative (which will be discussed later), but also positive externalities. In economics an externality is the effect of a transaction between two parties on a third party who is not involved in carrying out that transaction. The production of a public good has beneficial externalities for all, or almost all, of the public. In this case, externalities produced by transport are not directly related to transport structure and can often take the shape of social and relational advantages. Then easier access to the market is often ensured by well developed transport networks (such as railway and road systems).

Improved accessibility standards permit a change in economic activities, usually improve the land value and open the Alpine space to new entrepreneurial initiatives that can create an economic surplus and improve the local employment (even though sometimes local wages can suffer a decrease).

Below, some changes in economic and social life are listed. They are often linked to improvements in transport effectiveness within a framework that is called "death of distance" (Rietveld & Vickerman 2004) and can bring new opportunities for spatial development:

- Development of interregional and international trade, allowing more materials to be obtained at a lower cost,
- relocation of firms and consumers,
- better matching of needs with means of satisfying them,
- identification of possible new sources of supply for local enterprises,
- market enlargement and trade globalisation,
- possible growth of employment rate (in the short or in the long term), and
- increase in tourism, leisure and business trips.

Generally, positive tourism and commercial development can be related to sufficient levels of accessibility, which thus becomes a factor of local development.

In this respect, a balanced and functional economic network with substantial effects on the local economy has been developing. Evidence of this is given by the diffusion of relatively recent new businesses in the manufacturing and high-tech service industries, which add to those already well established in other more traditional sectors (e.g. timber, food, hand-made products, hydro-power etc.).

C1.3 Adverse economic effects

Some negative effects can result from transport development both on the economy and on the sensitive Alpine environment, which is suffering from the ever-increasing impact of freight and passenger transport (EEA 2006).

Conversely, adverse effects can result from improved means of accessibility to peripheral or economically weaker Alpine regions, which may lose markets due to the increased competition generated by new infrastructures. Intensified global trade has led to local losses in businesses that face particular competition in the globally integrated market. Within the Alpine territory this could lead to the market exclusion of traditional firms and less competitive enterprises. Even though this situation can bring a possible advantage for other competitors, local shops and small shopping centres may be forced to close, reducing the supply of local goods in smaller Alpine centres. Furthermore, the concentration of

suppliers is reducing options for the less mobile sectors of the population.

Traffic infrastructures tend to increase traffic flows and produce growing external costs, especially in terms of environmental degradation (e.g. noise, air pollution) and other aspects such as urbanisation and spatial planning, safety and financing.

These costs are often not fully considered when investments in transport infrastructures are made and most national accountings do not recognise them. Alternative investment choices remain possible and can lead to similar or even better economic effects in the region, since transport policy has its own specific features and should not be considered as a substitute for a sound economic policy (Blauwens et al. 2002).

Transport infrastructures can also produce a multitude of diverse effects on local development within the respective territories, which in their complexity and inconsistency are sometimes difficult to assess for the local population. Therefore the consideration of the local effects of infrastructural projects is becoming a priority in the Alps. Promoting public consultations and involving local stakeholders when new infrastructures have to be built can help in finding socially acceptable options at local level (Dematteis & Governa 2002).

C1.4 Transport and development in the Alps: towards the identification of a trend for the Alpine countries?

According to recent studies, there is a link between the availability of transport services within a region and its social and economic development (Button 2003). This relation is supposed to work in two directions: on the one hand, transport demand grows according to the economic development of a region; on the other hand transport services and infrastructure improvements can induce economic development, especially in the long term (Quinet & Vickermann 2004).

One of the hot issues of discussions on the effects of transport is that indications exist which display a close relationship between transport and economic growth, while at the same time a correlation between transport and economic growth cannot be established in other regions (Zambrini 2005).

C1.4.1 Close relation between economic and transport growth

A direct relationship between mobility and economic growth (usually expressed by GDP) has been identified in the European countries (Button 2003): a higher development of the transport system accompanies higher levels of economic wellbeing. This same relationship can also be found, at national level, in the countries participating in the Alpine Convention that are among the richest in the EU (EUROSTAT 2005; OECD 2006). An internal comparison among Alpine countries shows a stable economic situation in the region. National GDP levels are quite high (OECD 2006) and infrastructure development in physical terms has been limited in the last few years. In most developed European countries (including the Alpine ones) the strongest infrastructure development was mainly concentrated in the 1960s and 1970s (Button 2003).

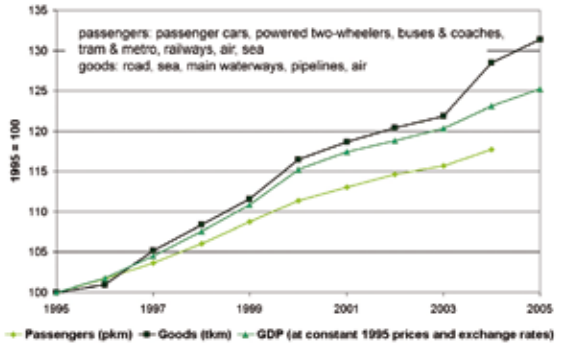
A further clarification can be added with reference to the relationship between transport and economic growth. Economic growth is positively affected by substantial improvements in transport infrastructures when the general infrastructure provision is rather poor. In contrast, this relationship is generally weaker when transport networks are well established.

Sometimes infrastructure endowment and GDP does not show a strong correlation. Other factors including land prices, availability of labour and employment opportunities, the transport intensity of the local economy and the intensity of competition on the local economy can equally have substantial effects on regional economic development (Zambrini 2005).

Furthermore, transit traffic usually depends on the economic growth of neighbouring regions rather than on local development of the transited area.

In the period from 1995 to 2002, the volume of freight and passenger transport and the economy have both been growing (DG TREN 2004). Since 1995, the growth in transport volumes in Europe as a whole has almost paralleled growth in GDP (EEA 2006). Specifically, freight traffic has grown at a faster rate (+34%) between 1995 and 2004, compared with GDP growth over the same period (+26%). Heavy goods traffic has grown at a slightly slower rate.

On the other hand passenger transport seems to have grown less substantially in EU countries (+30%) and in the Alpine area. In passenger transport, a partial decoupling was achieved between 1996 and 2002 (EEA 2006). In the following figure, the development of passenger and road transport is compared to GDP growth in the EU (see Fig. C1-1). It is important to focus on the recent substantial growth of freight and passenger transport as well as of GDP between 2003 and 2004, which can only be partially related to some methodological changes in data collection.



GDP at constant prices	1995- 2005 p.a.	**2.3%**	2004–2005	**1.7%**
Passenger transport- Pkm	1995- 2004 p.a.	**1.8%**	2003–2004	**1.8%**
Freight transport Tkm	1995- 2005 p.a.	**2.8%**	2004–2005	**2.2%**

Fig. C1-1: Transport growth in EU-25 with respect to passengers, goods and GDP (Source: Statistical pocketbook 2006 (http://ec.europa.eu/dgs/energy_transport/figures/pocketbook/2006_en.htm)

The situation described above is common to most European countries and is considered to be a natural consequence of the establishment of the EU internal market (EEA 2007). In the EU more goods are transported over longer distances and more often than ever. As the data reported confirm, no clear signs of separating freight transport volumes from GDP have been shown until now and passenger transport volume has been growing in most EU countries (EEA 2006).

C1.4.2 Decoupling economic and transport growth

However, since a lot of different components participate together in the determination of GDP, it is not possible to establish a precise causality relation between these two variables.

Separating transport volume from economic growth is considered to be a primary method of limiting or reducing the environmental and health impacts and other side-effects of transport. The goal to achieve is a separation of mobility from all its side-effects, according to the EU and other international organisations such as OECD. To this end, special attention is paid to the issue of the internalisation of external costs of transport and the reduction of transport subsidies (EEA 2007).

Pricing is a method of addressing transport volumes. For instance, price elasticities show that transport volumes respond to changes in fuel prices.

Effects of fuel prices on transport volumes

It can be useful, for example, to consider how transport demand is affected by changes in fuel price. Examining this change can be useful for assessing the possible effects of a higher fuel price on the choice of passenger transport modes, or evaluating the modifications induced in road transport when a fuel charge is introduced. One way of defining elasticity is as the proportional change in one variable relative to the proportional change in another variable. Thus it is a measure of relative changes.

The figure below (Fig. C1-2) shows the results of a study of elasticity of transport demand in relation to fuel prices.

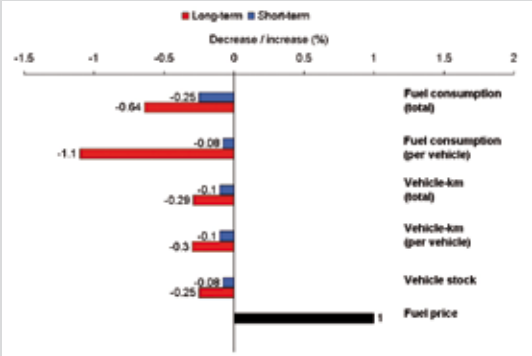


Fig. C1-2: Elasticity of transport demand with respect to fuel price (Source: EEA 2006).

For example, a 1% increase in fuel prices is responsible for a 0.1% short-term decrease in terms of vehicle-km. The long-term decrease is higher, namely 0.3 % per single vehicle or 0.29 % in total. With a constant or declining occupancy rate, the transport volume in terms of passenger-km decreases at the same rate or faster, respectively. This means that the transport volume from 1990 to 2002, as depicted in the figure above (with the development of fuel prices), would have grown even faster if fuel prices had stayed at a constant level.

Economic growth and transport in the Alps

The trends discussed above have changed substantially over the last 30 to 40 years. Models and studies developed over a long period of time suggest that in the 1960s – for example – the relationship appeared to be stronger and that transport demand would have grown disproportionately with respect to regional GDP, as happens today in most developing countries (Quinet & Vickerman 2004).

Since this general trend is confirmed also within the Alpine Space, according to the available data at EU level, a growth in the demand for transport services and infrastructure is also likely to occur in the Alpine territory, especially if an adequate quality of transport services is ensured.

In any case, it is questionable whether the issue of new transport infrastructure construction in the Alps is crucial for regional economic growth. As already mentioned, the reasons for building new infrastructures in the Alps cannot be strictly economic. But rationales may also consider other so-

cial and ecological benefits that can be stimulated by transport in the Alpine region – and that should also be assessed in economic terms (see discussions of external costs below). For instance, improvements in short-range mobility can have an effect on local social networks, and new rail networks, accompanied by sound transport policies, can help to reduce the use of motor vehicles in the Alpine area, by improving both freight and passenger transport by rail.

C1.5 External costs of transport from an economic perspective

C1.5.1 A complex definition

The issue of the external costs of transport, particularly those of road freight transport, is increasingly being discussed in the Alpine region, both in regard to their environmental impact and to their direct economic costs (e.g. infrastructure investments, insurance, etc.), not usually recognised by national accounting. Detailed information about transport costs is essential both for micro-economic and private decisions and for macro-economic policy choices.

Different types of costs are usually considered to make up the structure of transport costs. The main cost categories considered are internal and external costs (cp. Fig. C1-3), where the former include infrastructure and private costs and the latter environmental and social costs and costs related to congestion, accidents and land use (Greene et al. 1997).

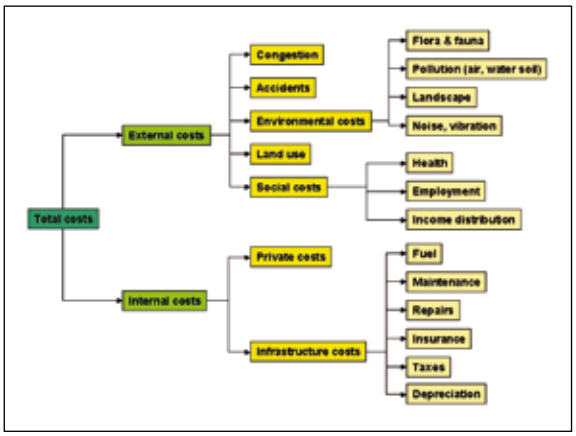


Fig. C1-3: Components of transport costs (elaboration on Greene et al. 1997).

The most interesting components of transport costs for the Alpine region are external and infrastructure costs. Measures must be taken to internalise external costs and to compensate for rising infrastructure costs especially by means of tolls, which are widely borne by public authorities (both at the national and EU level) but can lead to substantial advantages for private trade and interests.

Some of the typical transport costs that should be covered by users are land use (e.g. purchase and development of land), infrastructure supply (e.g. construction and maintenance costs of the infrastructure) and possibly external costs borne by the population and public authorities (e.g. environmental and congestion costs).

This is an extremely sensitive subject, particularly in those Alpine countries which have a very high rate of through traffic (for example Switzerland, Austria and Italy).

When trying to assess the costs of the transport system in the Alpine region, it is essential to work both on macro- and micro-level. Firstly, macro cost categories are defined, which then have to be split into micro sub-categories, as illustrated in Fig. C1-3 above. In this context, among others, the following costs in particular have to be taken into account:

- Investment and management costs of the system, including in this macro-category costs relating to labour force employed and logistic costs (such as handling, inventory, stock-out and other costs),
- external costs, including the impact on the environment and human health, as well as accident costs, and
- time costs, including also the cost of congestion in terms of longer travel time.

For each of the costs reported in Fig. C1-3 an indicator has to be set and agreed among stakeholders (policy, research, enterprises and other user groups, resident population). A balance with resulting benefits (for example in terms of time-savings and better accessibility) has then to be made.

Moreover, to define other specifically Alpine cost categories, it is necessary to promote a review of the methods used in different countries to assess transport externalities and the tariffs currently applied, with the aim of defining the parameters to be used in order to determine the “true costs”, as provided by Article 14 of the Transport Protocol of the Alpine Convention.

Strategy for response and use of economic instruments

Concerning the external costs – more precisely the environmental costs of transport – it is important to remember that there are different methods of assessing them, and an agreement on these is far from being reached among experts. To attempt an evaluation of these costs is rather complex and delicate. The benefits generated by mobility and transport activities for the Alpine economy have also to be considered. Comprehensive studies have been developed both at national and at EU level, the results of which are presented in Figures C1-4 and C1-5 at the next page (EEA 2006).

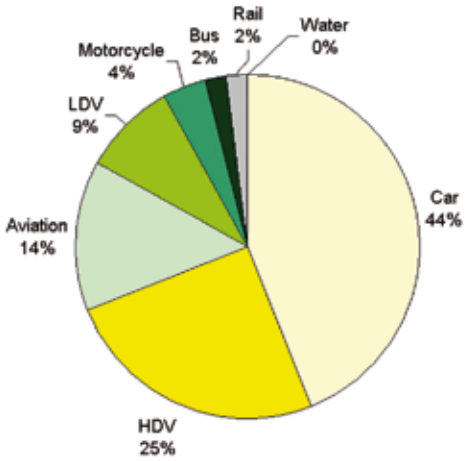


Fig. C1-4: Composition of external costs of transport in EU-15 plus Norway and Switzerland by transport mode (Elaboration on INFRAS 2004).

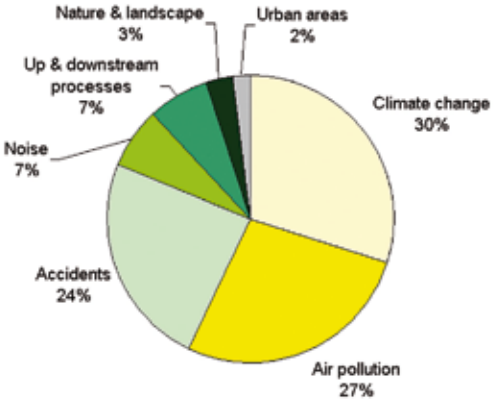


Fig. C1-5: Composition of external costs of transport in EU-15 plus Norway and Switzerland by cost category (Elaboration on INFRAS 2004).

According to these studies, transport imposes significant costs on society. In the EU-15 plus Norway and Switzerland (EU15+2), external costs from transport were estimated at 7.3% of GDP in 2000, which is almost 650 billion EUR (INFRAS/IWW 2004). Car use causes the largest share of external costs (44%), followed by heavy-duty vehicles (25%). Road transport as a whole accounts for 83% of external costs while the share of rail and water transport is very small.

The cost-categories considered in the Swiss study include accidents (medical care, costs of lost opportunities to society, suffering and grief), noise (damage to human health), air pollution (human health, material damage, biosphere), climate change (damage from global warming), nature and landscape (damage reparation, compensation), urban effects (time loss, land take), upstream processes (additional environmental costs including risk) (EEA 2001). The results of some interesting analyses developed at national level in some Alpine countries are given in the table below (Tab. C1-3).

	INFRAS		AMICI DELLA TERRA		EC WHITE PAPER	FRENCH MINISTRY	
						min	max
	cent EUR/t*km	EUR/veic*km	cent EUR/t*km	EUR/veic*km	EUR/veic*km	EUR/veic*km	EUR/veic*km
Incidentality	0.68	0.04	0.4	0.02	0.01	0.02	0.04
Noise	0.51	0.03	1.47	0.08	0.02	0	0.05
Air pollution	3.1	0.17	4.94	0.27	0.09	0.01	0.28
Greenhouse emissions	1.5	0.08	0.78	0.04	0.01	0.03	0.04
Nature and landscape	0.22	0.01					
Urban effects	0.13	0.01					
No direct costs	0.87	0.05					
Congestion			0.78	0.04	0.06	0	0.23
Infrastructure					0.03	0.03	0.04
TOTAL	**7.01**	**0.39**	**8.37**	**0.46**	**0.22**	**0.08**	**0.65**

Tab. C1-3: External costs of freight transport evaluated on the basis of main European studies (Source: MATT 2005).

The marginal external costs[1] – which form the best basis for the establishment of internalisation instruments and represent the incidence of a certain mode of transport on the environment – vary considerably between and within transport modes. They also depend heavily on the type of vehicle, the fuel used, and on the specific traffic situation. Hence, when defining transport price, flexible pricing instruments are needed to internalise such costs effectively. Eventually, a pricing policy should result in an optimal transport provision in a competitive system which should incorporate all aspects of sustainable development.

There is a common need to address the serious challenge of growing external costs in the Alpine area with appropriate measures. This appears also from the EU charging policy known as Eurovignette.

[1] Marginal external costs (MEC) are the change in the cost to parties other than the producer or buyer of a good or service due to the production of an additional unit of the good or service. Environmental pollution is an example of external costs and can be assessed in marginal terms. (For example, suppose it costs the producer €50 to transport another unit of a good. Suppose this movement results in pollution which causes €60 worth of damage to the public. The marginal external cost is €60).

Some of the main problems generated by the transport activities in the Alpine area are the following:

- Economic inefficiencies, including increasing transport costs and transport networks unable to cope with the growing logistic requirements and mobility needs in relation to commercial competitiveness,
- increasing congestion problems in the whole Alpine region, mainly in urban areas during the summer period,
- a large number of traffic accidents and related high general health and social costs,
- increasing environmental damage and growing energy consumption, and
- imbalances and inefficiencies of territorial and urban planning reinforced by the current transport network.

In order to address the negative effects on the Alpine economy caused by increasing mobility, the EU is pushing Member States to adopt measures promoting environmentally friendly means of transport, a more balanced use of transport infrastructures and specific incentives to reduce their environmental and socio-cultural impact.

Main findings

Status

The transport system can play a substantial role in supporting local development in less accessible areas. The economic effects of transport in the Alpine region remain complex to assess accurately, since economic advantages can add to adverse economic effects.

In general, new transport infrastructures in Central Europe are only one of a multitude of factors influencing regional development and have only limited effects on economic development in the Alps.

From an economic point of view, transport is considered as a public good, producing both positive and negative externalities in terms of improved accessibility, development of inter-regional trade, development of local markets but also increasing environmental (ecosystem, energy, noise, pollution) and functional costs (congestion, accidents, land use).

Trends

A steady growth of trade within the EU common market is predicted which will affect and intensify traffic within and across the Alps.

The construction of new infrastructure can have positive effects on local employment and market enlargement, and can help to foster competition and regional sectoral specialisation. On the other hand it can also expose less competitive and traditional firms and areas to global market forces and lead to complex structural changes in regional economies. Furthermore, an improved transport infrastructure leads to polarising effects on shopping facilities and consumption between central and peripheral Alpine regions, which often reduces local daily supply options for the latter. Some of the effects deriving from new infrastructure in the Alpine area go far beyond the scope of the Alpine region and have to be considered on a European scale.

Hot issues

Some of the Alpine countries are among the richest in the world and their general economic situation can be defined as stable. In this context until now no decoupling between economic and traffic growth has been achieved and a considerable future traffic growth is expected for Europe and especially the Alps. No clear correlation between regional added value and transport infrastructure can be established for the Alpine region. While improved transport infrastructure may enhance regional development, several other factors are equally steering economic development.

The issue of internalisation of external costs is very complex. As well as negative external effects, such as environmental degradation, noise pollution, building damages and insurance costs, beneficial external effects such as social interaction and time savings need to be taken into consideration.

Even though the assessment of external costs of transport in the Alps remains a complex task, some efforts in this direction have been made in the Alpine countries and at European level. On the other hand, economic instruments are increasingly adopted in the framework of national transport policies in the Alpine countries. At European level the recently updated Eurovignette Directive (Directive 2006/38/EC) addresses the problem of external costs and of harmonising charges for heavy vehicles using the road network. It draws attention to the need to find a common methodology to assess external costs of road freight transport in accordance with the Transport Protocol of the Alpine Convention.

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C2 Effects in the Social Sphere

Large parts of the Alpine arc are characterised by decentralised settlement patterns. These are places where people live and work that can be rather far away from the main economic and commercial centres.

There is a particular risk of decentralised settlements in strongly agricultural areas where the decline of alternative employment opportunities other than agriculture forces people to leave, and which are not easily connected with one of the above-mentioned economic centres (Meyre & Stalder 2006). Unlike the peripheral areas in the lowlands (Sweden, Germany), the Alpine arc is characterised by a rather small-scale pattern in which depopulating areas and areas with a positive growth rate are located close to each other.

For people living in peripheral areas, reaching shops, public transport stops, public offices, health and social centres can be difficult. All this, together with the often poor connection to communication networks and to the limited public transport services, contributes to make the distance from the other areas longer and penalises the groups who for some reason do not own a car or are not able to drive causing a problem of social equity.

The social sphere is affected by transport and mobility in many ways. These consist of positive and negative factors: for instance, the separation of homes and workplaces and their corresponding social contacts, a change in life quality in urban and rural surroundings due to noise and a change of access to open space, faster and better accessibility to shops and public services or the disappearance of public services from sparsely populated areas. Among these factors, demographic change plays a key role in the effects on social sphere in the Alpine area.

This chapter therefore introduces the role of accessibility in social equity and the groups which are most affected. The effects of an ageing population on transport needs are outlined and the situation in the Alpine arc is analysed.

"Basic provision"

A certain politically determined minimum level of public services, including the infrastructure necessary to provide them: drinkable water and sewage treatment, energy, telecommunications, postal service, radio, tv, public transport and road network, medical and pharmacological, school, education, primary necessity goods.

"Public services"

Products and services of a public (cooperative) nature, i.e. goods that would not be provided – or not provided to a sufficient, universal degree – if left to the market alone (Egger 2006)

C2.1 Accessibility and social equity

In mountain areas public transport can only provide a partial service (see chapter A3). Peripheral municipalities, in particular, are serviced by public transport only few times or even only once a day. Because of the lower number of potential users and the higher cost of supply in comparison with the central areas, the maintenance of the service can be quite unprofitable for this kind of municipalities and the consequences are:

- A high car dependency (the car is the most flexible means of transport and facilitates access to jobs, leisure and other services);
- The penalization of those such as the elderly, disabled people, children or simply those with a low income who do not own a car or who are not able to drive. For these groups of the population, reaching the basic services can become a real problem. In particular, circumstances such as a bus stop which is too far away, or a reduced bus service, may constitute serious limits for these groups of people, and are an obstacle for participation in community life and for their social inclusion (WHO 1999, WHO 2002).

The social inclusion of a particular group or of an individual is affected by many transport-related factors:

- Access needs: some groups such as students, employees, parents with children or elderly people tend to require access to more activities than retired people, or people who have no dependants;
- Location and land use: in a more accessible location, destinations are closer together, reducing the amount of physical travel required to reach a given set of activities;
- Mobility options: people's ability to travel is affected by the quantity, quality and affordability of their travel options;
- Mobility substitutes: telecommunications and delivery services can sometimes substitute for physical mobility, reducing the amount of travel needed to reach activities.

The more responsibilities and physical, economic or social constraints an individual bears, the more likely they are to experience transport-related social exclusion.

The situation is sometimes worsened by the tendency towards a reduction in decentralised shops and, at the same time, an increase in the number of shopping centres in or near towns. This contributes to the separation of living, working and buying locations (see chapter B2) while the accessibility of shops within walking distance has decreased. Like a vicious circle, the low use of infrastructures and services which leads to their abandonment makes these locations even less attractive for the inhabitants as well as for those who might move there (Steiner 2005).

Elderly people and less mobile people in those regions which registered a depopulation are particularly penalised by the lower availability of infrastructures (see chapter B1). In many mountain municipalities there are not enough customers to

keep shops, pharmacies, post offices, associations etc. open (Machold & Tamme 2005). For instance, almost half of the Tyrolean municipalities, and in particular those characterised by a rather low demographic density, have no post office any more, and one third are lacking a grocery shop (Stalder 2005; Steixner 2005).

The increasing concern for maintaining public service provision in sparsely populated mountain regions has led to the development of sustainable strategies and innovative solutions for improving public transport, roads, infrastructures relating to youth, health, telecommunications and daily needs. This allows these regions to upgrade, both as economic areas and as places of residence (Petite 2006).

An important challenge for the future is making these decentralised areas sufficiently accessible, keeping under consideration both the environmental and the socio-economic aspects. In these areas accessibility, if inserted into a political framework of sustainability, can have important implications on economic development, quality of life, the vitality of mountain areas and on the development of cultural landscape.

Adequate accessibility, both from the point of view of transport and communications infrastructures and from the point of view of the connection to public services (public transport, telecommunications network, social and cultural services, etc.), is important for the physical and intellectual mobility of individuals. It is important both for elderly and for younger and highly skilled people. The former constitute a share of population which is constantly increasing, whose requirements have to be identified and met. As for the latter, transport systems and infrastructures are essential because they make it possible for them to commute in order to study, work and benefit from the educational, cultural and recreational opportunities of the urban centres. At the same time they use facilities to do the shopping.

However, good accessibility is not the only variable to guarantee a vital mountain region (Pfefferkorn et al. 2005). For a balanced demographic structure and the integration of all social and age groups, more appropriate policies and economic measures are necessary in order to support services, infrastructures, any sort of cultural stimuli and a good interchange between modern trends and traditional values. Only this integrated approach permits the conservation of settlement patterns and of human capital (Bätzing 2005; Egger 2005).

C2.2 The ageing population

Elderly people and young people still in the educational process are the two groups which suffer the most from scarce means of access. If the former continue to live in the municipalities where they have always lived, facing the difficulties associated with living in peripheral areas and the closing down of many shops and services, it is likely that many of the latter will leave these areas as soon as they can in order to benefit from a wider range of services and opportunities.

The exodus of the population aged between 20 and 64 years, typical of peripheral municipalities, contributes to the overall ageing of these towns. Ageing is a global phenomenon but in certain areas it can have particularly serious consequences.

In 2000 in Europe the percentage of persons over 64 years amounts to 15.7 % (= EU-15; EU-25: 16.3 %, EUROSTAT 2000) and has continued to increase in the last 15 years. EUROSTAT (2006) expects that in 2050 one third of the population will be over 65 years, i.e. the share will double by 2050.

Ageing of population

A summary term indicating the shifts in the age distribution (i.e. age structure) of a population toward older ages. It is a direct consequence of the ongoing global decline of fertility and mortality (Gavrilov & Heuveline 2003).

Over-ageing

A population can be regarded as "over-aged" when more than 15% of the total population is over 60 years old (Bähr 2004).

Old age index

A *dynamic indicator used to describe the demographic structure of a region (ASTAT 2003). It is defined as the number of people over 64 per 100 young people under 15 (Gavrilov & Heuveline 2003).*

With its particularly high percentage of people over 64, Italy is at the top of the compared Alpine States. But there is no difference between the Italian Alps and the national value. The Principality of Monaco was not considered because, due to its particular conditions (tax policies, climate, society and leisure facilities), mainly old and well-heeled people have settled there. Hence the highest values could be observed here. From a demographical point of view a dynamic development was registered for Slovenia and for Liechtenstein. Both have a very low share of people older than 64.

A more differentiated picture shows the distribution of municipalities with an above-average share of elderly people. For 63% of municipalities within the Alpine Convention area, the percentage of inhabitants older than 64 years is above 15%. 41%, or 1,529, of these municipalities are in Italy while more than a quarter are in France. Almost 87% of "over-aged municipalities" are in the Italian Alpine Convention area, 60% in the German and more than half in the French and Swiss ones. Within the Italian Alpine arc, Alto Adige/Südtirol is striking with its share of 15.7% of people older than 64. Only 39 (33.1%) of the 116 South Tyrolean municipalities exceed the share of 15%.

The old-age index (see box) accurately determines the distribution of over-ageing in single mountainous regions. The Alpine-wide average value is 100.3. An analysis of the population older than 64 confirms a high percentage of elderly people in Italy's Alpine regions. In Liguria in particular, the old-age index amounts to 241 (Fig.C2-1 and Fig.C2-2). Among those five regions with the highest old- age indices, four are located in Italy's Alpine arc. The regions with the lowest old-age index are Liechtenstein (63), Vorarlberg/AT (64), Rhône-Alpes/FR (70) and Tirol/AT (73).

Map C2-1 depicts a high contrast between the northern and the southern part of the Alpine arc. Due to their low share of over-aged people, the autonomous provinces of Alto Adige/ Südtirol and Trentino, as well as the autonomous region Valle d'Aosta, are an exception. Due to a high migration rate, some Austrian municipalities in Obersteiermark and some municipalities bordering the Bavarian Alps are also suffering from over-ageing. On the contrary, Liechtenstein and the Austrian regions of Vorarlberg, Tirol and Salzburg show a below-average old-age index.

Country	Persons over 64 in the total population [%]		Alpine Convention area			
	National values	Alpine Convention	Municipalities	Municipalities recording over 15% of persons older than 64 years	Share of municipalities, recording over 15% of persons older than 64 years [%]	Total share of all municipalities with over 15 % of persons older than 64 years [%]
1	2	3	4	5	5/4	5/5 (total)
Austria	15.4	15.1	1,148	493	43	13.2
Switzerland	15.4	15.9	944	519	55	13.9
Germany	16.4	17.3	285	170	60	4.6
France	16.1	15.1	1,749	990	57	26.6
Liechtenstein	11.3		11	0	0	0
Italy	18.3	19.1	1,756	1,529	87	41
Monaco	22.4		1	1	100	0
Slovenia	14.0	14.0	60	26	43	0.7
Alpine Convention	**17.0**		**5,954**	**3,728**	**63**	**100.0**

Tab. C2-1: The share of people over 64 in the Alpine Convention area. Data refer to 1999 (France), 2000 (Switzerland), 2001 (Austria, Italy, Germany and Liechtenstein), 2002 (Slovenia). [Source for Alpine Convention: INSEE 1999 (France); Bundesamt für Statistik Bern 2000 (Switzerland); Statistik Austria 2001 (Austria); Bayerisches Landesamt für Statistik und Datenverarbeitung, 2001 (Germany); Amt für Volkswirtschaft 2001 (Liechtenstein); Statistical Office Slovenia 2000 (Slovenia)].

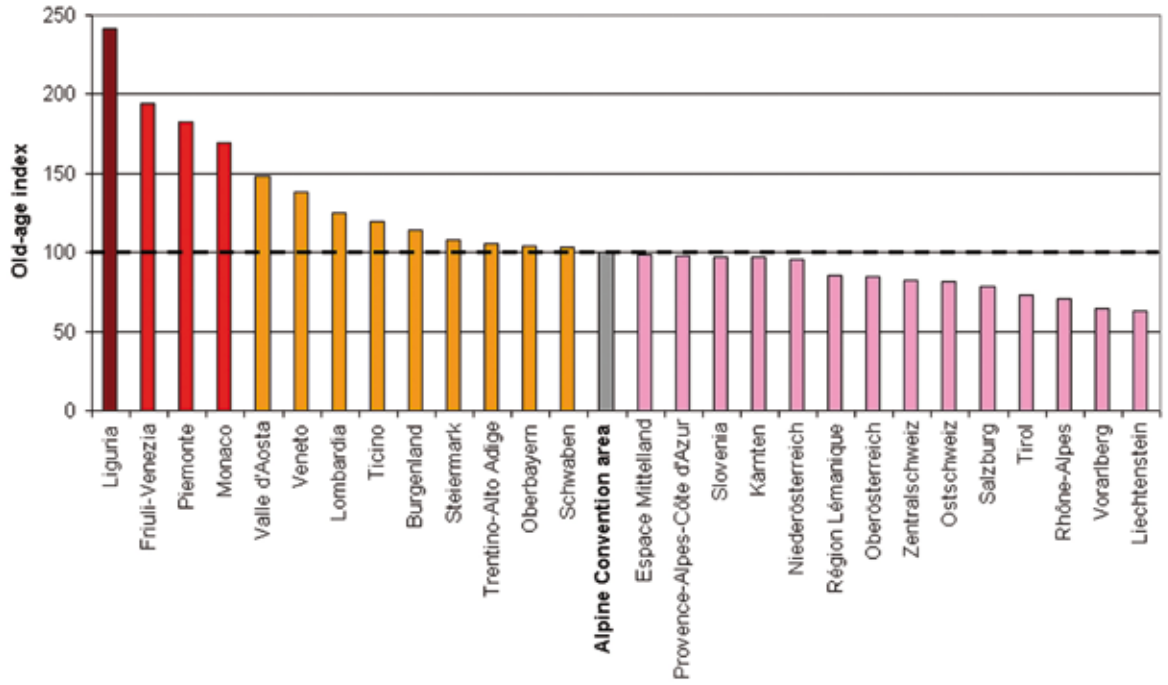
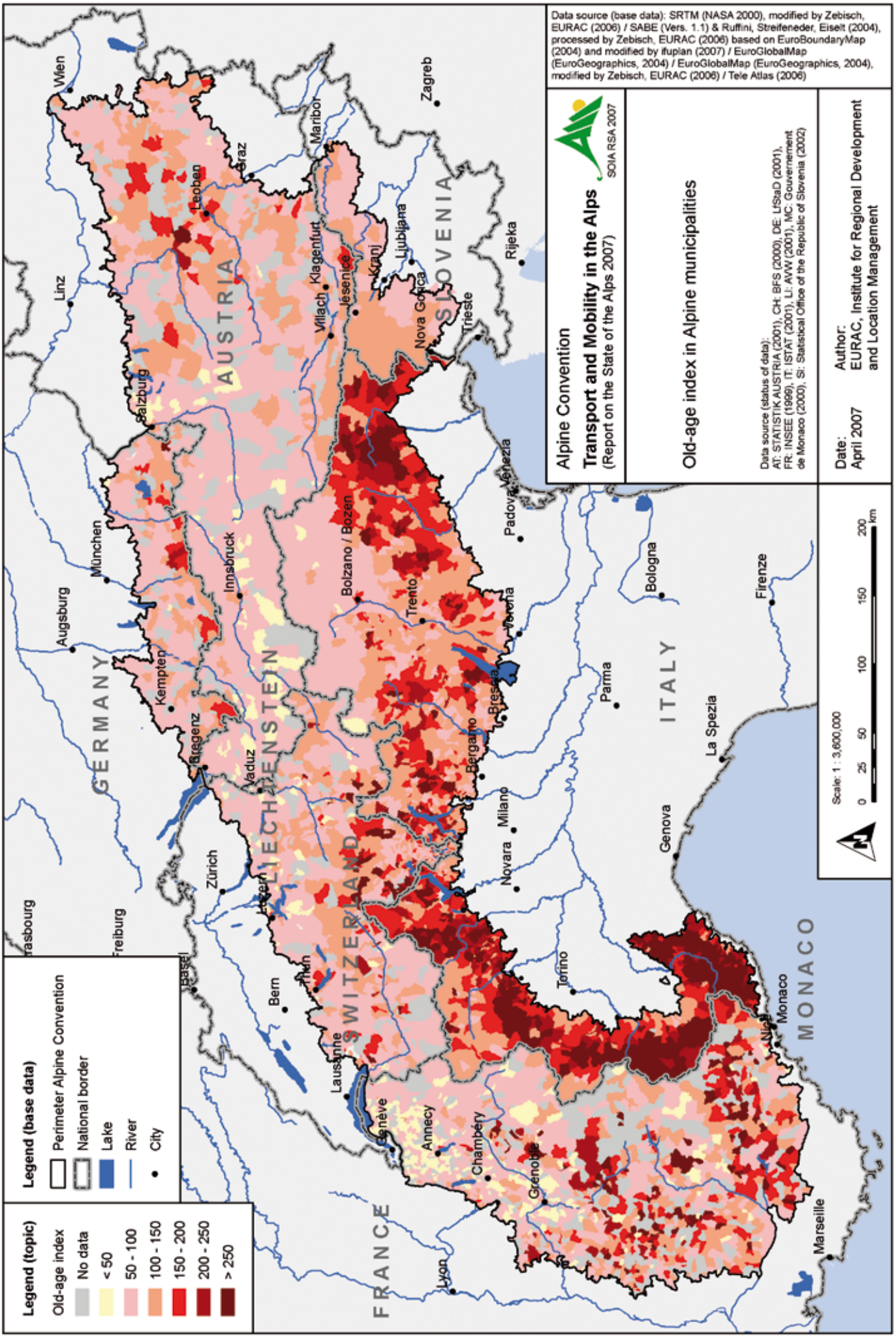


Fig. C2-1: Old-age index in Alpine Convention regions. Data refer to: 1999 (France), 2000 (Switzerland and Monaco), 2001 (Austria, Germany, Italy and Liechtenstein), 2002 (Slovenia) (Sources: see tab. C2-1).



Map C2-1: Old-age index in Alpine municipalities.

Are these over-ageing phenomena connected with a certain size of municipality? According to the population values of the municipalities, a tendency to ageing was detected for the least densely inhabited municipalities (<500 residents) and, not surprisingly, for densely populated large centres with more than 25,000 inhabitants (Tab.C2-2). A particularly low average old-age index is recorded for those municipalities with more than 1,000 but fewer than 10,000 inhabitants.

Moreover, 82% of those municipalities suffering from depopulation attain a value above 100. It has to be assumed that the process of ageing will be proceeding there. However, the situation for the thinnest populated municipalities is getting even worse. Due to the emigration of the young people and the declining birth rate, these municipalities are becoming substantially weaker.

Population	Municipalities	Old-age index average	Municipalities with an old-age index > 100		Municipalities with a population decrease between 1990 and 2000*		Municipalities with an old-age index > 100 and a population decrease between 1990 and 2000*		
	Total		N°	[%]	N°	%	N°	[%]	[%]
Columns	1	2	3	3/1	4	5	6	6/1	6/4
≤ 500	1,872	119.9	1,080	57.7	688	36.8	563	30	81.8
501-1,000	1,095	98.0	503	45.9	310	28.3	228	21	73.5
1,001-2,500	1,584	92.7	618	39.0	385	24.3	258	16	67.0
2,501-5,000	817	93.7	325	39,8	141	17.3	104	13	73.8
5,001-10,000	360	95.6	169	46.9	66	18.3	55	15	83.3
10,001-25,000	178	99.6	88	49.4	34	19.1	27	15	79.4
25,001-50,000	34	123.6	22	64.7	13	38.2	10	29	76.9
≥ 50,000	14	121.6	12	85,7	5	35.7	5	36	100.0
Total Alps	**5,954**	**100.3**	**2,817**	**47.3**	**1,642**	**27.6**	**1,250**	**21**	**76.1**

Tab. C2-2: Old-age index of the municipalities of the Alpine Convention.

* Data refer to: 1999 (France), 2000 (Switzerland and Monaco), 2001 (Austria, Germany, Italy and Liechtenstein), 2002 (Slovenia) (Sources: see Tab. C2-1).

Municipalities	Region (NUTS 2)	Inhabitants (2004)	Old-age index
Luzern	Zentralschweiz	59,904	188.98
Bolzano/ Bozen	Trentino-Alto Adige	97,236	158.44
Maribor	Slovenia	111,673	137.34
Kempten	Schwaben	61,576	135.07
Trento	Trentino-Alto Adige	110,142	130.83
Rosenheim	Oberbayern	60,108	121.65
Annecy	Rhône-Alpes	52,100	121.20
Salzburg	Salzburg	142,662	118.73
Innsbruck	Tirol	115,498	116.52
Klagenfurt	Kärtnen	91,723	108.98
Villach	Kärtnen	57,829	106.87
Grenoble	Rhône-Alpes	156,203	102.7
Kranj	Slovenia	52,689	91.98
Chambéry	Rhône-Alpes	57,592	91.95
Alpine Convention	-	-	**100.30**

Tab. C2-3: Old-age index of the most populated municipalities. Data refer to 1999 (France), 2000 (Switzerland), 2001 (Austria, Germany, Italy), 2002 (Slovenia) (Sources see Tab. C2-1).

Most of the urban centres in the central Alps attain an old-age index above 100 except Kranj (91.98) and Chambéry (91.95), that means there is more than one old person for every young person (Tab. C2-3). High values were also registered for Luzern and Bolzano/Bozen, whereas in Luzern there are two inhabitants older than 64 for every person younger than 15.

Those municipalities in particular with fewer than 100 inhabitants attain the highest rate of over-aged people. Ribordone, near Turin/IT, is the municipality with the highest old-age index: it amounts to well over 5,500, i.e. there are 55 people over 64 years for every one person under 15. Six of the ten municipalities with the highest old-age index are located in Piemonte.

In addition, the relationship between the old-age index and the accessibility of the Alpine municipalities was analysed (see chapter B2). Although the easily accessible locations at the southern foothills of the Alps are characterised by a positive migration rate, they register an old-age index of over 100 (Fig.C2-2). The closer the vicinity to the Alpine main ridge in this part, the more this index is increasing.

As shown in table C2-4, analyses revealed no meaningful linear relationship between old-age index and accessibility (at least in the way it is calculated in project REGALP, i.e. as the number of accessible inhabitants within a travel time of three hours). Municipalities with an old-age index lower than 100 represent the largest percentage of “less accessible municipalities” category (fewer than 0.4 Mio inhabitants accessible within a three-hour journey) and the smallest percentage of the ‘most accessible municipalities’ category (over 1.5 Mio inhabitants accessible within a three-hour journey). However, when average accessibility values are taken into account (between 0.4 Mio and 1.5 Mio inhabitants accessible within a three-hour journey) trends are less clear.

Accessibility		Municipalities (%)							
		Inhabitants <= 500		Inhabitants 501-1,000		Inhabitants 1,001-2,500		Inhabitants > 2500	
Total of municipalities	Accessible Inhabitants within a travel time of 3 hours (in Mio.)	Old-age index <= 100	Old-age index >100	Old-age index <= 100	Old-age index >100	Old-age index <= 100	Old-age index >100	Old-age index <= 100	Old-age index >100
1,475	0.0 - 0.2	17,8	20,2	11,1	6,1	17,4	7,9	11,3	8,3
1,258	0.2 - 0.4	13,2	8,7	11,9	5,5	22,7	8,9	18,7	10,5
1,265	0.4 - 0.6	11,9	24,3	6,7	12,6	11,7	13,2	10,9	8,6
133	0.6 - 0.8	3,8	0,8	9,8	5,3	27,8	3,8	42,9	6,0
707	0.8 - 1.0	12,7	19,0	15,3	8,9	13,7	10,0	10,7	9,6
687	1.0 - 1.5	15,7	20,1	8,6	6,0	14,6	10,5	13,0	11,6
59	1.5 - 2.0	0,0	42,4	0,0	8,5	10,2	11,9	13,6	13,6
345	2.0 - 3.0	0,6	22,0	3,5	18,6	4,9	20,6	5,2	24,6

Tab.C2-4: Municipalities with an old-age index above and below 100 according to the population classes and accessibility (Regalp, 1995; no data: 35 municipalities) [Source: Austria (Old-age index: Statistik Austria 2001); France (Old-age index: INSEE 1999); Germany (Old-age index: Bayerisches Landesamt für Statistik und Datenverarbeitung, 2001); Italy (Old-age index: ISTAT 2001); Slovenia (Old-age index: Statistical Office Slovenia 2002); Switzerland (Old-age index: Swiss Federal Statistical Office 2000)].

Considering the demographic size of municipalities, communities with fewer than 500 people and an old-age index over 100 are the largest category both in the group of municipalities with the poorest accessibility and in the two groups with the best accessibility.

It seems therefore that the old-age index is linked to other variables and that good accessibility alone is not enough to guarantee a balanced demographic structure. As project REGALP pointed out, some municipalities display a good demographic growth in spite of their poor accessibility. That is the case in areas whose economy is dominated by the tourism industry, with a high number of 'incoming' commuters, a growth in the number of new buildings and a very small-sized primary sector.

Main findings

Status

Generally, the age-structure of a society depends on various aspects. Furthermore, the situation in mountain municipalities is strongly influenced by the overall national and regional situations.

In most Alpine countries the share of inhabitants over the age of 64 is above the respective national average (exception: Austria, France and Slovenia).

On average the highest shares are registered in the Italian Alps, the Italian-speaking regions in Switzerland (Ticino) and Monaco.

Very small-structured municipalities (<500 inhabitants) and municipalities with over 25,000 inhabitants on average record a higher old-age index.

Trends

Elderly people are one part of the population which is more dependent on good accessibility to serve their needs. The share of this group will increase to 30 % of the average population by 2050.

Hot issues

Accessibility is an important requirement for the vitality of mountain areas. However, good accessibility alone does not guarantee a well-balanced social structure at regional level, as other factors such as economic branches, commuters or quality of buildings may be important.

Demographic change generates new needs and technological progress gives new opportunities. The provision of public services should be re-organised in another and, for an older population, better adapted way.

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C3 Environmental and Health Effects

C3.1 Air quality

Air pollution can cross both natural and political boundaries, especially in the case of pollutants with a higher atmospheric lifetime like ozone and particulate matter. Acidifying compounds can be transported over thousands of kilometres before being deposited, thereby affecting ecosystems far away from the source of the pollution. In Alpine areas, pollutants emitted or formed in valleys are dispersed over large areas by specific meteorological conditions such as valley and slope winds, and temperature inversions during autumn and winter. They affect sensitive ecosystems. Thus the control of air pollution in the Alpine States is necessarily an activity best addressed by countries in co-operation with each other. The Alpine Convention aims to reduce air pollutants. The reduction of traffic emissions will play an important role in achieving this goal.

C3.1.1 Impacts of air pollution on ecosystems and human health

Vehicle emissions as important sources of high concentration of air pollutants

Vehicle emissions contribute significantly to ambient air concentrations of nitrogen oxides (NO and NO_2) and fine particulates (PM) – and indirectly to ground-level ozone (O_3), since NOx and VOC (volatile organic compounds) are the main precursors of ozone and secondary particulate matter (PM). As PM10 (particulate matter < 10 μm) is the smallest size so far subjected to regulatory measures in the EC, the further elaborations cover only PM of this size, although recent discussions are now entering on a limit value of PM2.5 (< 2.5 μm).

Nitrogen oxides, ozone and PM10 affect human health, ecosystems and vegetation. The synergetic effects of these pollutants can increase harmful effects. In the case of particulate matter and nitrogen oxides, high concentrations occur mainly during winter, whereas ozone is mainly a problem during the summer, because the formation processes are triggered by sunlight.

Health risks

For humans, the most common adverse effects of the above-mentioned pollutants are - depending on the concentration of pollutants and the exposure - coughs and other respiratory problems such as bronchitis, but asthma and allergies may also occur. Cardiovascular function, too, can be affected both by pollution-induced inflammation and even by impacts on the autonomic heart function. There are wide variations in people's susceptibility to air pollution. The greatest effects are generally seen in those people with underlying disease such cardiovascular or respiratory diseases. Children, the elderly and those taking in large amounts of air while exercising outdoors in polluted conditions also appear to be vulnerable (EEA 2005).

Ecosystem damages

Nitrogen oxides can contribute to acidification and eutrophication in terrestrial and freshwater ecosystems, but they can also have direct toxic impacts on plants by being taken up via their stomata.

However, the main effects of acidification and eutrophication occur by deposition. Nitrogen deposition is the most significant factor in endangering mountain forest ecosystems. High deposition rates convey nutrient imbalances and higher frost sensibility. Having been exposed for many years to high nitrogen deposition, a lot of ecosystems are losing their capacity to absorb more nutrients, with the consequence that they will be leached out of the root zone or emitted into the atmosphere.

Ecosystems are characterised by specific thresholds – so called Critical Loads – which indicate the level at which the detrimental effects of long-term deposition are to be expected. Forests are particularly threatened due to high deposition, as are ecosystems with a low nutrient status or with a low base saturation. In Austria, for example, critical loads for nitrogen are exceeded predominantly in the Northern Limestone Alps, where deposition is higher than in other parts of Austria.

Ozone is a cytotoxin which is taken up by the leaves of plants and induces chlorosis and loss of foliage (Herman & Smidt 2003). Therefore ozone-related vegetation damage mainly occurs on sites with a good water supply in the summer months when the stomata of plants are open for prolonged periods. Due to high precipitation many parts of the Alps offer good water conditions and therefore suffer a high risk of plant damage.

Special topographic and meteorological factors in the Alps

Dispersion conditions and accumulation over several days are – besides emissions of primary particles and precursors of secondary particles including NOx – a key factor for high NO_2 and PM10 concentrations in Alpine valleys and basins. Adverse dispersion conditions affect especially the valleys and basins in the south-eastern parts of the Alps, which are shielded from oceanic north-westerly winds by the central Alpine ridge.

C3.1.2 Measuring air quality

Due to the long history of monitoring of air quality and enforcement by EU-regulations which aim to limit the concentration of air pollutants endangering human health, ecosystems and vegetation, there is a relatively high level of harmonisation of air quality measurements. While NOx and ozone, for example, have been measured for some decades in many countries, PM10 measurements were not begun before the late 1990s, replacing the monitoring of total suspended particulates. The status and trends of deposition loads cannot be discussed within this report.

The following map (Map C3-1, next page) provides an overview of the monitoring stations which were considered in this study. Longtime data series were not delivered for all stations, and data for the whole set of parameters are not available for all stations.

Map C3-1: Air quality measuring stations (classification according to Directive 2001/752/EC).

Type of stations in relation to dominant emissions sources	
Traffic	*Stations located such that their pollution level is influenced mainly by emissions from a nearby road/street*
Background	*Stations that are neither traffic nor industrial; located such that their pollution level is not mainly influenced by any single source or street but rather by the integrated contribution from all sources upwind of the station*
Type of area	
Urban	*Continuously built-up area*
Suburban	*Largely built-up area: continuous settlement of detached buildings mixed with non-urbanised areas (small lakes, woods, agricultural)*
Rural	*All areas that do not fulfil the criteria for urban/suburban areas*

Air quality limits for ambient concentrations have been set by the EU and the European member states to protect human health, ecosystems and vegetation.

Pollutant	EU Directive	Value and number of times exceeded limit allowed	to be met in
Protection of human health			
NO_2 (LV)	1999/30/EC	200 µg/m³ (1h average) limit exceeded < 19 times for 1 hour average / year with margin of tolerance	2010
NO_2 (LV)	1999/30/EC	40 µg/m³ (annual mean) with margin of tolerance	2010
O_3 (TV)	2002/3/EC	120 µg/m³ (8h average) < 25 days (averaged over three years)	2010
O_3 (ITH)	2002/3/EC	180 µg/m³ (1h average)	
O_3 (ATH)	2002/3/EC	240 µg/m³ (1h average)	
PM10 (LV)	1999/30/EC	50 µg/m³ (24h average) < 36 days / year	2005
PM10 (LV)	1999/30/EC	40 µg/m³ (annual mean)	2005
Protection of ecosystems and vegetation			
NOx (LV)	1999/30/EC	30 µg/m³ (annual mean)	2001
O_3 (TV)	2002/3/EC	AOT40 of 18 mg/m³h (5 year average)	2010
LV limit value – TV target value – TH threshold, ITH Information Threshold – ATH Alert Threshold			

Tab. C3-1: EU ambient air quality limit and target values, thresholds (Source: EEA 2005 and own compilation).

The European Information System on Air Quality (AirBase) provides Europe-wide collected data on nitrogen oxides, ozone, and PM10: http://air-climate.eionet.eu.int/databases/airbase/index_html

Nevertheless, there remain some monitoring stations at national level which do not supply any data to the EU. These data have also been used for the analyses shown in Tab. C3-1.

Current EU legislation (the EC framework directive on ambient air quality and management and related daughter directives) is based on threshold values recommended by the World Health Organization (WHO). Nevertheless, it is important to stress that the levels for PM10, ozone and NO_2 do not represent no-effects thresholds.

C3.1.3 Concentration of nitrogen oxides – state and development

The hot spots of NO_2 pollution are motorways and trunk roads both in urban locations and at major Alpine transit routes. In remote rural Alpine areas, the indirect effect of NO_2 by ozone formation is more relevant.

Long-term development of NO_2 concentration

Although during the last two decades a reduction in NO_2 concentrations and an improvement in air quality have been achieved, pollution remains at a level which requires further measures to comply with European regulations.

The most important reduction took place in the years around 1990; the average concentration decreased by nearly 30%. This reduction was primarily caused by the introduction of cars with three-way catalytic converters in the late 1980s and early 1990s in all EU countries. This was induced by Directive 91/441/EEC – although many Member States had already encouraged the introduction of catalytic converters to cars before 1990. Emission standards for Heavy-Duty Vehicles (HDV) (Directive 91/542/EEC, Stage I and II) and passenger cars (Directive 94/12/EC) also contributed – although to a smaller extent – to emission reductions in the period 1994–98 (Molitor et al. 2001). After 1995 the concentrations did not change more or less until 2000 (see Fig. C3-1).

Similar trends – reductions of NO_2 concentration, although to a smaller extent – can be identified for background stations. In urban areas, the reduction effects were higher than in suburban and rural areas.

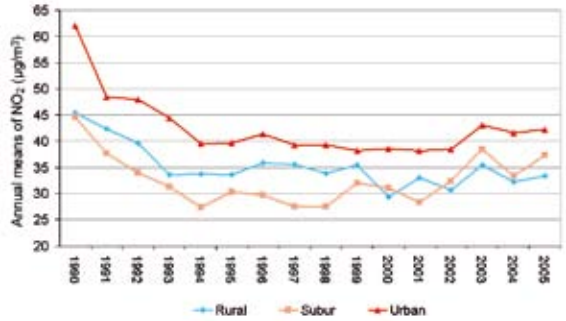

Fig. C3-1: Annual means of NO_2 on traffic stations in the Alps (data from AT, CH, DE, no longtime data series available for the other countries).

Focusing on the developments of the last 10 years and analysing also the data from recently established traffic-related monitoring sites, in the last few years a trend of stable NOx and increasing NO_2 concentrations can be detected in the Alpine countries, irrespective of the type of area (urban, suburban, rural) of the monitoring site (see Fig. C3-2). The rea-

son for this may be the continuously increasing traffic loads (see chap. A2 and A3) which compensate for the NOx reduction effects caused by technical improvements. Furthermore there are likely to be increasing emissions of NO_2 due to the use of diesel particulate matter filters (UBA 2006b).

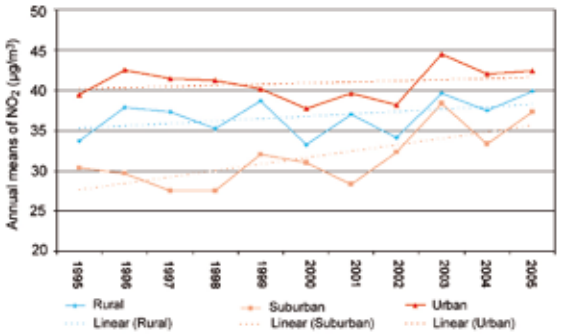

Fig. C3-2: Annual means of NO_2 on traffic stations in the Alps (data from AT, CH, DE, FR, no longtime data series available for the other countries).

Instances when the annual limit value for NO_2 was exceeded

By 2010 the limit value of 40 µg/m³ of NO_2 (annual mean) has to be attained Europe-wide (Directive 1999/30/EC). Until this date a decreasing margin of tolerance (MoT) was defined, triggering the development of air quality management plans if the limit is exceeded.

Since the EU-Directive (1999) came into effect, the number and percentage of stations exceeding the limit value plus the MoT have been increasing (as the MoT limit value decreased). In 2005 the sum of limit values and MoT was exceeded at 32% of all traffic stations in the Alps (see Tab. C3-2), both in urban and rural areas. In contrast, these values were not exceeded at urban and rural background stations.

Year	Limit value plus margin of tolerance	Number of traffic stations	Number (percentages) of stations where limit was exceeded
2000	60 µg/m³	22	1 (5%)
2001	58 µg/m³	24	1 (4%)
2002	56 µg/m³	33	4 (12%)
2003	54 µg/m³	57	11 (19%)
2004	52 µg/m³	60	16 (27%)
2005	50 µg/m³	31	10 (32%)

Tab. C3-2: Stations which exceeded the limit values plus margin of tolerance between 2000 and 2005 (data from AT, CH, DE, FR, IT, LI).

Several traffic stations record increasing annual means above the future limit value of 40 µg/m³ so that it is likely that the limit value will not be met by the attainment date. Nine out of a total of 15 stations which exceeded the limits in 2005 are situated in an urban environment, three in the rural area near the motorways A10, 12 and 13 in Austria.

In the last three years, about 50% of all traffic stations recorded values in excess of the future limit value of 40 µg/m³ (see Fig. C3-3).

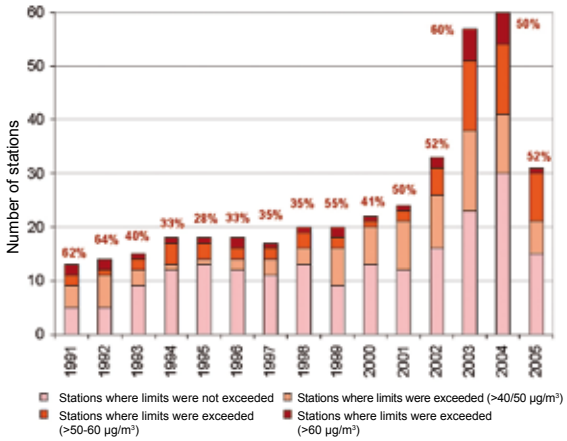

Fig. C3-3: Percentage of traffic-related stations showing where the future European long-term limit value for NO_2 (40 µg/m³) was exceeded at all stations (data from AT, CH, DE, FR, IT, LI).

Instances when the short-term limit value for NO_2 was exceeded

The EU short-time limit value of less than 19 days (per calendar year) of the one hour average of 200 µg/m³ will have to be met from 2010 on. For the period until 2010, however, higher limit values are effective (200 µg/m³ plus margin of tolerance). For this report only data from Austria have been delivered. Though for Austria it is known that – taking advantage of the margin of tolerance – the value has not been exceeded in the last years except at one traffic station in 2005.

Considering only the limit value of 200 µg/m³ without tolerance, the limits were exceeded on more than 18 occasions (the future EU short-time limit value) at some traffic stations, especially in the last two years. In 2005, one hour mean values above 200 µg/m³ were measured at almost 20% of all traffic-related monitoring sites (see Fig. C3-4). Thus the new general tendency of increasing annual means of NO_2 in areas strongly influenced by traffic is also reflected by a higher frequency of short-time peak values.

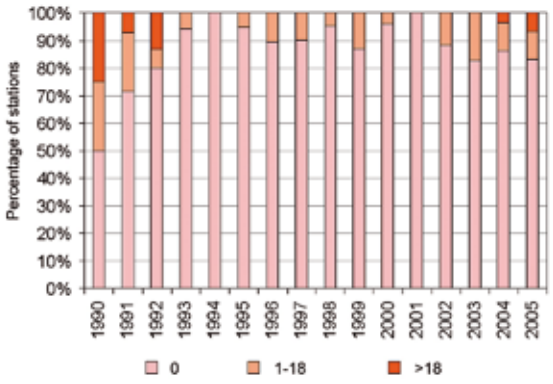

Fig. C3-4: Percentage of traffic stations in the Alps exceeding the European short-term limit value for NO_2 (data from AT, CH, DE, FR, LI).

According to Directives 1996/62/EC and 1999/30/EC the exceeding of 1h average or annual mean limit values for NO_2 requires the Member States to draw up plans to comply with the limit value at the attainment date, which will be 2010. In the case of NO_2 the main source is road traffic.

Case study: Development of NOx emissions and concentration at Alpine highways

Trends of air quality measurements for NOx and traffic emissions close to highways are available for three sites in Austria and one site in Switzerland (see Fig. C3-5). In Austria, the air quality monitoring sites are situated at the A10 Tauernautobahn (Zedernhaus, Salzburg), A12 Inntalautobahn (Vomp, Tirol) and A13 Brennerautobahn (Gärberbach, Tirol). In Switzerland the monitoring site is next to the A9 at Sion (canton Wallis).

NOx traffic emissions were calculated with the help of traffic data from nearby traffic counting stations and the handbook of emission factors (Keller & Hausberger 2004). On the A10 (Katschberg) about 15,000 vehicles/day are passing by on average, 23% of which are heavy duty vehicles (HDV). The A12 (Vomp) shows a much higher traffic flow of about 50,000 vehicles/day and a share of 17% of HDV. At the A13 (Matrei) the traffic flow amounts to about 30,000 vehicles/day; the share of HDV is about 22%. The A9 (Sion) which is not completed yet, shows about 19,000 vehicles/day and a very low share of HDV of only 3%.

The emissions show a decline for the A12 highway in Austria and the A9 Switzerland, the A10 shows an increase until 1998 and a decline from 2000 onwards. The emissions at the A13 are roughly at the same level from 1994 to 2005. The trend of the emissions is decoupled from the traffic flow, which shows a more or less constant increase for all four highways in this period.

The concentrations do seem to reflect the trends in emissions apart from the last two years. This decoupling might be due to an underestimation of NOx emissions in the handbook of emission factors as the real world emissions of Euro 2, Euro 3 and Euro 4 passenger cars are considerably higher than for the test driving cycle (Hausberger 2006, Umweltbundesamt 2006b). Furthermore, it has to be noted, that close to traffic the NO_2 concentrations do not necessarily reflect the trends of NOx ($NO+NO_2$) emissions as there is an increase in the NO_2/NO ratio of Diesel car emissions due to increased use of oxidation catalysts in Diesel cars. This leads to an increase in NO_2 concentration even for constant or slightly decreasing NOx emissions.

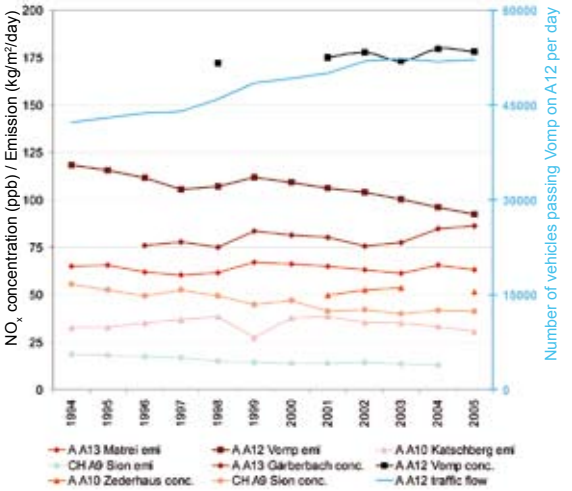

Fig. C3-5: Trend of NOx emissions and concentrations at highways in Alpine valleys as well as the traffic flow of the A12 at Vomp (data from AT and CH).

C3.1.4 Concentration of ozone – state and development

Ground level (tropospheric) ozone is not directly emitted in the atmosphere. It is formed by photochemical reactions. Ozone is by far the most important constituent of the so called photochemical smog, a complex chemical mixture of secondary pollutants. The photochemical reactions are triggered by sunlight in the presence of the precursors of ozone. The most important ones are volatile organic compounds and nitrogen oxides (NOx and VOC). Temperature and the intensity of insolation are key factors for the chemical reactions, so that ozone is much more intensively formed in the summer months. The combination of ozone formation, vertical mixing and depletion at solid surfaces triggers the daily variation of ozone concentrations. Depletion and titration of ozone by NO lead to low concentrations near the ground during night time, whereas in the reservoir layer at elevated altitudes, high concentrations can prevail over several days.

Therefore areas remote from the sources of the precursors are affected by higher ozone levels – especially long-term concentrations – than areas directly influenced by traffic emissions.

High long-term ozone levels in most remote parts of the Alps correspond to increased ozone concentration levels compared to Central European ozone levels. Precursor emissions and ozone formation in large parts of Europe, especially in the Po Valley and western Central Europe, contribute to a considerable extent to ozone levels on this spatial scale.

Long-term development of O_3 concentration

The long-term development of summer averages shows a slightly increasing trend in the Alpine countries (see Fig. C3-6), which is statistically significant only in northern Alpine valleys (Tirol, Salzburg), but superseded by considerable inter-annual variations caused by varying meteorological conditions (UBA 2006c).

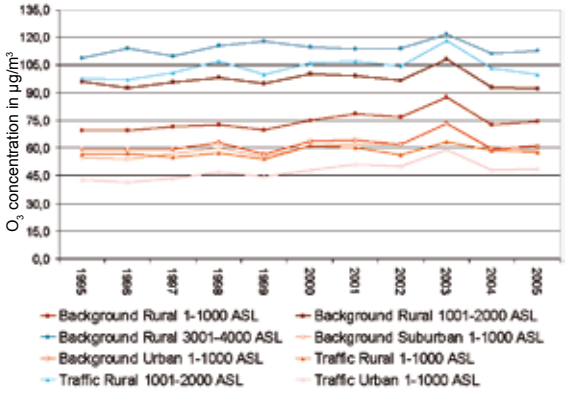

Fig. C3-6: Summer averages at background and traffic stations in the Alps (data from AT, CH, DE, FR, SI).

The high concentrations in 2003 are a consequence of extraordinarily long-lasting hot and dry periods with intensive insolation, which led to strong ozone formation throughout large parts of Europe and considerable transport of ozone into the Alps from (western) Central Europe (high peak concentrations even in remote areas in the northern Alps).

Exceeding the target value for the protection of human health

The EU Directive 2002/3/EC defined as the target value for the protection of human health the maximum daily 8-hour mean value of 120 µg/m³, not to be exceeded on more than 25 days per calendar year (averaged over three years). This target value becomes effective in 2010.

A large number of instances of the target value being exceeded are observed in high Alpine regions (due to small temporal variations at high mean concentrations), whereas several urban traffic stations (with low concentrations during night time and coinciding with NO peaks) comply with the target value.

With respect to the severe amount by which the target value is exceeded in most parts of the Alps it is obvious that attainment will require further action; until now only a minority of (urban) background stations meet the EU target (see Fig. C3-7). Even though most of the traffic stations did not exceed the future target value (up to 25 exceedances per year), nearly all stations did exceed the concentration of 120 µg/m³ at least once (long-term target).

Decreasing short-term peak concentrations (1-hour mean) and increasing occasions on which the target value is exceeded are not statistically significant (EEA 2003; UBA 2005).

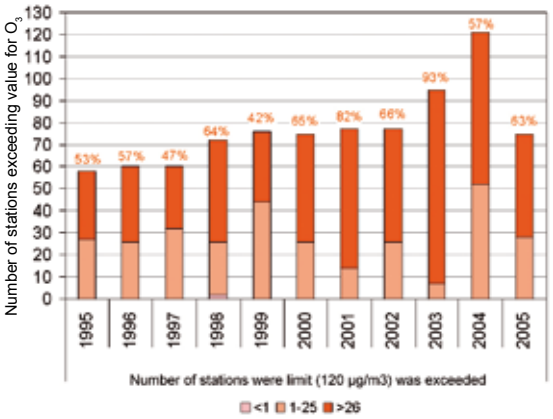

Fig. C3-7: Percentage of background stations showing where the European limit value for O_3 for the protection of human health (120 µg/m³ as maximum daily 8-hour mean value) has been exceeded at all stations (data from AT, CH, DE, FR, IT, LI, SI).

Long-term exposure of vegetation to ozone

To avoid damage to crops and natural vegetation like forests, the EU set the long-term target value for AOT40, the accumulated exposure over a threshold of 40 ppb, calculated from 1h mean between May and July. The target value is defined as 18,000 µg/(m³*h) and will be valid from 2010 onwards (Directive 2002/3/EC).

In the last ten years, a considerable percentage of the background stations did not comply with the target value for the protection of vegetation (see Fig. C3-8).

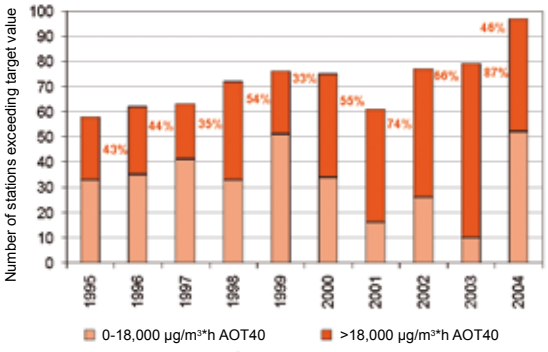

Fig. C3-8: Percentages of background stations in the Alps deviating from the European target value for the protection of the vegetation (AOT) (data from AT, CH, DE, FR, IT, SI).

Short-term threshold values of ozone

Related to short-term effects of ozone on human health, the information threshold (1h average of 180 µg/m³) and the alert threshold (1h average of 240 µg/m³) are set in Directive 2002/3/EC. If these thresholds are exceeded, the population has to be informed about the current situation.

Due to the meteorological conditions, there are large interannual variations concerning the number of times the thresholds are exceeded, as well as the number of stations exceeding the threshold values (see Fig. C3-9) for information threshold.

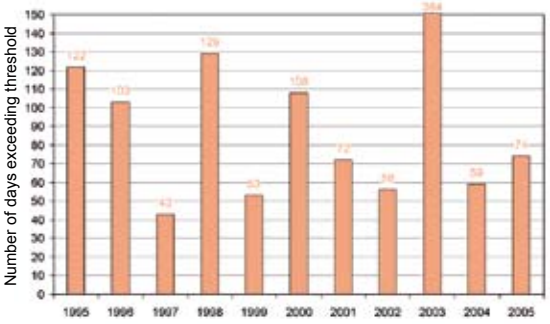

Fig. C3-9: Number of days exceeding or reaching the information threshold of 180 µg/m³ on background stations in the Alps (data from AT, CH, DE, LI, FR, IT, SI).

Similar variations between the years as for the information threshold can be observed for the alert threshold of 240 µg/m³ in the last decade. The maximum number of exceedances at the background stations has been observed in 2003 with 19 days of exceedances. In the same period of ten years the alert threshold was not exceeded at the traffic related stations.

C3.1.5 Concentration of PM10 – state and development

PM10 originates from primary particle emissions as well as from atmospheric formation of secondary particles.

The main sources of primary particles are road traffic (exhaust, tire and road abrasion, re-suspension), domestic heating (mainly wood), industry (process emissions, heat generation, indiscriminate emissions) including off-road machinery, construction works (indiscriminate emissions and off-road machinery), agriculture (indiscriminate emissions and off-road machinery), and natural sources (erosion, Sahara dust).

The contributions from different sources vary largely in the Alpine region, depending on local traffic volume, population density and industrial activities. The total (estimated) PM10 emissions for the Alpine region are not related to the PM10 pollution in a certain region and will therefore not be given here.

The main constituents of secondary particles are ammonium sulphate, ammonium nitrate and VOC, the precursors of which are SO_2, NOx and NH_3 emissions. Chemical analyses available until now indicate that in Alpine basins and valleys secondary pollutants are of less importance compared to extra-Alpine regions, where long-range transport contributes especially to secondary inorganic particles. The formation of secondary particles in Alpine valleys and basins depends on the amount of local SO_2 and NOx emissions.

"Trends" of PM10

PM10 monitoring began in the late 1990s. Most monitoring stations have been installed during the last few years. Therefore time series of PM10 data are short and do not really allow trend analyses.

Fig. C3-10 is based on the aggregation of 16 monitoring sites operated since 2001 and shows the maximum, mean and minimum annual mean value of this data set. No clear trend can be identified over this period; the high mean concentrations in 2003 were caused by adverse meteorological conditions during the first months of this year. The highest PM10 pollution among these 16 sites was recorded in Klagenfurt in all years.

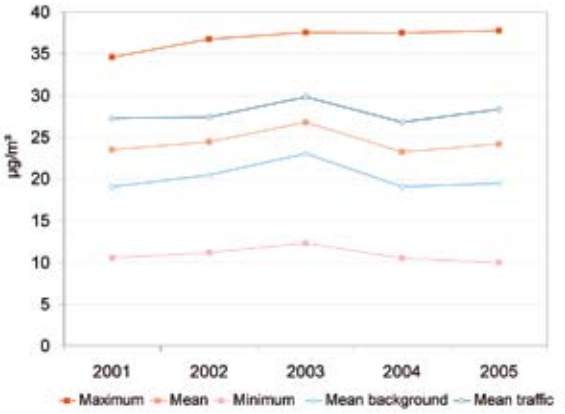

Fig. C3-10: Maximum, mean and minimum annual mean value of the PM10 annual mean value operated throughout the period 2001–2005 (data from 16 monitoring sites in AT, DE, LI).

Instances when the limit values of PM10 were exceeded

The limit value set for the daily mean – 50 µg/m³, not to be exceeded on more than 35 days per calendar year – is violated in all valleys and basins with high PM10 emissions, with particularly high numbers above the limit in valleys in the south-eastern part of Austria (UBA 2006c).

Averaged over the period 2001 to 2005 (with increasing numbers of PM10 stations), 5% of rural background stations exceeded the daily limit value, 11% of rural traffic stations, 39% of urban background stations, 66% of urban traffic stations, and 47% of industrial stations. It can be clearly seen that going over the PM10 limit value is an urban problem, aggravated by traffic contributions. Towns south of the central Alpine ridge suffer levels above the limit value in every year since the start of monitoring.

According to Directive 1996/62/EC and 1999/30/EC, going over the limit values requires the Member States to apply measures to the main sources in order to comply with the limit value at the attainment date, which was 2005 for PM10. In the case of PM10 the main sources are most often traffic and residential heating, locally also industry and construction sites.

The limit value for the daily mean (50 µg/m³, not to be exceeded on more than 35 days per calendar year) is much more stringent than the annual mean value (40 µg/m³), which is only exceeded at urban locations in Steiermark (Graz, Köflach).

Main findings

Nitrogen dioxide – state and trends:

NO_2 concentrations are constant or have even increased in recent years, due to continuously increasing traffic loads (which compensate for the technical efforts realized in the last decade for reducing emissions), and probably due to an increasing NO_2/NOx ratio of diesel car emissions.

Several traffic stations in the Alps, both in urban and rural locations, exceed the long-term limit value for NO_2 (annual mean of 40 µg/m³ plus margin of tolerance). It is likely that it will be difficult to attain the EU limit value in 2010 without additional measures.

Ozone – state and trends:

The EU target values both for the protection of human health and vegetation – to be met by 2010 – are exceeded in large parts of the Alps, especially in remote areas with constantly high ozone levels. During the last decade, an increase in the long-term ozone levels was observed. Attaining the target values by 2010 seems unlikely. The information threshold for ozone was frequently exceeded in the last few years.

Particulate matter – state and trends:

High PM10 levels exceeding the short-term limit value (daily mean) are observed in most major Alpine valleys and basins in many towns, especially at kerb side locations. The major sources are road traffic and domestic heating (wood burning). Up to now no trend can be detected.

Hot issues:

Effective measures to reduce the traffic emissions of NOx and PM10 – both for urban and regional traffic as well as transit – will be inevitable to improve air quality and achieve compliance with the EU limit and target values for NO_2 and PM10. For PM10 a reduction of PM emissions from domestic wood burning will be beneficial.

To achieve compliance with ozone target values, measures for reducing the emission of ozone precursors at least at a European scale would be necessary to reduce the high long-term ozone concentration observed throughout the Alps, even in remote high Alpine regions.

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C3.2 Noise – the health aspect

In Europe, transport (road, rail and air traffic) is the most important source of community noise. Approximately 30% of the European Union's population (EU-15) is exposed to levels of road traffic noise of more than 55 dB(A) (WHO-The PEP 2004 a). Exposure to high noise levels has decreased in some countries since 1980 due to technological measures, noise barriers and spatial planning. However, due to the expected growth in traffic, extra measures will be needed.

In several surveys it has been proved that a large percentage of the population feel disturbed by traffic noise. So the WHO (2000) states that noise is the only environmental factor for which complaints have increased since 1992.

Noise is not only an annoying disturbance of human quality of life it also has to be considered as a severe threat to human health. The scientific evidence for the adverse health effects of noise is growing. Good evidence was found for effects on communication, school performance, sleep and temper, as well as on cardiovascular effects.

C3.2.1 Impacts of traffic noise on human health and well-being

Health and health effects

The WHO defines health as the "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" and regards health as one of the fundamental human rights (SRU 1999).

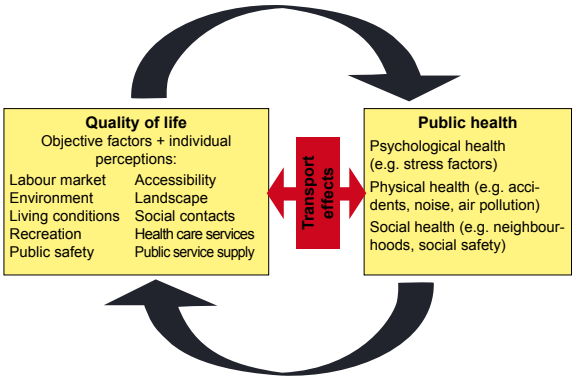


Fig. C3-11: Overall interrelation of human health and transport effects.

Noise does not cause a specific "noise disease" but acts as a stress factor to the human body (see Fig. C3-11). Unexpected sound rings an alarm in the human body, which releases certain hormones into the bloodstream. As a stressor noise can evoke indirect effects like disturbances of concentration, sleep disruption, heart disease, psychological symptoms, changes in social behaviour such as aggression and may play an important role in the aggravation of health problems. Fig. C3-13 (next page) shows one model depicting the possible mechanism of noise-induced health effects and their interactions (SRU 1999, WHO-The PEP 2004a).

What is noise?

Noise is sound which is perceived as a molestation. From a scientific perspective only sound pressure levels, not noise, can be measured.

Because of the logarithmic scale of sound / noise measurement a reduction of 10 dB(A) is perceived as a bisection of sound, a reduction of road traffic noise of only 3 dB(A) means a reduction in traffic quantity of 50% (SRU 2005).

Sound perception is individual: certain sounds are perceived as noise and others not – sometimes even if the same sound pressure level is measured (see Fig. C3-12).

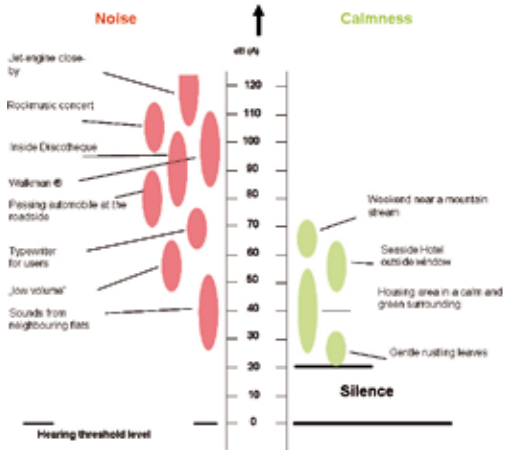


Fig. C3-12: Sound pressure and human perception (Source: LfU 2003).

Reactions to noise are very individual and depend on individual health, age, living environment as well as on social values.

The WHO PEP-Project (Pan-European Programme on transport, health and environment) differentiates health impacts on adults and health impacts on children.

For adults a review of epidemiological studies shows that noise exposure can produce various effects, including annoyance and sleep disturbance, but the evidence for a causal association between noise exposure and increased cardiovascular health risks is limited (see Fig. C3-14, next page, WHO-The PEP 2004a). No definite conclusion can be drawn for impacts on mental health, but a significant association between self-reported noise exposure and depression or cognitive failures was observed.

For children the possible effects of noise on cognitive functioning were studied the most frequently. They show sufficient evidence that noise exposure affects children's cognition, motivation and annoyance and influences their aptitude (WHO-The PEP 2004a).

Dimension of health effects evoked by traffic noise

Some scientific models give a first estimation of the dimension of traffic noise-related health effects: The German Federal Environmental Agency (UBA) calculated in models that about 12 Mio Germans expect higher risks of ischaemic heart diseases. According to estimations of the Austrian

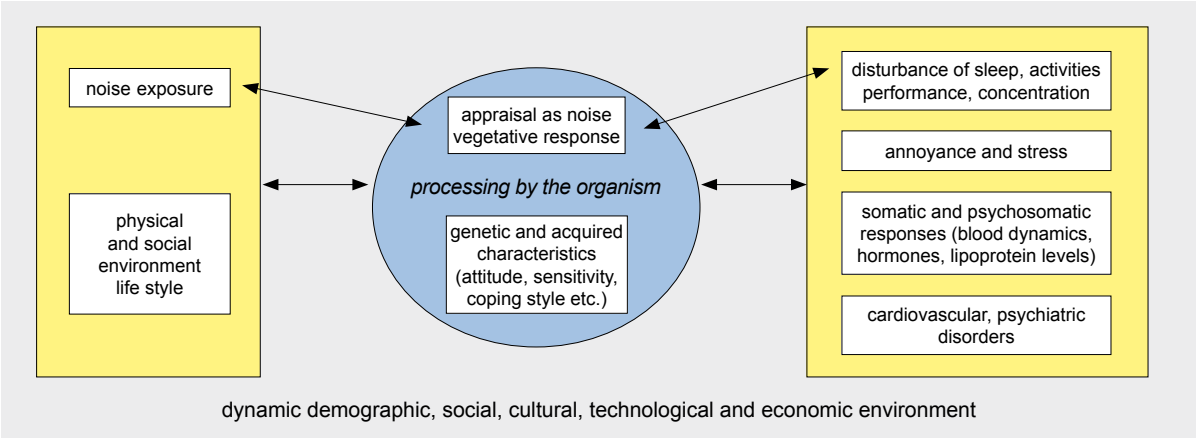


Fig. C3-13: Conceptual model representing relation between noise exposure, health and quality of life (Source: WHO-The PEP 2004 a, slightly modified).

Ministry for Environment about 32% of the Austrian population are exposed to road noise of about 60 dB during the day or 50 dB at night. About 9.4% of Austrians feel strongly or very strongly disturbed by noise of which 61% attribute this to road noise (Dörfler 2000; Statistik Austria 2005).

Latest studies reveal that there are no thresholds for risk increase, meaning cardiac risks may also occur as well with moderate noise immissions.

Another approach to describe the dimension of health effects evoked by traffic noise is to quantify them in terms of monetary values, in years of life lost (YOLL) or disabled adjusted life years (DALY) (BUWAL 2003, WHO-The PEP 2004 a). "It has been estimated that for Europe as a whole, the overall external costs (abatement costs) of road- and rail-traffic noise amount to 0.4% of the total GDP" (ECMT 1998, cit. from WHO-The PEP 2004 a, p. 50).

Human well-being and quality of life

"Well-being", an integral part of the WHO definition of health, means, in addition to physical health, things such as the possibility of taking part in social life, having social support, not suffering from violence, having no fear, being in a good temper and having the feeling of power and self-confidence.

Human well-being is affected by traffic noise in terms of communication disturbances inside and outside houses, loss of recreation values etc. One crucial element of social quality of life is human communication. Long term noise exposure may retard linguistic development as well as the reading and writing abilities of children. Noise may also decrease communication in neighbourhoods. Some studies show more social distance between neighbours in densely populated areas with high traffic loads (Höger & Schreckenberg 2003).

As a side-effect of the permanent expansion of traffic infrastructure and volume an increasing loss of really "silent areas" has been observed, where silence in terms of absence of human-made sounds can be explored. This means the sacrifice of human life's qualities, such as areas for contemplation, undisturbed nature appreciation or the experience of solitude.

Silent moments in the Kaiser mountain range (Photo: S. Marzelli).

C3.2.2 Data sources and indicators

By the time of the deadline for data submission to this report (middle of April 2006), strategic noise maps were not available. Actually an overview on traffic infrastructures due to noise mapping according to the thresholds of the EU Directive 2002/49 was planned, but no data (except for the roads of the German part of the Alps) have been delivered. An overview of road, railway and airport infrastructure for which strategic noise maps and action plans were made was not available until the data deadline.

Indicator C9-1: Emission of road traffic noise

This indicator has been recommended by the WG "Environmental Objectives and Indicators". However as only very few data are available this would require the calculation of noise emission from traffic flows on high level roads. Meanwhile the WG Transport has suggested using indicators based on the Directive 2002/49/EC. According to this directive up to 2007 strategic noise maps for high-frequented roads, railways and airports will be provided (see also chap. C3.2.6 on legal frameworks). Therefore the indicator has been changed into traffic noise indicated by noise impacts of roads, railways and airports.

Indicator C9-2: Noise immissions based on LUCAS field data

The LUCAS survey delivers unique data for Austria, Germany, France and Italy on the subjective perception of noise. Based on these field data collected at certain points in a regular grid (18 x 18 km) it has been planned to show in a case study the present noise immission as subjective estimation. But as for Indicator C9-1 no data were delivered by the time of the editorial deadline of this report.

Due to the data situation which is expected to improve from 2007 on – thanks to Directive 2002/49/EC – the indicators should be reformulated. It would be better to show areas and persons exposed to certain noise levels (dependent on thresholds) than showing emissions and immission. This information should be provided by the strategic noise maps in the future.

Indicator C9-3: Expenditure on noise abatement measures along main thoroughfares

Investments for noise abatement are one of the major measures for noise prevention from human living spaces. Measures are mainly taken by governmental bodies for traffic infrastructures where this is mandatory by the respective national legislation. The economic aspect of noise is highlighted in an Austrian case study (see chap. C3.2.5).

C3.2.3 What is different in mountainous areas?

Noise emission in mountains is often different compared to lowlands due to different traffic infrastructures (bridges, tunnels, viaducts) from where sound spreads differently. Also, motor sounds are louder in mountain areas as cars are driven in lower gears and with higher rotation speed.

Noise spreads quite differently in mountainous areas than in lowland areas. Topography leads to an effect such as in amphitheatres (see Fig. C3-14), so due to sound reflections from valley slopes noise is also perceived at higher altitudes. Noise absorption by soil and vegetation is less effective on slopes than in flat areas. Topography also alters meteorological conditions (inversions, wind systems) which remarkably influence noise spread.

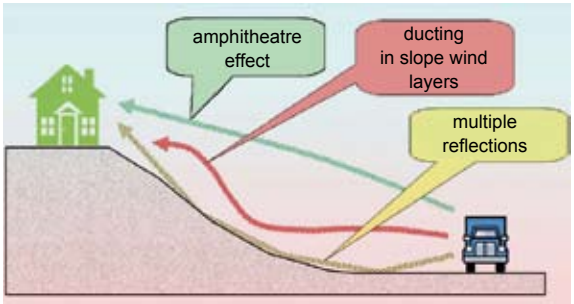


Fig. C3-14: Noise propagation (Source: ALPNAP 2006).

This leads to the effect that the same noise emission level leads to much higher noise immission in Alpine areas. A comparison by Scheiring (1988) discusses the difference of a motorway near Hamburg and the Inn Valley motorway in Tirol. Despite higher traffic loads in the flat land a 40 dB(A) level is reached within 416 m, whereas in the Inn Valley it takes about 2000 m for the noise to decline to the same level (SRU 2005).

For topographical reasons traffic infrastructures are mainly situated in the valley bottoms which often also feature high population densities. Due to the above-mentioned self-amplifying effects, also illustrated in Fig. C3-15, it could be expected that the population in Alpine areas is exposed to higher percentages of traffic noise than the population in the lowlands.

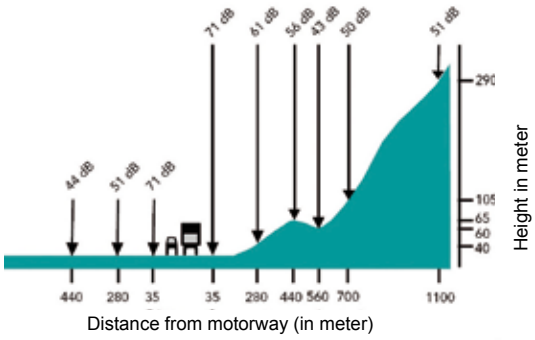


Fig. C3-15: Noise spread in mountainous areas (Source: EEA 2001, p. 22).

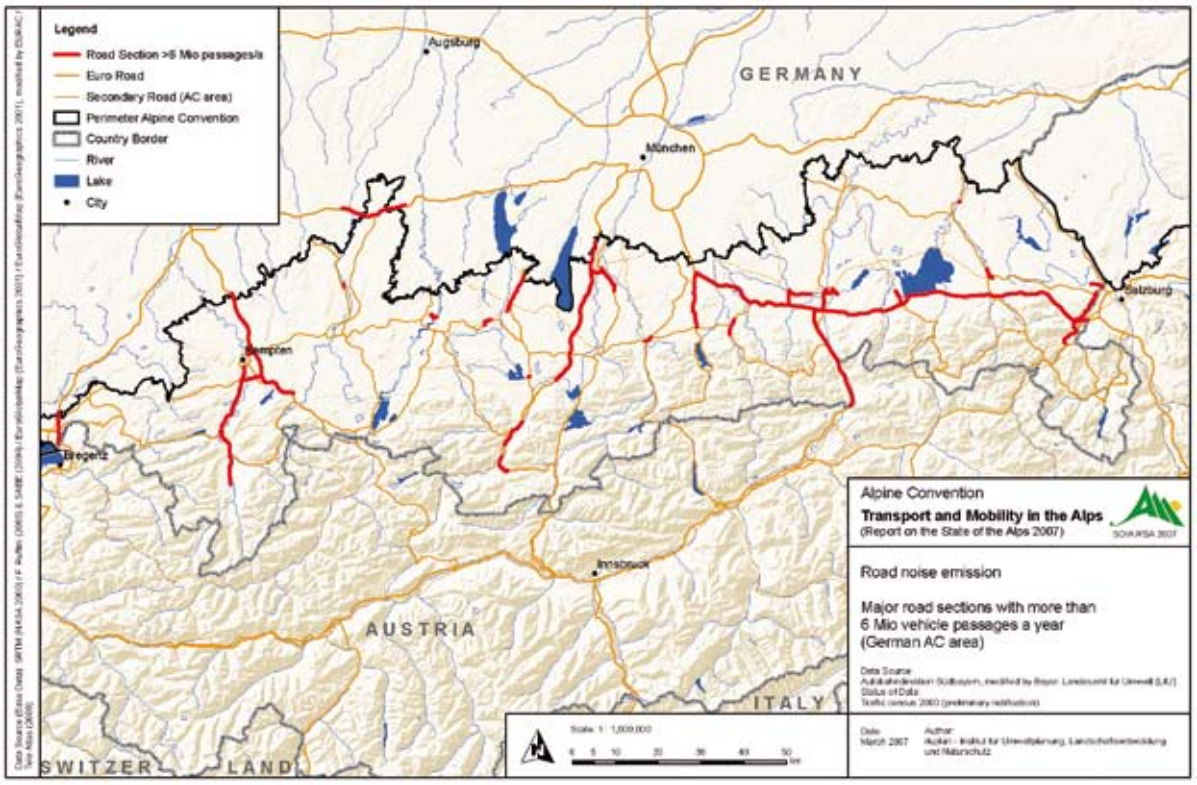
C3.2.4 Noise emissions and immissions

Road noise emission

Main sources of road noise are engine noise and the rolling noise made by the vehicles on the road. From a speed of 40 km/h (cars) and 60 km/h (trucks) the engine sound becomes less relevant than the rolling noise. In general heavy goods vehicles cause disproportionally more noise as they produce the same noise as up to ten cars at the same speed.

Map C3-2 (next page) shows the road sections in the German part of the AC which are used by more than 6 million vehicles per year and for which strategic noise maps and action plans will be worked out in the first phase of implementing the Directive 2002/49/EC.

Road noise emissions are monitored in Switzerland within the project “Monitoring flankierende Maßnahmen Teilprojekt Umwelt – MFM-U” (see Fig. C3-16, next page). Along the A2 are five measure points and at the A13 one measure point for air and noise emissions (near Basel noise and air quality are measured at different locations). According to this monitoring road noise level at night (from 10 p.m. to 6 a.m.) is about 6-7 dB(A) lower than during the day time. Stations which show the highest levels at day time are also the most affected stations at night time. The noise levels in 2004 did not change compared with 2003, a trend is not visible (BUWAL 2005).



Map C3-2: Major road sections with more than 6 Mio vehicle passages a year (German AC area).

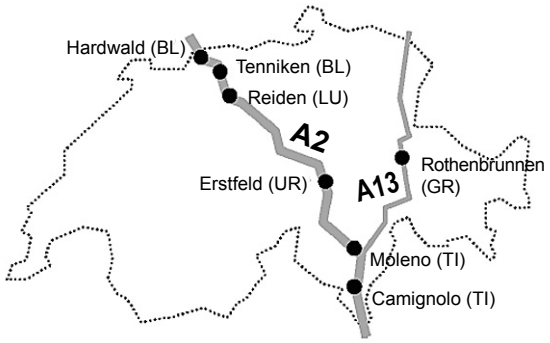


Fig. C3-16: Measure points for road noise emission in Switzerland MFM-U (Source: BUWAL 2005).

Railway noise emission

Noise emission by rail comes from three major sources: up to about 80 km/h the engine's sound is predominant, between 90 and 270 km/h the wheel sound is more important and above 300 km/h the wind sound of a high speed train is most important. Sounds of brakes, curves, uneven rails, and ventilation also are relevant for noise emissions.

Noise emissions from railways are perceived as less annoying than the noise of cars or aeroplanes at the same sound level. Due to this fact in Germany, Austria and Switzerland railways get a so-called "railway bonus", a reduction of five dB (A) of the outcome of the railway noise calculation (WHO-The PEP 2004a). However, a recent study points out that the bonus is no longer justified (Lercher 2007).

In Switzerland data on railway noise are monitored by the Bundesamt für Verkehr (BAV) at different railways (see Fig. C3-17). The results are regularly updated in yearly reports by the BAV. Some key results from the Gotthard line are that at night time noise is dominated by the higher frequency of freight trains and their double length compared with passenger trains. But also at day time freight trains are more responsible for rail noise, even if passenger trains pass over more frequently. In the yearly average railway noise level at night is only about 0.5 dB(A) lower than at daytime due to the dominance of freight trains. Road noise is on average about 5 dB(A) lower at night time.

Fig. C3-17: Measure points monitoring railway noise in Switzerland (Source: BAV 2004).

Aircraft noise

Noise emissions from aircraft are very irregular and difficult to express as an average number. Measuring of aviation noise is complex, affects very large areas of some tens or hundreds of square kilometres and it is a long term task. Therefore aircraft noise is mostly calculated by noise models. The main noise emissions are caused through take-off and landing activities. As only three international airports are situated in the Alps commercial aircraft noise can be considered as a minor issue compared to road and railway traffic noise.

Noise immissions

Noise immissions may be analysed in terms of "objective" data based on measurements and on "subjective" data based on census or field data providing the disturbance of traffic noise as perceived by individual persons. In any case a status of traffic noise immissions is not available specifically for the Alpine Convention area.

Noise immission based on objective data

A first impression of noise immissions can be derived for Austria from the reports summarising the results of an OECD questionnaire. Based on noise immission plans, railway noise cadastre and air noise zones data on noise immissons have been compiled. Impacts on communities through noise immissions are displayed in Tab. C3-3.

LAeq,day or Laeq,night+10dB	Municipalities below 20,000 Inhabitants [%]	Municipalities over 20,000 Inhabitants [%] (without Wien)	Pro-rata average for Austria
>= 55	61.6	51.1	60.9
>= 60	29.2	29.2	32.2
>= 65	5.0	18.5	9.8
>= 70	2.0	6.4	4.6
>= 75	0.0	2.0	1.0

Tab. C3-3: Noise immission by road traffic in Austria (Source: excerpt from UBA 2001, English translation).

Noise from rail traffic has been compiled in Austria based on the railway noise cadastre for night time (years 1993/94); residential areas and inhabitants on both sides of railways were taken into consideration. The result presented in Tab. C3-4 shows (the number of) people exposed to railway noise in three different noise zones at NUTS-2 level.

These data from Austria highlight the general situation at administrative level but do not allow a distinctive conclusion for the Alpine Convention area. Due to topographic reasons it may be estimated that people in mountainous areas of the Alpine Convention are disturbed to a higher extent.

Federal State	Inhabitants	Affected inhabitants in zone with noise level Lr* (night)			Inhabitants (%) in zone with Lr* (night)		
		55-60 dB	60-65 dB	>65 dB	55-60 dB	60-65 dB	>65 dB
Burgenland	270,880	11,046	341	40	0.39	0.13	0.01
Kärnten	547,796	10,468	5,015	1,021	1.91	0.92	0.19
Oberösterreich	1,333,480	34,687	17,095	7,110	2.6	1.28	0.35
Salzburg	482,365	22,008	11,707	7,501	4.56	2.43	1.56
Steiermark	1,184,720	27,536	11,810	2,697	2.32	1.00	0.23
Tirol	631,410	12,935	9,540	8,243	2.05	1.51	1.31
Vorarlberg	331,472	5,421	3,745	1,417	1.64	1.13	0.43
Austria total	7,795,786	184,061	89,763	38,122	2.36	1.15	0.49

Tab. C3-4: Inhabitants affected by railway noise in Austria (Source: excerpt from UBA 2001 English translation).

* Lr means a weighted sound pressure level under 5 dB

Pilot project noise data base in Switzerland

Switzerland does not apply the Directive 2002/49/EC but with its so-called "Lärmdatenbank" (LDBS) it provides a collection and delivery of noise data according to EU norms. Actually the LDBS will not only differentiate between noise types (road, rail, aviation) but additionally deliver noise data for the whole territory, data on recreation areas and "silence areas". In two phases data will be available for an overview based on federal data and a detailed version based on higher resoluted data at Cantons level. Till middle of April 2006 data for about 100 km² were available for the Canton Luzern (see Fig. C3-18). (Poldervaart & Jordi 2005; BAFU 2005, 2006; Ingold 2006).

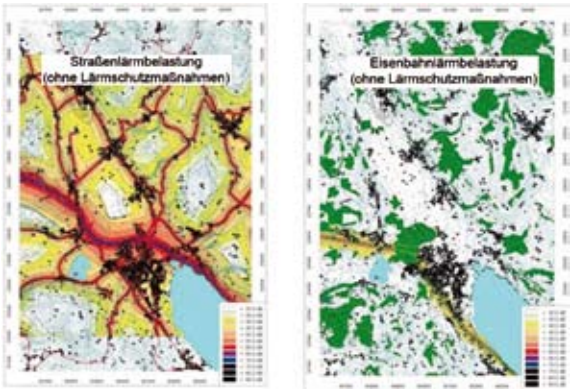


Fig. C3-18: Pilot maps from the Swiss LDBS, area of Luzern displaying road noise (left) and railway noise (right).

This approach marks a very advanced state of noise analysis which might be a standard for treating the topic in the whole of the Alps.

C3.2.5 Noise abatement measures

An estimate of measures of noise abatement is difficult as central documentation does not exist in Alpine countries. However some figures, based on numbers from Austria may underline noise abatement as a cost intensive issue (Tab. C3-5).

Year	on roads	in buildings	total
1990	13.0	6.5	19.4
1991	12.6	6.4	18.9
1992	20.2	8.6	28.8
1993	12.2	7.9	20.1
1994	10.5	7.4	17.9
1995	8.0	6.7	14.7
1996	6.8	5.0	11.8
1997	5.1	5.9	10.9
1998	6.0	4.7	10.7
1999	9.9	4.0	13.9
2000	11.4	2.8	14.1

Tab. C3-5: Noise abatement expenditures along Bundesstraßen (federal roads) in Austria (roads / buildings) from 1990-2000 in Mio EUR (Source: UBA 2004, English translation).

An increase in expenditure for road noise abatement is estimated by the Austrian ASFINAG according to Fig. C3-19.

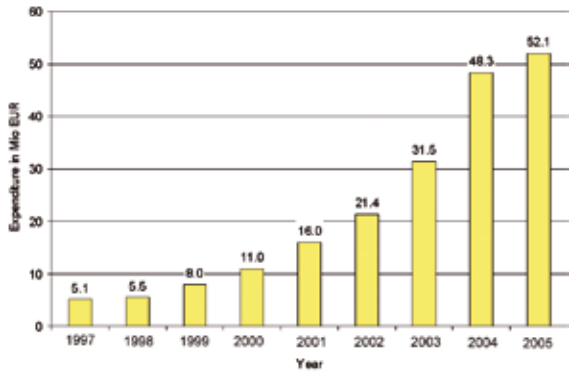


Fig. C3-19: Noise abatement expenditure on the existing highway and federal road system according to the Austrian ASFINAG (including estimates for years 2004 and 2005) (Source: UBA 2004, English translation).

For railways the use of the braking disc system on freight trains would allow a further reduction of noise of almost 10 dB.

C3.2.6 Legal framework and thresholds

According to the Traffic Protocol of the Alpine Convention the Member States have agreed to take enforced measures for noise abatement due to specific topography of the Alps (Art. 3 d), to reduce step-by-step pollution and noise emission of all transport systems [Art. 7, (2)] and they have agreed to reduce environmental impacts of air traffic [Art. 12 (1)].

Directive 2002/49/EC defines a common approach among all EU Member States which is intended to avoid, prevent or reduce harmful effects of environmental noise. For this reason noise indices (L_{den} and L_{night}) for the use of strategic noise mapping have been defined to harmonise data in EU Member States. After implementation the Directive will offer to the public strategic noise maps for conurbations, major roads, railways and airports. The Member States were to communicate to the Commission not later than 18 July 2005 any relevant limit values expressed in L_{den} and L_{night} and where appropriate L_{day} and $L_{evening}$ for road-traffic noise, rail-traffic noise, aircraft-noise around airports and noise on industrial activity sites. However this information has not been made available from the Member States.

Thresholds for health effects have been defined manifold, some common approaches have been compiled by WHO (see Tab. C3-6, next page; source WHO 2000).

What is ...?

...sound pressure level: *The sound pressure level (L) is a measure of the air vibrations that make up sound. Because the human ear can detect a wide range of sound pressure levels (from 20 micro-Pascal up to 200 Pascal), they are measured on a logarithmic scale with units of decibels (dB) to indicate the loudness of a sound.*

...a-weighted sound pressure level: *The human ear is not equally sensitive to sounds at different frequencies. To take account of the loudness of a sound a spectral sensitivity factor is used to weigh the sound pressure level at different frequencies (A-filter). These, so called A-weighted sound pressure levels are expressed in dB(A).*

...equivalent sound levels: *When sound levels fluctuate in time, the equivalent sound level is determined over a specific period of time. For this purpose the A-weighted sound level is averaged over a period of time (T), using a prescribed procedure (symbol L,T). A common exposure period T in community studies/regulations is from 7 to 23 hours ($L_{Aeq,7\text{-}23\ hr}$).*

...day-night level (L_{dn}): *This metric is used in environmental impact assessment as it correlates much better with community annoyance than the equivalent sound level. L_{dn} is the equivalent sound level over 24 hours, increasing the sound levels during the night (11 p.m. to 7 a.m.) by 10 dB(A) since noise during the evening and the night is perceived as more annoying than during daytime.*

...day-evening-night level (L_{den}) *is constructed in a similar way as the L_{dn}, increasing the sound levels in the evening (7 to 11 p.m.) with 5 dB(A) and those during the night (11 p.m. to 7 a.m.) with 10 dB(A).*

...night level (L_{night}) *is the equivalent sound level over night (11 p.m. to 7 a.m.).*

...sound exposure level (SEL) *of a noise event, such as the noisy passage of an aircraft, is the equivalent sound level during the event normalised to a period of one second (WHO-The PEP 2004 a, p. 17).*

Guideline values for community noise in specific environments				
Environment	Critical health effect(s)	Time base	L_{Aeq} (dB)	L_{Amax}, fast (dB)
Dwellings				
Indoors	Speech intelligibility and moderate annoyance, daytime and evening	16 hours	35	–
Inside bedrooms	Sleep disturbance (night)	8 hours	30	45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	8 hours	45	60
Schools and preschools				
Classrooms indoors	Disturbance of speech intelligibility, information extraction and message communication	During class	35	–
Playground outdoors				
Hospitals				
Wards/Rooms indoors	Sleep disturbance (night-time)	8 hours	30	40
	Sleep disturbance (daytime and evenings)	16 hours	30	–
Treatment rooms indoors	Interference with rest and recovery		As low as possible	
Other				
Outdoor living area	Serious annoyance, daytime and evening	16 hours	55	–
	Moderate annoyance, daytime and evening	16 hours	50	–
Outdoors in parkland and conservation areas	Disruption of tranquillity	–	Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low.	

Tab. C3-6: Compilation of threshold (Source: excerpt from WHO 2000).

Main findings

Status

Topography, meteorological conditions, and construction needs of transport infrastructure lead to a higher exposure of Alpine areas to traffic noise compared to lowlands.

Due to concentration of settled areas, traffic infrastructure and above mentioned conditions also the population in the Alps may be exposed to traffic induced noise at a higher proportion than people in the lowlands.

Trends

As traffic loads on roads, rails and in the air are expected to increase, the emission and immission of noise will also increase. Correspondingly an increase in costs for noise abatement measures may be expected.

On the other hand due to the implementation of the "Technical Specification for Inter-operability" (TSI) regarding railway noise, some specific emission levels may be reduced by technical measures in the future. The Directive 2002/49/EC on noise will give better information to the public. The action plans which have to be made in accordance with the Directive until July 2008 might force the Member States to take further action.

Hot issues

All major transport routes touching populated areas, in particular valleys, may be considered as hot spots of noise impacts in the Alpine Convention area.

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D Relevant Traffic Policies for the Alps and the Alpine Cooperation

On 26 May 2006 a group of residents from the border region between Tirol and Alto Adige/Südtirol blocked the Brenner pass for some hours to demonstrate for a more consistent reduction of air pollutants and noise exposure. They called for an extension of the night driving ban for heavy traffic, so far imposed only in Tirol, to the total route between Rosenheim (DE) and Verona (IT) and suggested raising the particular heavy vehicle fees up to the existing high level established in Switzerland.

For the last 15 years, however, it is not only those citizens affected by the main Alpine transit routes who are concerned about the pressure on environment and health. Politicians have also turned their attention to the Alpine regions and the increasing traffic development.

The Alpine Convention, introduced in chapter D1, considers traffic policy as well as other issues for preserving a sustainable development of the Alpine regions.

To act effectively, different cooperation bodies, discussed in chapter D2, have been set up in the Alpine Convention dedicated to traffic subjects.

EU policies, the subject of chapter D3, have also recognised the need for a coherent and sustainable transport policy (e.g. Eurovignette Directive, anchoring the “polluter-pays” principle).

National transport policies

To meet requirements for sustainable transport plans and strategies for sustainable transport have also been developed on national level, implementing and further structuring EU policies. The national transport policies described in chapter D4 have to satisfy social and economic requirements and at the same time increase transport safety and assure an efficient use of energy and a clean environment.

Infrastructure policies

Policies supporting the upgrading or construction of road and rail infrastructures (see chapter D5) as well as sea lines, are some of the major subjects of debates for solving the Alpine transport problems.

Policies managing freight transport

Generally, a lot of attention is paid to freight transport and the according policies which are explored in chapter D6.

The specific topographical situation of the Alps in combination with the growing traffic volume often causes traffic jams at bottlenecks for road freight traffic and in some cases safety problems. Therefore inventories of the measures for regulating heavy goods traffic were conducted in each country and control systems were advanced. However, the implementation of the Zurich Declaration developed beyond mere safety issues: Coordinated action was taken to regulate road traffic and to encourage a shift to alternative modes of transport, as for example the combined transport of goods by trucks and railway.

Combined transport could help lighten the load of road traffic but it is still limited as rail services often show functional inefficiencies. This calls for coordinated action, especially on key corridors between Germany, Austria and Italy, Switzerland and Italy and France and Italy. The emphasis is now placed on four new corridors which are expected to offer real alternatives to growth in road traffic: the Franco-Italian cross border base tunnel (Lyon-Turin-Ljubljana route), the Lötschberg base tunnel (opening planned for December 2007), the Gotthard base tunnel, and the Brenner base tunnel between Austria and Italy (completion for both expected by 2015). For all these infrastructure projects, existing rail corridors have to be improved and coordinated measures have to be taken to lighten road traffic on the major routes.

Road pricing is considered to be a crucial instrument for regulating traffic flows. Based on a European directive on the charging of heavy goods vehicles, each country released specific regulations. Thereby so far only in Switzerland the external costs of using transport infrastructure (e.g. environmental and social burdens, accidents, land use etc.) are equally considered resulting in comparably high heavy vehicle fees.

Passenger transport policies

Not only the freight traffic depends on the transport infrastructure – passenger transport is equally important and is discussed in chapter D7. To satisfy the growing demand, integrated transport systems were for example implemented in Italian towns with more than 30,000 inhabitants. Public transport was improved by establishing new tramways (Grenoble), additional regional bus systems (between Telfs and Schwaz in Tirol) or integrated timetables for local trains (BayernTakt in Bayern). Nevertheless private cars are expected to remain the principal mode of transport.

Traffic to leisure and tourist destinations makes up an increasing part of the traffic volumes primarily as a trend towards shorter but more frequent holidays can be observed. This part of the report will present EU-funded projects that address particular problems related to tourist and leisure traffic such as travel to resorts and on-site car-free mobility.

Success stories

Besides all the difficulties of drawing up policies in a multinational field, there have been some successful implementations of transport policies which are mentioned in chap. D8.

If all political agreements concerning the sustainable development of the Alps are put into practice by the joint efforts of the Alpine countries, the residents of the Brenner region can easily be pleased, and involved in a common effort to preserve the Alps as a unique living space within Europe.

D1 The Transport Agenda of the Alpine Convention

The Alpine Convention

The Alpine Convention, signed on 7 November 1991, is a framework agreement for the protection of the Alps, aimed at harmonising the policies of the signatory countries, to adjust the differences in the economic interests concerned in the Alps, with the requirement to protect of a natural heritage under threat. The Alpine Convention is divided into eight implementation protocols in specific domains; they constitute instruments for supervising the action of the signatory countries, aiming to prevent a policy of a "race to the bottom" in ecological terms.

The Contracting Parties participating in the Alpine Conference, the decisive body of the AC, are Germany, Austria, Switzerland, France, Italy, Liechtenstein, Monaco and Slovenia, plus the European Union.

Fig. D1-1: Structure of the Alpine Convention: Eight countries, Germany, Austria, Switzerland, France, Italy, Liechtenstein, Monaco and Slovenia, plus the European Union signed the Alpine Convention to protect the Alps (Graphic: ifuplan).

The transport protocol

The transport protocol was signed at Luzern on 1 October 2000; it constitutes a tool for supervising of the action of the contracting Parties in the domain of transport within the Alpine space. The protocol is still awaiting ratification by Italy, Switzerland and the European Union. Austria, Germany, Liechtenstein, France and Slovenia have already ratified this protocol.

The overall objective of the protocol is to identify a policy of sustainable development for transport in the Alpine space, allowing for environmental protection of sensitive population groups and areas, while encouraging the development of alternative modes as opposed to road transport (in particular piggybacking and sea-river transport).

Smog in the Inntal valley near Innsbruck/A. The transport protocol aims at reducing the negative effects of the excessive traffic flows on the main routes through the Alps (Source: www.transitforum.at).

Particular attention is also given to cross-border spaces and projects (consultation between countries, global consistency of functionality and of costs).

Further prominent objectives which are relevant with regard to analyses or observations of this report in particular comprise the transport protocol's

- Article 1 on general objectives,
- Article 3 on sustainable transport and mobility,
- Article 9 on public transport,
- Articles 10, 11 and 12 on the respective transport modes ,
- Article 13 on tourism and transport, and
- Article 15 on supply and utilisation of transport infrastructure.

D2 The Framework for Action by the Alpine Countries: the Cooperating Bodies

D2.1 The Alpine Convention Transport Working Group

Monitoring of the implementation of the transport protocol

This monitoring has been entrusted, under the responsibility of the Permanent Committee of the Alpine Convention, to a specific working group ("Working Group on Transport"), first officially mandated at the 7th Alpine Conference in Merano in November 2002, then completed at the 8th Alpine Conference in Garmisch in November 2004 and Alpbach in November 2006. Depending on procedures established by the Permanent Committee, the executive body of the AC, the working group consists of a delegation from each Contracting Party (representatives of the ministries for the environment and for transport) and a representative, acting as an observer, from each partner association or NGO, particularly interested in this topic.

The main areas of work, undertaken under the aegis of the Alpine Convention and given in greater detail below, concern:

- fair and efficient pricing of the trans-Alpine road transport,
- development of the existing trans-Alpine rail corridors,
- promotion of sustainable intra-Alpine mobility, both in links between communities, and in access to tourist centres.

Freight traffic through the Alps. The Alpine convention aims at developing a fair and efficient pricing system for trans-Alpine transport (Source: www.transitforum.at).

D2.2 The Zurich Declaration Monitoring Group

On 30 November 2001, on the initiative of Switzerland, the transport ministers from Germany, Austria, France, Italy and Switzerland signed the declaration "concerning the improvement of road safety, in particular in the tunnels in the Alpine zone", while the two Gotthard and Mont Blanc roadways were closed following serious accidents.

Since then, three meetings of the ministers have taken place (on 11 May 2004, on 14 November 2005 and on 20 October 2006), to consider the progress of the work and to adjust priorities. The next meeting will take place 2008 in Austria. Slovenia officially joined the group in 2006.

Having taken road safety issues as its starting point, the implementation of the declaration has developed to identify measures to be coordinated between the signatory Alpine countries for regulating road traffic and encouraging a shift to an alternative mode of transport, with three main areas of work (detailed below):

- the safety of the trans-Alpine road and rail tunnels,
- a study of mobility in the Alpine zone, with coordination and use of the CAFT 2004 "Cross Alpine Freight Transport" survey,
- the management and regulation of trans-Alpine road traffic.

D2.3 The process of bi- or multilateral cooperation on specific projects

The Alpine countries are participants in bilateral or trilateral cooperation bodies: the organisations that manage or operate the cross-border structures and infrastructure, cooperation concerning rail transport, improvement of access.

Such a bilateral cooperation exists for example between Italy and France in the project Lyon-Torino, the tunnel of Fréjus and the tunnel of Mont-Blanc. Other examples are the commission of the Austrian and the Italian government for the Brenner tunnel project and the French-Austrian group for transport.

The Zurich-group is an example of multilateral cooperation between Austria, France, Germany, Italy, Slovenia and Switzerland.

D3 EU-Directives Adopted or in the Process of Adoption

The Alpine space belongs to the Alpine population, but also to Europe in its widest sense. No solution may be developed for freight or for passengers without taking account, at least at European level, of a global vision of ways of life and methods of trade. Beyond their differences on various matters, the Alpine countries belonging to the EU and those who have entered in cooperation agreements with the EU are obliged to consider the frameworks and regulations decreed by the EU.

Policy directions, regulatory action, financial structure, support for INTERREG programmes (see chapter D8) – all these relations of the Alpine countries with the European Union are an important factor in recognizing the possibilities and the limitations of cooperation on joint issues.

Moreover, the European Commission White Paper "European Transport Policy for 2010: Time to decide" of 2001 was largely inspired by the Alpine experience, where certain issues were concerned, and provided valuable foundations for reference for the development of the national policies of the Alpine countries.

EU policy objectives and regulatory frameworks are an overall frame condition for a joint Alpine Transport Policy. Only the main cornerstones can be mentioned here, others are introduced below:

- the EC Treaty, which encompasses the principles of free movements of goods, free provision of services and free circulation of persons, as well as the objective of preserving and protecting the quality of the environment,
- the Action and development Plan for the EU, known as "Lisbon Strategy" (2000) targeting competitiveness, employment, economic reform and social cohesion, and
- the 6th Environmental Action Programme (Decision 1600/2002) and the renewed Sustainable Development Strategy (2006) calling among other objectives for:
  - » decoupling economic growth and the demand for transport with the aim of reducing environmental impacts,
  - » reducing pollutant emissions from transport to levels that minimise effects on human health and/or the environment, and
  - » achieving a balanced shift towards environmentally friendly transport modes to bring about a sustainable transport and mobility system.

Cohesion policy and the transport system

The building of a single EU market is a primary goal of the European Union. To achieve a competitive economic space, different policies have been set up aiming at ensuring competition and reducing the disparities among the EU regions, in order to guarantee their participation in the single market. The EU policy for cohesion among different regions involves the Alpine space, too. In order to achieve full integration of the Alpine region within the EU internal market, the main European regional policies have to be considered, wherein specific provisions have been made for financing specific programmes in the area.

The Community Strategic Guidelines for Cohesion Policy aim to improve the attractiveness of member states, regions and cities; encourage innovation, entrepreneurship and growth of the knowledge economy; and create more and better jobs (EU Commission 2006). Developing an efficient and sustainable European transport system, and an appropriate charging system for the traffic passing through the Alps, as well as supporting sustainable transport modes and intermodality, are considered to be sustainable ways of supporting the economic development of the EU, by giving priority to some specific projects. Improving the efficiency of the EU single market, taking into consideration the economic development prospects at regional level, enhancing competition as a significant factor in the distribution of economic activity and income among Europe's regions, and enlarging the EU to include new countries, are among the main objectives of an EU transport policy (EU Commission 1998).

Trans-European-Transport-Network (TEN-T)

According to the EU Treaty (Art. 154, 155, 156), the European Union must aim at promoting the development of trans-European networks (TEN-T) as a key element for the creation of the internal market and the reinforcement of economic and social cohesion, by shortening the distances among EU regions and giving faster access to regions which are falling behind, and to peripheral areas. The TEN-T policies are expected to have strong economic, social and environmental impacts on the Alpine area since some of the projected trans-European corridors will cross the Alps (see chap. A).

The enlargement of the EU and the resulting expected changes in traffic growth were also considered in the Commission strategy. This strategy aims for concentrating on a primary transport network made up of the most important infrastructure for international traffic and cohesion on the European continent, to introduce the concept of "sea motorways" and to include sections of pan-European corridors situated in the territory of candidate countries, including those which will still not be members of the Union at that time. The Alpine area will play a primary role in the EU transport policies framework because of its physical features and geographical position.

With the decision of 29 April 2004, the Parliament and the Council revised the Community position in the domain of the Trans-European-Transport-Network, identifying high-priority projects of joint benefit (i.e. aiming in particular to remedy a bottleneck or to complete a missing link in a major route, in particular cross-border projects, or projects that cross natural obstacles). These projects should start before 2010 and be completed by 2020, with co-financing from the European Commission.

The following four trans-Alpine projects are featured among the high-priority projects of European interest:

- TEN-T 1: Railway axis Berlin–Verona/Milano–Bologna–Napoli–Messina–Palermo including the Brenner corridor,
- TEN-T 6: Railway axis Lyon–Trieste–Divaca/Koper–Divaca–Ljubljana–Budapest–Ukrainian border,
- TEN-T 17: Railway axis Paris–Strasbourg–Stuttgart–Vienna–Bratislava, and

- TEN-T 21: Motorways of the sea (regular, high-capacity ferry routes between key ports in the EU to improve the efficiency and reliability of freight transport, providing viable alternatives for congested land routes on roads. In particular, motorways of the sea will help bypass the bottlenecks created by such geographical features as mountain ranges).

As part of the next financial perspectives (2007–2013), the European Commission proposed a detailed re-evaluation of the budget for the Trans-European-Transport-Network, which would be used for a limited number of projects, with a very encouraging level of support (up to 50% for the cross-border projects).

However, the final level of European support will depend on the overall budget allocated to the Trans-European-Transport-Networks, and on possible priorities that will be applied by the European Union among the various high-priority projects. At the beginning of 2006, the European budget for the period 2007–2013 was much lower than the initial expectations of the European Commission.

Tunnel safety

Directive 2004/54/EC on minimum safety requirements for tunnels in the trans-European road network, adopted in April 2004, fixes minimum safety requirements for the civil engineering work, and for the management and regulation of the tunnels. It was largely inspired by the work conducted as part of UN-ECE and the Zurich Group, which brought together the representatives of the Transport Ministers of the Alpine countries, and in particular included a working group on the safety of the Alpine tunnels.

Road user charges and Eurovignette

The European Parliament and the Council adopted on 17 May 2006 Directive 2006/38/EC amending Directive 1999/62/EC on the charging of heavy good vehicles for the use of certain infrastructures (so-called "Eurovignette Directive").

The 1999 directive provides for a framework for the levying of tolls and user charges on Europe's motorways, by establishing the principle that tolls and user charges must be related to infrastructure cost.

In its amended versions the directive now applies to the whole of the trans-European network and not just to motorways – as was previously the case. Although not obliging to do so, the directive also allows Member States to levy tolls and user charges on all other roads as well – any such revenues raised, however, must be in conformity with this directive.

Tolls will still be based on the principle of recovery of infrastructure costs although environmental considerations will also play a key role in determining the rate charged. Revenues from tolls or user charges are used for the maintenance of the infrastructure and for the transport sector as a whole. Importantly, the amended directive states that toll charges should not discriminate against international traffic and should not result in distortions of competition between operators. Fees should be non-discriminatory and their collection should not involve excessive formalities or create barriers at internal borders. The calculation of costs will be based on a core set of principles set out in Annex II of the directive.

As from 2012, the directive (subject to certain derogation) will apply to vehicles over 3.5 tonnes, rather than only to vehicles over 12 tonnes – the limit set by previous requirements. In other provisions, the directive allows for a greater variation of tolls depending on the level of congestion. A fairer system of charging for use of the road infrastructure is based on the "user pays" principle. Thus, toll variations, reflecting the pollution caused by vehicles, will be mandatory as from 2010. Member States will be able to charge different tolls depending on a vehicle's emission category (EURO classification) and the level of damage caused to roads, as well as the place, the time and the amount of congestion.

As far as the "polluter pays" principle is concerned, the directive states that any future decisions for all modes of transport will take account of both internal and external costs. In addition, any future decision on this matter will take full account of the tax burden already borne by road haulage companies, including vehicle taxes and fuel excise duties. Provisions have been put in place to allow the Member States to increase tolls with a "mark-up" on roads in particularly sensitive mountainous regions such as the Alps or the Pyrenees. Any revenue thus collected must be re-invested into alternative transport infrastructure.

In accordance with implementation procedures the European Commission will begin work on developing a generally applicable, transparent and comprehensible model for the assessment of external costs for all modes of transport, serving as the basis for future calculation of infrastructure charges.

Combined transport modes – Marco Polo Programme

In continuation of the PACT Programme ("Pilot Actions for Combined Transports") of subvention to combined transport operators, the EU continues to encourage transfer to alternative modes of transport, using the Marco Polo and the Marco Polo II Programme, which covers all alternatives to road transport for the years 2003–2013. In addition, the EU is fostering the development of interoperability by organising competition on the trans-European rail network for freight with the second package of measures for rail transport and for passengers with the third package of measures for rail transport.

Environmental impacts of transport plans and projects

The EU issued the following two directives dealing with the impacts of transport plans and projects:

- Directive 85/337/EC on the "Assessment of the Environmental Impact of Certain Public and Private Projects", as amended by Directives 97/11/EC and 2003/35/EC (EIA): This directive influences directly and indirectly many transport infrastructure projects.
- Directive 2001/41/EC on the "Assessment of the Effects on the Environment of Plans and Programmes" (so-called "Strategic Environmental Assessment – SEA") extends the consideration of environmental aspects to plans and

programmes. It will therefore affect the development of transport development plans at national, regional and local level.

Information of the public

Directive 2003/4/EC on the "Freedom of Access to Information on the Environment" facilitates the access to information held by public authorities. This emerged being of high relevance for transport related information and triggered an increasing awareness of citizens.

This is supported by Directive 2003/35/EC which provides for public participation in respect of the drawing up of certain plans and programmes relating to the environment (implementation by the EC of the UN-ECE Aarhus Convention). The main objectives are to foster the effective public participation and taking account of these concerns in the decision-making process. The directive opens this participation to associations, organisations and groups, in particular non-governmental organisations promoting environmental protection. By this the decision-making process is compassed to gain more accountability and transparency.

Environmental protection and biodiversity

In addition, the EU has adopted several major directives concerning protection of the environment and biodiversity which affect the development and operation of transport infrastructure. In particular:

- Directive 2002/49/EC concerning evaluation and management of noise in the environment requires, before 2008, the evaluation of noise maps and of action plans to deal with the noise of road and rail infrastructure, with annual traffic in excess of 6 Mio road vehicles and 60,000 train journeys respectively,
- Framework Directive 96/62/EC on "Ambient Air Quality" requires the implementation of action plans to reduce air pollution in the areas where the limit values and alert thresholds defined by the so-called "daughter Directives", which sets the limit values for specific pollutants (e.g. PM10, Ozone, lead, etc.), are exceeded and
- in 1992 the EU adopted Directive 92/43/EEC on the "Conservation of Natural Habitats and of Wild Fauna and Flora ("Flora and Fauna Habitat Directive"). The directive has the objective to preserve Europe's biodiversity by setting up of a coherent European ecological network of special areas of conservation, called Natura 2000. This network is intended to conserve the natural habitat types as the animal and plant species of Community interest. Together with Council Directive 79/409/EEC on the conservation of wild birds, the preservation objectives and the delineation of special areas of conservation (SAC) and special protected areas (SPA) are meanwhile important aspects to be considered in transport projects.

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D4 National Policies on Transport Infrastructure Programmes

All Alpine countries have gradually become aware of the negative consequences of uncontrolled development of transport (lack of safety, noise, pollution, use of space and consumption of non-renewable energy), which are particularly acute in areas with heavy traffic, such as the Alpine crossings. All Alpine countries are taking account of these issues to an increasing extent in their national transport strategies.

Germany

In 2004, Germany completed its national strategy for sustainable development and in 2003 adopted the Federal Transport Infrastructure Plan which aimed to:

- ensure a sustainable mobility compatible with the imperatives of the environment,
- encourage European integration and strengthen Germany's economic position, for the purpose of creating and preserving jobs,
- encourage the setting up of sustainable structures in this area and habitat,
- create conditions for competition that are equitable and comparable for all modes of transport,
- increase safety,
- reduce the negative effects on the environment (use of space, noise and atmospheric pollution, consumption of non-renewable energy).

In addition, the Federal Transport Infrastructure Plan takes account of environmental issues. All projects, i.e. also those relevant to trans-Alpine traffic, are, before their inclusion in the Federal Transport Infrastructure Plan, subject to a uniform evaluation according to criteria relating to:

- cost-benefit analyses,
- environmental protection and nature conservation, and
- regional planning (including urban development).

The weighting of the environmental and nature conservation concerns is in this context not least of special importance in view of the objective of shifting traffic to more environmentally friendly transport modes. Within the framework of an overall economic cost-benefit analysis, the possible noise nuisances are recorded on the basis of the willingness of the parties involved to pay for prevention measures, the climatic effects (CO_2) by the estimate of prevention costs, the possible damage due to other air pollutants (e.g. NO_x, dust, soot, CO, SO_2) by direct damage cost for health, vegetation and buildings.

Within the framework of a preceding environmental risk assessment, the environmental effects are described (verbally) in terms of quality and find their way into the identification of a so-called environmental risk factor ranging from 1 to 5, which determines on the classification of the project, among other things, in line with the requirements of the Habitat Directive.

Austria

Austria has adopted both a general transport plan and a national strategy for sustainable development, as well as a strategy aiming to attain the Kyoto objective; these three programmes are divided into measures to enable the objectives of the transport protocol to be attained. In 2002, Austria published its general transport plan which aimed to:

- strengthen Austria as an economic space,
- develop the networks efficiently and appropriately for requirements,
- improve safety, and
- provide financing of measures.

France

In 2003, France adopted a national strategy for sustainable development, with a programme of very practical actions in the domain of transport (intended to separate economic growth from the environmental effects of transport), a health and environment plan (intended, in particular, to reduce diesel particle emissions), a noise pollution action plan (intended, in particular, to achieve sound proofing of homes), as well as a climate plan.

At the interministerial committee meeting of 18 December 2003, dedicated especially to directions for transport looking ahead to 2020, a new policy and scheduling of transport were defined around several objectives: economic development, attractiveness of territories, consideration of the global and local environmental issues.

As part of this initiative, an innovative financing system has been put in place: a new agency for financing of transport infrastructure which implements the state contribution (7.5 billion EUR between now and 2012) to the financing of the major new infrastructure projects (75% of which are rail or river projects), in the form of subsidies or reimbursable advances, and which takes its resources in particular from motorway tolls.

All Alpine countries place emphasis on developing the potential of rail transport for freight across the Alps (Source: Rail Cargo Austria).

Switzerland

In Switzerland, the objective of sustainable development is anchored in the federal constitution. As far as transport policy is concerned, sustainable mobility means that the infrastructures must be planned in such a way that they respond to mobility needs while taking into account the cost and efficiency criteria and the demands related to public service. They can thus ensure to all population groups and to all the regions of the country access to an operational transport system. It is also necessary to guarantee that this accrued mobility is complemented by an improvement in traffic safety and that it does not harm the environment.

More concretely, the objective of sustainable mobility is implemented through:

- a public transport modernisation programme (Rail 2000, NRLA, connection to the European high-speed rail network, abatement of railway noise),
- equalisation of conditions of competition between rail and road, in particular by the introduction of the MLHVT in 2001, and
- the coordination of means of transport so that freight traffic can be shifted from road to rail.

Italy

In Italy, the national strategies are organised as a General Transport and Logistics Plan (PGTL) passed in 2001, which favours trans-Alpine and intra-Alpine mobility. The PGTL is accompanied by transport plans at various local levels, preferably linked to local mobility. It aims to contain the exponential growth of road traffic and its concentration on major routes, with three objectives:

- the development of the potential of rail transport for freight across Alpine space, in liaison also with the main ports of North Italy,
- the creation of itineraries for developing freight transport of freight from the North to the South by rail with gauges appropriate for transporting containers and swap bodies, in liaison with the transhipping ports and the main mountain passes, and
- the strengthening of the system of transfer points for road-rail transfer in the South.

Slovenia

In Slovenia, the Resolution on the Transport Policy of the Republic of Slovenia (Intermodality, Time for Synergy), which was adopted at the beginning of 2006 by the National Assembly, defines – in terms of the starting points, vision, objectives and measures – the basic trends of a transport policy for the future. The main indicators of this transport policy originate in mobility, accessibility, the environment, safety, economic development, optimal exploitation of resources, intermodality/interoperability and a balance among transport systems.

Considering the complexity of sustainable development, those responsible for transport policy consistently noted the objectives and measures of a policy that equally, simultaneously and independently addresses all four dimensions of sustainable development: economics, society, the environment and ethics. The main objectives of the transport policy include the attainment of a social optimum in the part concerning the transport sector, an increase in transport safety and security, efficient use of energy and a clean environment.

From an environmental standpoint it will be necessary to facilitate the development of new transport techniques and technologies which alleviate the burden placed on the environment and foster the use of more energy efficient and ecologically acceptable vehicles. With the changing social habits and economic dynamics, Slovenia attempts to raise public awareness about the significance of sustainable development, the role of transport and its operation as well as optimal utilisation.

Public interest in providing mobility is also linked to social and environmental factors. The described vision of mobility in Slovenia is a response to the unbalanced development of passenger transport. Two different laws and two different administrators responsible for providing public transport services dictate the conditions for the work of major public transport operators, bus and railway operators.

The Slovenian traffic authority argues that the awareness of passengers needs to be raised in order to steer passenger transport in the direction of intermodal objectives.

Since economy is also a component of sustainable development, Slovenia has envisaged in its transport policy measures the setting up of a market-based system for charging fees for the use of infrastructure. It is in the interest of the state to have developed and competitive transport operators that provide quality services, are successful, increase added value and innovations, since fierce competition on the European transport market means that companies are forced to streamline their business operations and fight for survival.

From an economic viewpoint, the inclusion of private capital in the development of transport infrastructure is anticipated. Private capital should be engaged in all those areas where the desired goals can be attained by means of a private initiative thus partly taking the burden from public finances. Regulations and other legislative acts should primarily lay down conditions for the development of a quality market structure in the field of transport.

With the construction of a suitable infrastructure, Slovenia would like to enable a smoothly flowing and safe traffic for Slovenian and foreign transport operators entering and transiting the country. A free-market economy and administrative regulation foster the development of this sector, rather than traffic obstruction, and promote the competitiveness of Slovenian transport operators.

D5 Development of Alpine Transport Infrastructure

D5.1 Road infrastructure policies

In the last eight years serious road accidents have occurred in some of the main Alpine crossing tunnels, causing deaths and injuries. The accidents blocked trans-Alpine traffic for months and even sometimes years, and mounting reconstruction costs of up to more than 180 Mio EUR (see more details in chapter A1.2.2).

As part of the **Zurich group**, the Alpine countries have already contributed to applying the provisions of the European directive on road tunnel safety, issued in April 2004; nevertheless, a list of works in progress at European level on rail tunnel safety has still to be produced, in order to identify the additions that might be necessary when taking account of the specific characteristics of the Alpine region.

With regard to the technical safety of heavy goods vehicles, the Working Group has produced a comparative list of provisions applicable in the Alpine countries, and is considering ways of reducing of the risk of heavy goods vehicles catching fire.

For the Alpine space in the Trans-European-Transport-Network (TEN-T) no motorway projects as priority projects are reported (EU 2005). In the different Member States main road upgrades or network completion are the subject of the respective national transport programmes. Some examples of road construction projects are indicated in chapter A1.2.1.

D5.2 Rail infrastructure policies

Most of the rail lines crossing the Alps are old, and the tunnels accompanying them were produced using the drilling techniques of the late 19th century, when it was necessary to dig for the shortest distance, using the tools of the time. On certain sections, therefore, these lines have gradients that are incompatible with developing modern, efficient freight services.

To deal with the projected growth in trade and to offer a real alternative to road transport, four major drillings are in the process of implementation or design on major routes (see Fig. D5-1):

- Lyon-Torino base tunnel,
- Lötschberg base tunnel,
- Gotthard base tunnel,
- Brenner base tunnel.

These routes were recognised as having high priority for the structuring of trade in Europe, so that, between 2007 and 2020, it will be possible to introduce an alternative to growth in road traffic on the North-South route as on the South European route.

Fig. D5-1: The four rail tunnels currently under construction.

Franco-Italian cross-border base tunnel

The new mixed (freight and passenger) link project connecting Lyon and Torino (TEN-T no.6 priority project see chap. D3) has a dual objective:

- to ensure sustainable development of rail freight across this section of the Alps (expected capacity of 40 Mio tonnes/year), by replacing the current mountain line with a new level line with, in particular, a cross-border base tunnel about 52 km long, and
- to allow passengers to cross the Alps in the best possible conditions, while providing an efficient service covering the major towns of the Alpine corridor.

Following the technical studies initiated by the Treaty of Torino on 29 January 2001, both countries had to complete their respective procedures in 2006 for Italy and 2007 for France. The structure should be able to come into operation before 2020, at a cost of seven billion EUR.

Swiss New Rail Links through the Alps (NRLA) and its major tunnels

In Switzerland, the implementation of the NRLA in stages is in progress. Proceeding in this way, by stages, allows costs to be controlled and the rail service offered will be able to be coordinated with demand. The main elements of the NRLA are:

- the drilling of the Lötschberg base tunnel: the breakthrough of this tunnel, 34.6 km long, took place at the end of April 2005. The installation of rail technology is under way; the opening of the tunnel is planned for December 2007,
- the construction of the Gotthard base tunnel: 54% of this tunnel, with a length of 57 km, has already been drilled. It should be completed by 2015/2016. This structure will be extended to the South by the Ceneri base tunnel (15 km), which is planned to open in 2016. The building authorisation was granted in October 2005, and
- the Zimmerberg and Hirzel tunnels are assigned to the second phase of the NRLA. Given the uncertainty of federal finances, these structures will be built in stages. The Zimmerberg tunnel will be built a few years later than planned. It is not considered necessary for the Hirzel tunnel to be in operation at the current time.

The initial capital expenditure was set at 8.9 billion EUR (CHF 14.7 billion). In the summer of 2004, credit was increased by 549 Mio EUR (CHF 900 million), reaching 9.5 billion EUR (CHF 15.6 billion, 1998 prices). The probable final costs are estimated at 10.0 billion EUR (CHF 16.4 billion, prices in 1998, Schweizer Parlament 2006). An amount of 5.9 billion EUR (9.66 billion CHF) is planned for the St-Gotthard-Ceneri route and 2.6 billion EUR (CHF 4.22 billion) for the Lötschberg-Simplon route.

The lengthening of the NRLA to the north of Switzerland is regulated by an agreement with Germany.

The new and upgraded line Karlsruhe – Offenburg – Basel, which is the most important German feeder line to the NEAT in Switzerland, is classified in its entirety as a first priority project in the 2003 Federal Transport Infrastructure Plan. It is intended to complete the widening of the whole line to four tracks by 2015, simultaneously with the opening to traffic of the Gotthard Basis Tunnel in accordance with the Memorandum of Understanding concluded with Switzerland in 1996.

The Federal Railway Infrastructure Upgrading Act contains further feeder lines to the NEAT. First priority projects are:

- upgraded line München – Lindau – German/Austrian border,
- upgraded line Stuttgart – Singen – German/Swiss border,
- upgraded line Ulm – Friedrichshafen – Lindau.

A convention has also been concluded between Italy and Switzerland. Through the coordination of infrastructure planning and of measures improving rail operations between the two countries, the convention is to improve the connections, in particular with Malpensa airport. In the longer term it is planned to ensure an optimal link between the NRLA and the high-speed Italian network.

In this context, various lengthening variants of the NRLA to the south of Lugano are now being studied. Switzerland is examining four variants of a new stretch between Lugano and Chiasso (“AlpTransit Sud”). As for Italy, it is developing three alternatives for a new stretch towards Luino-Novara (“Gronda Ovest”). These alternatives will be assessed by the end of 2006.

Brenner base tunnel

In April 2004, Austria and Italy signed an agreement on the Brenner tunnel. The total cost of the 56 km-long tunnel is estimated at approximately 4.6 billion EUR. Regarding the financing Italy and Austria envisage topmost TEN subsidies from the European Union and a Private-Public-Partnership (PPP) is intended. The public part would be financed by 40% by Italy, 40% by Austria and 20% by the European Commission. The work for a pilot tunnel started in 2006. It is planned that the Brenner base tunnel will be in use by 2020.

In June 1994 (Memorandum of Montreux), Germany, Italy and Austria agreed on the gradual construction of the feeder lines and the Brenner Basis Tunnel „in line with requirements“. These lines are to be upgraded in such a way that the capacities needed for additional traffic volumes can be provided in good time.

After the completion of the measures for capacity enhancement on the German feeder lines in 2001, further upgrading has to be oriented towards the demand to be expected, which depends ultimately on the completion of the Brenner base tunnel. In this connection, the considerable additional railway capacity between Germany and Italy which the NEAT in Switzerland with the Lötschberg and Gotthard base tunnels (completion scheduled for 2007/2015) and the four-track German feeder line Karlsruhe – Basel will offer, should also be taken into consideration.

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D6 The Transport of Freight through the Alps, a major Concern

More than 10 Mio heavy goods vehicles travelled over Alpine crossings in 2004. Freight traffic volume doubled in 20 years and has had a significant impact on journey safety and on the environmental quality of the Alps. This trend has caused increasing exasperation among the population who live beside the major road transport routes. Because of these circumstances the conditions of freight transport in the Alpine space are a major issue for its future, particularly the transport arising from international trade.

Given this situation, the Alpine countries are gradually developing national and joint actions for regulating road freight traffic, ensuring better journey safety, and identifying pricing in relation to costs of road transport to take account of all the direct and indirect costs.

These actions are still to come: although the national policies are well established, implementing effective cooperation is a more problematic task, at least in the short term.

D6.1 The management and regulation of road freight traffic

Within the framework of the Zurich group, the Alpine countries have prepared an accurate inventory of the measures which exist in each country for regulating heavy goods vehicle traffic through the Alps and are in the process of collecting opinions from the various parties involved, in order to perform an assessment of the existing or planned traffic management systems; the major objective is to reach joint or jointly-agreed actions, favouring a global approach to the Alpine space. In this context, two areas of work are particularly significant:

- proposals for extension of the effective measures already implemented by certain Alpine countries and able to be transposed to others, and
- the expert study of new regulatory systems such as the principle of an Alpine transport exchange, proposed by Switzerland.

This exchange would require a common approach by all Alpine states. It would allow, through market mechanisms, the management of the restricted road capacities on Alpine passes, or of the number of trips through the Alps.

Germany – Monitoring of freight transport

With a view to the improvement of road safety, environmental protection and fair competition, great importance is attached to the enforcement of rules and regulations.

The task of enforcement is, in principle, incumbent on the police authorities of the Federal Länder. Moreover, by virtue of its powers, the Federal Office for Goods Transport (BAG), performs roadside checks at federal level mainly in the sector of social legislation, the legislation governing the transport of dangerous goods, technical checks at the roadside, cargo securing, weights and dimensions as well as the legislation governing road haulage and also the compliance with legal provisions.

Roadside checks by the BAG which also include the feeder roads to the Alps were carried out on about 615,000 vehicles in 2005 (approx. 50% domestic and 50% foreign vehicles).

The offender rate determined during those checks amounted to about 19.9%. Infringements of the social legislation (driving and resting periods) accounted for 60% of the offences, infringement of the road traffic law for about 25%.

Austria – night traffic ban

In Austria, due to the NO_2 limits having been substantially exceeded, the government of Tirol has ordered night traffic to be prohibited on a 46 km section of the Inntal A12 motorway from winter of 2002/2003.

France and Italy – tunnel cooperation and traffic monitoring

Heavy goods traffic at the Mont Blanc and Frejus tunnels has been divided according to the conditions after reopening of Mont Blanc tunnel. Bilateral safety measures have also been taken at the Tende road tunnel (see subchap. A1.2.2).

At Montgenevre pass, due to the physical characteristics of the road, heavy goods vehicles of more than 26 tonnes have been prohibited since August 2003, except for limited exemptions. A binational monitoring committee has been set

In Austria toll charges for motorcars are controlled by video (Source: ASFINAG).

up. Similar provisions have existed since July 2003 at the Larche/Maddalena pass.

To take it further, which entails indispensable but proactive action, it will be necessary to include these measures in the wider context of traffic management over the whole Alpine space (see also text box on AlpCheck). If the measures established for regulating road traffic consisted only of transferring the charge that cannot be applied to the other routes, it would be inapplicable for population living alongside the road and ill-suited to the objectives of the Alpine Convention.

Case study: INTERREG IIIB-project AlpCheck

Problems related to data sharing on mobility are evident, mainly due to differences in the data collection systems that lead to a difficult homogenization. AlpCheck aims to create an informative system able to manage data coming from the existing monitoring systems in the Alpine area. It should be global but it will have to adapt itself to the characteristics of each user. The system has to adapt itself to multiple requirements and various contexts and different types of travel.

Project objectives: Tasks integrated with the system and developed through pilot projects are

- *to investigate with innovative technologies local, tourist and freight traffic flows,*
- *to analyse the consequences of the traffic in environmentally critical points, and*
- *to underline in the whole mobility network the routes of "empty trucks" in order to define a freight flow reallocation.*

Source: http://www.alpinespace.org/alpcheck.html

D6.2 Identification of optimum pricing for freight transport

The reality of transport costs, as a means of real competition between the different transport modes, is an important area of work for the Alpine countries. Part of the work of the Alpine Convention transport group includes the task of identifying a better pricing system for trans-Alpine road transport, incorporating all external factors, based on the comparison of the practices of the various countries and the cost of transport over major routes (see also information on road pricing in chapters A1 and C1).

At the same time, each country is attempting to increase the costs of its road journeys within the framework of the wider applicable rules, which also explains the expectation of new possibilities opened by modification of the Eurovignette directive (see chapter D3).

In 2005, **Germany** introduced a system of toll charges for heavy vehicles using the motorway infrastructure (LKW Maut), calculated in relation to the emission of pollutants and the mileage covered. After deducting the costs of operating, monitoring and inspecting the system, the toll charges received are allocated to constructing and improving transport infrastructure.

In **Austria**, toll charges for heavy goods vehicles and coaches were introduced on the motorways and Austrian expressways on 1 January 2004. These are calculated in relation to mileage covered. In addition, the increase in the tax on mineral oils for diesel by 3 centimes per litre (but only 2 centimes for fuels without sulphur), on 1 January 2004, represented another step towards the allocation of real costs of road transport. All vehicles above a permissible gross weight of 3.5 tonnes – in other words mainly commercial vehicles but also large motor homes and buses – will be obliged to pay a toll.

2,000 km of the high-level-road network (motorways and expressways) – in the responsibility of the state-owned Austrian Motorway Company ASFINAG – are subject to the new toll collection system. Because the current EU-Directive 99/62/EC permits tolls only in relation to the infrastructure costs, it has been decided that these costs will at least be credited on the basis of the distance travelled. Recipient of the toll revenues is ASFINAG, which is also responsible for toll collection.

The toll rates – graduated in three classes according to the number of axles – have been fixed in November 2002 in a decree by the Minister of Transport on basis of the law concerned. The rate for vehicles with two axles is 0.13 EUR/km, with three axles 0.182 EUR/km (+ 40%) and with four or more axles 0.273 EUR/km (+110%). The theoretical average toll rate is therefore 0.22 EUR/km (excl. VAT).

In **France**, the rate of TIPP on diesel fuel came closer to that for petrol in 2004. Various studies have been carried out to check how an appropriate pricing system might influence the behaviour of users in terms of use of the Alpine roads, or contribute to financing alternative infrastructures. These considerations will continue as part of the Lyon-Torino project, with France and Italy having agreed, for all Franco-Italian journeys, to identify measures for regulation and pricing of road transport in order to ensure that the future rail link should be attractive.

In **Switzerland**, to encourage the transfer between modes of transport (an objective included in the Federal Constitution since the acceptance of the article on protection of the Alps), the Mileage Related Heavy Vehicle Tax (MLHVT) has been implemented since January 2001. This fee applies the "polluter pays" principle and allows for offsetting of the effects of the gradual increase in the weight limit of lorries which reached 40 tonnes in 2005. The fee is charged on the Swiss and foreign vehicles of more than 3.5 tonnes and calculated on the basis of the mileage covered, the gross vehicle weight and the pollution emission rating of the vehicle.

The joint land transport committee, which monitors the EU-Switzerland agreement, fixed the rate to apply from 1 January 2005, until the entry into operation of the Lötschberg base tunnel (opened since June 2007). These rates are based on a weighted average of 178.42 EUR (CHF 292.50) for a 40 tonne vehicle over a 300 km distance. Two thirds of the MLHVT received is allocated to financing the NRLA and other major public transport infrastructure projects.

D6.3 Optimization of rail corridors

Looking ahead to 2020, the projected new trans-Alpine rail infrastructure is not sufficient to fulfil the need to present tangible signs of real support for alternative modes of freight transport. It is essential to combine practical actions in terms of successive phases of time, to first stabilise the current situation of freight transport across the Alps by rail, and then to attempt to make progress wherever possible and however possible. This implies the use of coordinated measures from one end of the economic route to the other to improve the service offered on the existing different rail corridors, and to progress towards network interoperability. This objective is largely monitored by the Alpine Convention transport group.

The Brenner 2005 plan

In July 2002, representatives of the Ministries of Transport from Germany, Austria, Italy and Greece decided to form three working groups, which would be responsible for finding solutions to the current problems in the trans-Alpine transport of freight, by developing, first and foremost, measures intended for combined transport in the Germany-Austria-Italy corridor on the Brenner route. The objective was to achieve an increase in the combined transport volume on the Brenner route by 2005, of at least 50% in comparison with 2001. The measures have been grouped into the "Brenner 2005" action plan.

By adopting this action plan, all the transport and administrative economic interests have contracted highly practical, tangible responsibilities with the aim of coordinated action for the purpose of increasing the capacities and improving the competitiveness of trans-Alpine freight transport by rail. The 'Brenner 2005' action plan consists of three packages of measures:

- package no.1 consists of top priority measures, for which implementation has started immediately,
- package no.2 concerns measures, for which implementation has been able to start after a relatively short period and which aim to improve competitiveness, and
- package no.3 concerns measures which can be implemented in the medium term, for example infrastructure measures, which will form the foundation for long-term growth of combined transport.

The results of the implementation of these measures are in some cases very positive. The packages are covered by a monitoring report produced each year. The data for 2005 data show a 21% increase in unaccompanied combined transport, and a 63% decrease in accompanied combined transport, leading to a total decrease of 19%. Some specific outcomes of the action plan are presented in chapter A1.3.

The IQ-C corridor (International Group for Improving the Quality of Rail Transport in the North-South-corridor)

In January 2003, a Memorandum of Understanding was signed by the ministers of the four countries of the North-South corridor via Simplon and Gotthard, namely Italy, Germany, the Netherlands and Switzerland.

The IQ-C programme specifies a range of short-term measures aiming to identify and eliminate the current weak points of the rail corridor, with the aim of encouraging transfer between modes of transport. Concrete measures are described in chapter A1.3.

Currently, the IQ-C group is concerned, first and foremost, with analysing the introduction of the ETCS in the North-South corridor (the variables affecting infrastructure are evaluated with respect to their benefit/cost ratio). It is planned to install ETCS on the whole corridor by 2012/15. This would allow locomotives equipped with a single safety device to use the whole corridor.

Maurienne Corridor, Aiton-Orbassano rail motorway experiment

The service on the Aiton – Orbassano line should be extended to 20 return journeys a week, from the end of the work of modernising the historic line. In the very short term, priority is given to improving the frequency of the shuttle service and to completing the work in the tunnel. During the Franco-Italian summit of 4 October 2005, the French and Italian Ministers decided to initiate studies of forms of operation for the subsequent service, after the work is completed.

In the medium term, the ministers have also decided to draw up a coordinated action plan to optimise the rail service on the existing line, in order to curb the drop in the market share held by rail freight transport and to establish the credibility of the Lyon-Torino project in the long term. For this purpose, RFF, RFI, SNCF and Trenitalia, under the aegis of the two Ministries, will put together a practical action plan. France and Italy could then sign a memorandum of understanding, as in the approach taken for Brenner by Germany, Austria and Italy.

D6.4 Offering alternatives using sea and river modes

Development of fast sea transport routes in Mediterranean

For France and Italy, it is important to facilitate bypassing the Alps and to lighten traffic on the major road transport infrastructure. This is particularly relevant due to the development of high-frequency and high-quality sea links, both for the North-South or Mediterranean long distance route, and for the Iberian Peninsula-France-Italy link or the France-Italy link. France has made a solid commitment to financing these projects planned by the France Transport Infrastructure Financing Agency (AFITF).

A group of studies is currently in progress, with the aim of launching a request for proposals jointly with Italy and Spain in 2007. In particular France, as part of the CIG of the southern Alps, has conducted a study concerning the potential volume of traffic that can be transferred from road to a fast sea route such as this.

This study, which looked at just under ten potential routes, was based on a comparison of the "door-to-door" transport costs. It shows that fast sea routes are a credible alterna-

tive to the “all-by-road” approach, with, in theory, a potentially substantial volume of traffic able to be picked up. But the sea route approach is very sensitively affected by transport costs, frequency, quality of maritime service, and organisational investment constraints for the operators.

In addition, the Toulon – Civitavecchia line (mixed freight and passengers), created in January 2005, is a coastal route which might be suitable to become a “sea motorway”, in the event of an increase in capacity and frequency. Currently the average load factor in the region is about 40%. Three departures a week in each direction are offered with a journey time of 14 hours for a price of about 450 EUR for a heavy goods vehicle with driver. In comparison, using “all by road” transport, the trip would amount 800 EUR and 22 hours of driving.

In Germany, the transfer of freight to waterway

A reduction of the transit goods traffic by land transport modes can, in principle, apart from the possibilities inherent in the inland waterways, also be achieved by means of short sea shipping. In Germany, the “From road to sea/waterway” concept is vigorously pursued as a key issue of transport policy in order to make progress with the decongestion of road traffic for the benefit of transport services by waterway; indirectly, the concept also takes account of trans-Alpine freight traffic.

D7 Encouraging Sustainable Mobility for the Population in the Alpine Space

Freight transport represents a substantially significant element of transport in the Alpine space. But it should not be forgotten that more than 13 Mio people live in this area. For their everyday life and leisure activities, as for the tourists and visitors attracted by the exceptional quality of the Alps, encouraging sustainable mobility in movements of people within the Alps is a requirement that holds a high priority in the transport protocol of the Alpine Convention.

Encouraging sustainable mobility is based on actions taken at local level by the competent local and national authorities, which makes it a focus of interest for the organisations involved in the Alpine Convention. Many projects are also developed through the Alpine space INTERREG programmes (see chapters D7.2 and D8).

D7.1 Sustainable mobility of passengers in and around Alpine communities

Sustainable passenger mobility takes place at different levels, such as inner urban traffic and local traffic as well as long distance traffic. A wide variety of initiatives and projects is under way to improve passenger mobility in the Alpine area.

For economic, ecological and recreational reasons, the bicycle's role in the transport system is also gaining importance in developed European countries. Regardless of the age and social status, a wide range of people take up cycling.

Some examples of successful policies are given below.

Improvements in urban passenger transport in Italy

In Italy, any towns of more than 30,000 inhabitants must produce an "Urban Traffic Plan", consisting of pricing and regulatory measures, or even coercive measures in the event of prolonged and effective environmental alerts. The main objective is to regulate the use of the car, whether for routine journeys, which may be made more efficiently by using public transport, or for journeys in districts that continually experience congestion.

The Urban Traffic Plan therefore aims to implement an integrated transport system (public funds and private vehicles, urban and extra-urban services and public transport services managed by various operating entities), both in terms of infrastructure and services offered and in terms of demand control and regulatory activities: park-and-ride facilities, cycle paths, town centre shuttle services, etc.

Some particularly interesting actions for all these plans have been developed in the towns of the Alpine space: Imperia, Bergamo, Bolzano, Brescia, Como, Trento, Trieste and Udine. For example, since 1998, Udine has more than tripled its park-and-ride facilities, and Imperia and Bergamo have doubled their paid parking spaces. The larger Alpine towns have also instituted traffic limiting zones and pedestrian areas. This policy received a particular boost in Udine and Trieste.

Other actions also contribute to a sustainable local mobility, such as

- the development of cycle paths (Trento, Trieste, Udine), and
- programmes for developing innovative vehicles for public transport (Imperia, Udine, Trieste, Trento).

It should be noted that in Brescia, Bergamo and Trieste, there is an obligation to control exhaust gas emissions exist (application of a blue sticker, the *Bollino Blu*).

On the other hand, the Italian Alpine towns remain behind in setting up telematic systems for traffic management (even though some of them, such as Brescia, have interesting initiatives), and makes too little use of the financing of innovative actions put into place in 1999–2000 by the State for 'sustainable mobility'. Trieste is the only town which has a contribution for the development of innovative systems.

Transborder regional railway connection between France and Switzerland

Between France and Switzerland, a railway link project between Cornevin – Eaux Vives – Annemasse (CEVA project) is under study. It foresees the construction of a 4.8 km long railway tunnel between Cornavin – La Praille and Eaux-Vives – Annemasse. The line between Eaux-Vives and the French border will be doubled and will be constructed in the cut and cover mode. A bilateral convention project is being drawn up, which will concern such issues as end user competences and maintenance, electrical supply and infrastructure gauge. The railway link is planned to come into service between 2010 and 2020.

Another project now under consideration aims to improve the railway connection between Mendrisio and Varese (MEVA). The project includes a new, 5.2 km long line between Stabio and Arcisate (Italy). Entry into service is planned for 2010. In December 2005, the Federal Council adopted a message destined for the Parliament. It suggests that the costs of these two projects, which are to be financed by the Confederation, would be covered by an infrastructure fund reserved for agglomerations.

Regional tram and coach extension around French cities

In France, three projects are in the design phase or in the process of implementation in the Grenoble conurbation area, apart from the pricing integration at department level, established on 1 October 2002:

- the implementation of a third tram line and the extension of the existing lines to Grenoble (to come into operation in 2006),
- the metropolitan tramway: Grenoble-Moirans link, 18.5 km long (entry into operation expected in 2008), and
- while waiting for completion of the above projects, an express coach link between Crolles, Grenoble and Voiron came into operation on 2 September 2002, running every 10 minutes, as well as the use (currently experimental) of the hard shoulder of the A48 motorway, which is very often congested.

Tramway in Grenoble (Source: S. Marzelli).

Regional rail system development in Austria

As part of the implementation of the infrastructure programme for local transport in Salzburg (NAVIS), a rapid transit system is being set up. This project plans for an automatic traffic timing system in the Salzburg–Strasswalchen, Salzburg–Golling and Salzburg–Saalachbrücke/Freilassing zones. The creation of 12 new stations in total, as well as two lines on the route connecting Salzburg's main station to Saalachbrücke/Freilassing, and the establishment of regular time-controlled links, will allow for new development of local rail traffic from "greater Salzburg", which will provide an attractive alternative to private vehicle use.

In November 2003, the Tyrolean Government took the decision to improve the public transport system in the Innsbruck urban region in the form of a regional rail system and a city bus system running between Telfs and Schwaz.

In November 2003 the Tyrolean Government took the decision to set up the following projects:

- modernisation of the Stubaitalbahn to transform it into an attractive regional line, with direct access to the main station of Innsbruck on a new route allowing journey time to be reduced,
- construction of of a new regional line between Völs and Hall in Tyrol, which will enable the town centre to be crossed using the existing tram-lines in combination with a service to the main station,
- extension of the network of the Innsbruck tram system, partly using the new regional railway lines to be constructed, and
- development of regional city bus traffic between Telfs and Schwaz, using the new turntable at the Innsbruck bus station.

Increasingly attractive conditions for public transport in Germany

In Germany, Bavaria is endeavouring to transfer passengers in the Alpine region from private cars to public transport, by improving services and fixing attractive prices.

From 1996, the government of the Free State of Bavaria, with the financial accommodation of the Federal State, put into place an integrated timetable (BayernTakt) which improves the attractiveness of public transport, in particular for leisure purposes, with wider implications for Alpine tourism. The majority of the tourist regions are integrated into the DB rail network. Terminal transport is provided by bus or shared taxi. The construction of park-and-ride facilities, close to the stations, is encouraged by financial support.

Cross-border links already exist using short-distance public transport between Bavaria and Austria, like the Berchtesgaden-Salzburg link or the bus link between Reit im Winkel and Kössen. The Lake Constance card can be used to travel by rail, boat and bus throughout the lake region, from 21 EUR a day.

The Bayern Ticket represents an attractive price for public transport throughout Bavaria. In addition, combined tickets have been launched in Bavaria, allowing the ticket holder to use several means of transport, such as the railway or the mountain railway. In Allgäu, the "Allgäu Card" can be used for public transport over short distances.

Especially in the Alpine region, the local and regional authorities that organise public transport provide visitors with the option of using short-distance public transport at concessionary prices (ski bus, saver season ticket, day ticket, transport of bikes by train) and have created special routes for leisure traffic (for example: circular bus route from Wendelstein in the districts of Rosenheim and Miesbach).

Light railways such as the "Bayerische Oberland Bahn" (BOB) have been successfully revitalised through the engagement of private railway enterprises.

Development of cycling in Slovenian communities

Slovenia is endeavouring to promote changes relating to the choice of transport means in urban communities and to at least partly replace daily car commuting with cycling. Recently, a growing number of people have taken up recreational cycling in clean and friendly environment outside big towns on account for tourist, amateur sport or health preventive reasons. Cycling and walking areas are therefore becoming a focus of urban planners, designers and traffic experts.

The national cycle network consists of long distance, main and regional cycle routes. The municipal cycling routes are connected with the national cycle network.

D7.2 Sustainable mobility of passengers in access to tourist sites

The conference on "Environmentally Friendly Travelling in Europe – Challenges and Innovations Facing Environment, Transport and Tourism", held on 30 and 31 January 2006 in Vienna, provided an opportunity to report on numerous local experiences and cross-border cooperation. The aim was to encourage an intelligent provision of public transport for the tourist area itself, and to develop a serious provision of access to stations by rail rather than using private vehicles. Some directions for further work were proposed (see chap. E2):

- encouragement of sustainable mobility via tourist areas as a factor in a positive competitive image,
- development of cross-border cooperation between local authorities, transport operators and tourism operators for a better organised provision at the different levels of public transport in the Alps, and
- acceleration of research into clean vehicles with lower use of non-renewable energy.

This conference was also an opportunity for the communities involved in the "ALPS MOBILIY II – Alpine Pearls" INTERREG programme (see chap. D8) to form themselves officially into an association, chaired by the mayor of Werfenweng (Austria).

Wide acceptance of park-and-ride facilities in Germany

In Germany, many municipalities have started to restrict the circulation of private cars in town centres, by creating park-and-ride facilities at the peripheries, sometimes linked to the centre by shuttle services, in order to reduce noise and pollution. The following Alpine towns are taking part in this project: Bad Aibling, Bad Kohlgrub, Bad Reichenhall, Bad Tölz, Bad Wiessee, Berchtesgaden, Fischen im Allgäu, Füssen, Garmisch Partenkirschen, Hindelang, Lindau, Mittenwald, Oberammergau, Oberaudorf, Oberstaufen, Oberstdorf and Ruhpolding. The current results show that this provision is widely used. The current results show that this provision is widely used, particularly during the summer months. For example, at Oberstdorf, up to 3,300 daily car journeys to or from the town centre are prevented by the park-and-ride offer.

In the Bavarian Alps, the towns of Bad Reichenhall, Oberstdorf and Berchtesgaden are involved in the INTERREG IIIB project ALPS MOBILITY II. Its main objective is the creation of a combined provision using sustainable means of transport to go to the most beautiful countryside and the towns and villages that show the greatest respect for the Alpine environment.

Cableway of major importance in Slovenia

Slovenia provides cableway transport service for tourist and recreational purposes and as part of regular passenger transport services.

Cableway transport in the Republic of Slovenia consists of more than 280 cableway installations, with six distribution cableways, 46 chair lifts and more than 230 drag lifts.

These facilities are controlled by 47 operators, registered at the Chamber of Commerce and Industry of Slovenia. Among them, there are six sport centres of national importance, ten centres of regional and 39 centres of local importance. On average, the Slovenian cableway transport system carries more than 13 Mio passengers on a yearly basis. The objective is to establish a quality cableway system as an element of the overall Slovenian tourist provision.

Case study: Results of the expert conference "Environmentally Friendly Travelling in Europe"

In January 2006 Austria, while holding both the Presidency of the EU and the Presidency of the Alpine Convention, organised a large conference on "Environmentally Friendly Travelling in Europe" which produced widely acknowledged recommendations (see Annex). Based on a wide variety of projects and policy approaches presented, the recommendations of the conference provide a detailed framework for promoting tourism based on sustainable mobility and the integration of these endeavours in local development as well as a large variety of sectoral policies. For example the suggestions include,

addressing the transport sector:

- *cross-border package offers using public transport,*
- *logistic chains for luggage,*
- *offers combining public transport and cycling,*
- *integrated tariff-systems.*

Logo of the conference.

addressing the destinations:

- *mobility management,*
- *origin/destination car-free service chains,*
- *creation of strategic partnerships between tourism industry and transport companies.*

addressing policy-makers:

- *provision of reliable data,*
- *promotion of existing labels for destinations.*

More details are presented in the report Annex D7.

Variety of tourist mobility offers in Austria

In Austria the model project "Sustainable Mobility – Car-free Tourism", was initiated in 1998 as a future-oriented common project for environment, tourism and mobility by three Austrian Ministries, the Land Salzburg and the two model communities Bad Hofgastein and Werfenweng. It was financially supported by the European Union.

The project was initiated in recognition that a sound and clean environment is essential to attract visitors to a tourist resort. But tourism, particularly motorised transport, has negative impacts on the environment, including air pollution, noise and land use. Tourism is inherently linked to transport. Visitors travel to their holiday destinations and back home, and make local trips during their stay at a resort. The impact of motorised transport affects the region's ecosystems and diminishes its recreational value.

Car-free travel to **Bad Hofgastein** is easy because the community is situated on the Tauern railway, the main connection between Munich and the South. The only problem is that the railway station is 2 km from the city centre. This means a change to bus or taxi. A private bus service therefore connects the railway station with the city centre. In Bad Hofgastein the focus is on a traffic management and the replacement of vehicles with internal combustion engines by electric vehicles for special purposes (car rental, car sharing, hotels, delivery): about 75 electric vehicles are in use in Bad Hofgastein. The city of Bad Hofgastein actively supports the bicycle as a means of transport and gave grants to every citizen for a new bicycle. Several hundred bicycles were bought by the citizens, before the project was officially closed in 2005.

In **Werfenweng**, which has not got a railway station of its own, a dial-a-taxi-service, called the Werfenweng-Shuttle, has been set up to the next railway station, Bischofshofen, 14 km from Werfenweng.

The first solar re-charging station for electric vehicles in Austria was installed in Werfenweng (25 electric vehicles are in use in Werfenweng). A 12.5 m² photovoltaic system with a power of 2,200 W/h produces about 2,000 kWh/year for the electric vehicle fleet for visitors. A further focus lies on the development of a new tourism product. The special interest group “Holidays from the Car” offers special “all-inclusive-packages” (“mobile without a car”), partly in cooperation with international tour operators, some of whom specialise in travel by public transport. Information is already present in tour operators’ catalogues and tourism fairs. The group makes point-of-sales material, is implementing a new design for the communities’ PR, and organises information journeys for travel agency sales agents. All activities are accompanied by PR measures, e.g. press releases, newsletters, media cooperation (e.g. television spots in local TV), visualisation in the community (signs at the community entrances, stickers, pennants, flags), events (Sustainable and Mobile Day, car-free day with PR activities aimed at certain interest groups).

Rental station for a variety of passenger transport vehicles in Werfenweng, Austria (Source: Tourismusverband Werfenweng).

Since 2006, **Neukirchen am Großvenediger** has been accepted as a model community in the project “Sustainable Mobility – Car-free Tourism”. Neukirchen am Großvenediger focuses first on the network of bicycle lanes and trails, being a well known community for mountain biking, and pedestrian trails as well as an improvement in car free access to Neukirchen by creating special offers.

In the region **Gesäuse, Eisenwurzen, Erzbergland** in the Land of Styria, the project “Xeismobil“ in the framework of the INTERREG project “mobilAlp“ was initiated, to marry the needs of preserving public transport in an Alpine region with making the region accessible to tourists by sustainable transport means. 16 communities in the region work together to create offers for an individual nature experience starting from public transport stops or railway stations.

The goals are reached by implementing a better offer on public transport (rail, bus, dial-a-ride), transport demand management by combining all transport means and through the implementation of a mobility centre, through marketing and through the implementation of alternative propulsion systems for public transport.

D8 Improving Transport in the Alps: some European Success Stories

At the end of this part of the report some successful projects, carried out at a transnational level in the Alpine space are presented. Through these examples the abstract framework of policies may become more visible and tangible and may inspire further new activities.

D8.1 Digest of current INTERREG projects

The INTERREG IIIB "Alpine Space Programme" developed by the EU (with an investment in the structural funds amounting to 59.7 Mio EUR over the period 2000–2006) encourages international cooperation to improve efficiency, intermodality and accessibility in the Alps. Eight projects were implemented in the period of 2000–2006:

- the **AlpenCorS** project is concerned with the large-scale issues of a policy of road corridors in the Alpine space. In particular, it endeavours to define the form of corridor 5 (Lisbonne-Kiev), identifying its spatial coherence, the role of the entities involved and the methods for bringing it into operation.
- the **ALPS MOBILITY II – Alpine Pearls** project is concerned with actions of sustainable mobility in the tourism sector. It defines the "Alpine Pearl" label and aims to encourage communication of experiences concerning mobility.
- the **ALPINE AWARENESS** project aims to raise the awareness of several target groups about the issues of sustainable mobility in the Alps (young people, tourism professionals and transport professionals).
- the **AlpFRail** project, in line with the strategy of transfer to alternative modes of transport, aims to develop international solutions to manage transport of freight across the Alps, putting the existing infrastructure to more efficient use and identifying the missing links (see below).
- the **MONITRAF** project aims to create tools for evaluating trans-Alpine traffic, to encourage the formation and activity of a network of partners, and to assess the effects of road traffic in the Alpine space.
- the **ALPNAP** project aims to forecast the emissions of atmospheric pollutants and noise pollution, caused by transport in particular, and to assess their impact on the environment, quality of life and health of those living along transport routes.
- the **VIANOVA** project aims to reduce car traffic in the conurbations, particularly for individual journeys, and to motivate inhabitants to undertake more physical activities (cycling, walking).
- the **mobilAlp** project deals with all kinds of mobility (home-work, tourism, trade), and must produce a chart of sustainable mobility in the Alps, in terms of protection of the territory and the environment, by development of public transport and clean technologies.

Other projects have already been identified. They will be able to be developed in the next programme for 2007–2013, for which the major issue is the involvement of a greater number of Alpine local authorities. The proposed priority area "connectivity and accessibility" may encourage transport related activities. In addition to the programme of international cooperation, other programmes of cross-border cooperation around the Alps make their contributions to the solution of shared problems and provide frameworks adapted to the cooperation and development of the cross-border transport networks.

Scientific Workshop on Mountain Mobility and Transport SWOMM

The "Scientific Workshop on Mountain Mobility – SWOMM" took place in two sessions in 2005 (Bolzano) and 2006 (Domodossola) and collected some of the most important research and scientific projects concerning transport and sustainable mobility in mountain areas, in the following thematic fields:

- *transfer of goods from road to rail,*
- *Alpine corridors,*
- *environment-friendly means of transport,*
- *strategies for efficient transport systems,*
- *traffic management,*
- *impact of traffic on the Alpine environment, and*
- *international aspects of Alpine transport.*

SWOMM was promoted by the Italian Ministry for the Environment, Territory and Sea (MATTM), in the framework of its activities for the AlpFRail INTERREG III B Alpine Space Project (aimed at establishing an Alpine railway network and shifting freight from road to rail) and developed in cooperation with the European Academy of Bolzano and the Committee for the Simplon tunnel centenary.

In this framework, experts and officers of institutions involved in mountain mobility and transport at national and local levels from all the Alpine countries presented the results and issues concerning Alpine transport in the first session. This was followed – in the 2nd session – by a round table discussion of the main contents of SWOMM.

A final publication focusing on the main topics raised during the two sessions of SWOMM has been issued (Angelini 2007).

D8.2 Insights in selected INTERREG projects

INTERREG IIIB project "Alpine Freight Railway" (AlpFRail)

AlpFRail project, launched in summer 2003, aims at developing a transnational solution to cope with trans-Alpine goods transport using the existing infrastructure (cp. also information on AlpFrail in subchap. A1.3.2). In this connection, special account is to be taken of environmentally friendly rail transport mode.

The project is focused on inter-corridor solutions in terms of networks and systems. Moreover, missing links are to be identified and a traffic scenario is to be developed with an ensuing operational concept for Alpine transport, taking into consideration the enlargement of the EU to the east and the inclusion of the Mediterranean ports.

For four years the lead partner, Logistik-Kompetenz-Zentrum Prien, cooperated with national governments, provinces, regions, chambers of commerce, associations, railway undertakings, carriers and ports from the entire Alpine arc in this project. This project was concluded in 2007. At the moment, specific projects such as the "Adria Train" and the "Trailer Train" are being fine-tuned.

INTERREG IIIB project "ALPS MOBILITY II – Alpine Pearls"

The idea for the project was developed against the backdrop of the endangerment of the sensitive Alpine space by motorised traffic, which has considerably reduced not only the ecological balance but the recreational value as well. The focus of the project was the creation of innovative eco-tourism offers called "Alpine Pearls".

The project, which follows up the successful project "ALPS MOBILITY" in the framework of INTERREG IIC, had a financial volume of 3,216,960 EUR (of which the EU co-financed 50%) and ran from May 2003 to September 2006. Partners from Germany, France, Italy, Austria and Switzerland worked transnationally and transsectorally. They produced and implemented innovative environmentally friendly solutions for soft mobility, car-free tourism and sustainable regional development.

The "Alpine Pearls" offer combined points of interest to tourists and the advantages of soft mobility with environmentally sound means of transport. The objective was the creation of an attractive mobility and tourism package for a pleasurable and comfortable journey to the most beautiful landscapes and the most environmentally friendly resorts in the Alps. Transportation will be provided by train and bus, taxi, and environmentally friendly vehicles, as well as by ship or boat, bicycle, or on foot, and horse-drawn carriages or sleighs. In order to become an "Alpine Pearl," each partner region has to fulfil certain mobility and tourism standard in terms of sustainability, according to a fixed criteria catalogue.

The work consisted of the following steps:

- specifying the details for trans-Alpine realisation in an implementation study, which was elaborated by a transnational expert group,
- planning of the "string of pearls," the sustainable travel chain to the Alps and between the partner regions, and the creation of bookable package modules,
- development and improvement of mobility services and infrastructure conditions for an environmentally friendly travel chain between the resorts ("pearls") and their surrounding regions, e.g., bicycle routes, charter trains and charter buses,
- improvement of regional mobility services (e.g. innovative public transport services, promotion of non-motorised transportation, use of the latest mobility technologies, etc.) and improvement of infrastructure conditions (e.g. traffic calming measures, improvements for cyclists and pedestrians), and
- development and implementation of a common PR strategy for the tourism product.

The basis for participation as an "Alpine Pearl" is the criteria catalogue, which takes into account all facets of an attractive, soft-mobile holiday destination. The criteria encompass the following areas:

- transportation in general, mobility / transportation to the pearl, mobility guarantee in the holiday region,
- tourism, regional and local development, and
- nature and environment, culture, education, participatory planning.

The "Alpine Pearls Association – Promotion of Sustainable Tourism with Environmentally Friendly Mobility," as the umbrella organisation of the participating communities, links partner regions and communities in the entire Alpine space. This network of soft-mobile "Alpine Pearls" is being built up to become a strong tourism label for soft mobility.

The association's budget consists of proceeds from membership and marketing fees. Other income is based on subsidies and sponsoring. With these proceeds, the association finances common marketing and communication activities, its management, and events.

Currently, the following communities are members of the Alpine Pearls Association: Werfenweng, Chamois, Ratschings, Villnöß, Welschnofen, Deutschnofen, Steinegg, Tiers, Feltre, Pievi di Cadore, Forni di Sopra, Sauris, Berchtesgaden, Bad Reichenhall, Arosa, Interlaken and Les Gets.

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E Main Conclusions for the Alps

E1 Conclusions and Synthesis in View of Sustainable Mobility

The results presented by the authors of the different chapters allow conclusions to be drawn in view of the objectives of sustainable mobility and of the Alpine Convention's objectives in particular.

Starting from this, at the end of this chapter an integrated view of the conclusions will be attempted. Based on this synthesis some options for action will be sketched. The chapter finally refers to the main challenges for policy which are the subject of chapter E2.

Sustainable mobility

The main objectives of sustainable development such as equity between present and future generations have been adopted by Member States and the EU in the renewed EU Sustainable Development Strategy. These objectives may be applied under the focus of this report on sustainable transport and mobility.

In these terms sustainable transport and mobility would not endanger public health or ecosystems and would meet the needs for mobility consistent with the use of renewable resources below their rates of regeneration, respectively the use of non-renewable resources below the rates of development of renewable substitutes (cp. OECD 2000). It also includes the needs of economic development balanced with the other aspects of sustainability.

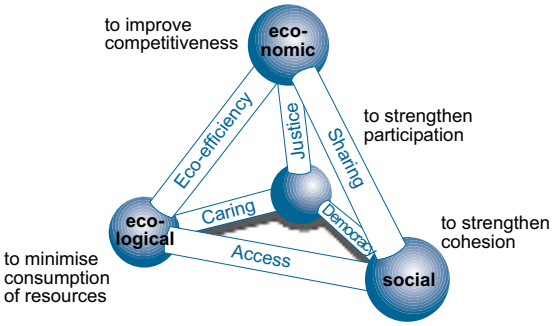

Fig. E1.1: Dimensions of sustainable development (Source: EUDB).

Mobility has been defined (see chapter A) as a basic social and economic human need, but this does not necessarily mean in every case physical transport of goods or persons. Basically it is possible to provide increasing mobility in terms of possible activities with less transport. Shortly said: main objective for sustainable mobility is mobility of citizen but not transport. Although an important need, mobility remains only one societal objective among others (SRU 2005).

Mobility in the Alps as well as in the whole of Europe has to face the well-known dilemma between the present economic dependency on a reliable transport system and its sometimes negative impacts on life quality and environmental quality. Long term developed transport supply and demand patterns need to be developed towards sustainable mobility structures. This will require the horizontal integration of reduced transport demands as an policy objective (EEA 2006).

The specifics of mountain regions when talking about traffic effects

Regarding transport conditions and traffic effects mountainous areas are very different from flatland areas. The morphological shape demands different constructions of traffic infrastructure like galleries, tunnels, bridges etc. Costs for construction and maintenance of infrastructure are often higher. Accessibility may temporarily be restricted by weather and road conditions as well as by natural hazards (e.g. avalanches, land slides, rock fall like on the Gotthard-route during summer 2006 etc.)

Mountains provide recreational and aesthetic landscapes and high biodiversity because they extend through different altitudinal zones. Large unfragmented areas are an endangered resource for recreation and sometimes represent the last retreat for animals with large habitat demands. This peculiar characteristics make the alpine space highly attractive for leisure activities and tourism.

Morphology also leads to the concentration of traffic flows on a limited number of routes, often in narrow valleys where human population density is also high. So the potential for conflicts between social life quality of inhabitants, economic requirements and ecology is often higher than in flatlands.

The relief and the narrowness of many valleys limit the air volume for reception of emissions and have amplifying effects on traffic noise. In addition the particular meteorological conditions like inversions and local wind systems impede the rarefaction and transportation of pollutants.

E1.1 The transport system

The transport system has been explored in this report in respect of the most important transport modes in the Alps – road and rail. Within this transport infrastructure (chapter A1) lies the basis for transport activities. These are freight transport (chapter A2) and passenger transport (chapter A3), both of which are divided into road and rail.

E1.1.1 Transport infrastructure

Road

Road density in the Alpine area corresponds at least to general European averages, so no further efforts are necessary to achieve conditions comparable to other areas of Europe. Local improvements may still be necessary to widen existing bottlenecks and ease burdens for people living close to roads with very high traffic loads. The improvement of the Alpine road infrastructure is needed above all to increase the safety standard especially in the tunnels. In general improve-

ments of infrastructure for easier interoperability between different transport modes and an intensified implementation of traffic management systems can offer efficient and smart solutions.

Road pricing still is affected by heterogeneity between countries but will be made easier with the implementation of the EU-Directive on the Eurovignette. Successful results of the Swiss LSVA in terms of modal shifts promise to encourage this approach. In future, mileage related tolls may have stronger effects on transport, on regional and long distance traffic equally. However it remains the question on which parts of the national road systems these tolls will apply to.

Railway

As with the road infrastructure, the railway density in the Alpine area also corresponds to EU averages. In the last decades the modal split has moved increasingly towards road transport.

Therefore the increases may be compensated for either by more effective use of the existing rail network, or by carefully selected upgrades or extensions of the railway infrastructure. Such measures are a precondition to compensate for the predicted increase in freight volumes and to offer more competitive services.

Insufficient interoperability between the different national railway infrastructures represents an important bottleneck of railway infrastructure. Optimisation of interoperability and of schedules may explore further potential for a successful increase in rail transport.

Development of transport infrastructure needs intensified consultation and participation

Infrastructures are a long term investment in terms of financial effort as well as in the effects in space and development. In many countries, responsibilities for infrastructure development are still shared between different organisations. Considering the long-lasting effects, consultation between the responsible authorities and efforts to achieve integrated solutions, already at strategic level, should be intensified.

Concerning the construction of large infrastructures, decision-making processes should be applied and local governance and participation promoted, which involve stakeholders at all levels. This could help in assessing the possible social consequences the infrastructure might produce at local level (see Dematteis & Governa 2002).

For example a possible strategy might be, to strengthen regional and local transport networks which are able to connect the local territory to the main infrastructure and to create favourable effects also in the long run, whose positive consequences will be felt at the local level.

E1.1.2 Freight transport

The amount of freight transport is increasing both on road and on rail, however road freight transport is growing at a higher rate.

Road freight transport

A detailed comparison of the main Alpine crossings in the last few years is difficult due to bypass effects following tunnel accidents and closures. But in general a significant increase in total road transport volumes is reported for most Alp crossing passes (see Fig. A2-6). The highest traffic load is on the Brenner pass. The share of long distance transport is estimated to be about 47% of the total road freight transport.

The reasons for the increasing share of road transport may be found in the way international transport is organised, serving complex production processes of pre-manufactured and singly delivered parts in tight time schedules.

Accidents in recent years have underlined that tunnel safety will be a key element for maintaining predictable road freight transport. Therefore improvements of safety measures for road tunnels are under way almost for all long road tunnels.

Rail freight transport

Against the backdrop of generally increasing freight transport (up to 24% in the period 1994–2004 in terms of transported tonnes) the highest share is transported across the St. Gotthard route. One remarkable observation is the successful shift towards rail freight transport in Switzerland thanks to measures promoting Swiss rail freight.

Some important requirements of rail freight transport comprise punctual delivery, short and reliable transport times or current information on the transport progress. In particular cross-border rail transport suffers from slow transport speed and delays due to technological differences such as rolling stock and signals.

The increase in the amount of rail freight transported will depend also on improvements to the infrastructure itself, in terms of electrification and performance.

The lack of interoperability between the different infrastructures and equipment limit the competitiveness of rail freight transport.

E1.1.3 Passenger transport

Passengers are transported increasingly by car. Some case studies show that use of car transport is significantly higher in rural regions compared to urban areas. Some support for this development may come from the preference of infrastructure investment for road extension in the last decades. But urban development featuring sub urbanisation around former centres has also triggered this development.

But also on long distance roads such as motorways a further increase in motorised individual transport could be observed.

The development of rail transport is hard to interpret for the Alpine area as only few data were available to analyse. In Switzerland increasing passenger numbers are reported, while the national railway company offers an attractive and frequent service. Besides the railway, bus companies and on-demand services can serve local demand.

In view of the expected growth of passenger volumes even the effects of the envisaged upgrade of transport infrastructure will not be a sufficient solution. Therefore serious efforts are needed to improve the attractiveness of public transport and to support alternative transport modes in the future.

E1.2 Economy, tourism and economic effects

As the most important drivers behind transport in the economic field for this report, the economy (chapter B2) and tourism (chapter B4) have been selected. The economic effects deriving from development of transport and of the drivers have been analysed in chapter C1.

In Europe the discussion of the interrelation of the economy and transport is about the positive effects of transport but also on the "two-way road principle"[1] and spatial distribution effects of transport infrastructure for the economy. Passenger transport growth has paralleled economic growth at EU average levels, but freight transport volume has grown disproportionate to the GDP and here road freight transport is continuously increasing its market share. Also as a general phenomenon, access to basic services depends mainly on car use and is presently supported by price structures. Therefore the definition of external and internal costs, and the calculation of benefits for the economy are needed to make further progress. In Europe price structures are increasingly below the level of external costs, but there are promising developments in transport pricing (SACTRA 1999, EEA 2004, EEA 2006).

E1.2.1 The economy

One of the objectives of the Alpine Convention is to promote regional economic development, enhancing job opportunities as well as supplying the goods and services necessary for economic, social and cultural well-being.

Polarised economic conditions in the Alpine area

Despite the commitment of the Alpine Convention both in rural and urban areas, the Alpine arc is characterised by remarkable polarities of its economic conditions. Hence, significant differences regarding the economic situation can be detected between the various Alpine countries, regions and lower administrative units. Many of the economically strongest regions are situated in or close to the Alps. In general the contrast between the central part and the eastern and western fringes of the Alps is striking. The distribution of the GDP is particularly adapted to show this finding. With a few exceptions (e.g. the surroundings of Wien and Graz) functioning like a bridge there is a clear division between the particularly high values of the more centrally located parts of the Alps (e.g. Bayern, Swiss foothills) and the lower parts on their peripheral western and eastern flanks.

However, there is a close economic interrelationship between the Alpine and non Alpine regions which is indicated by the high GDPs in the Italian part as a consequence of the economic centres included in the NUTS 3 level. Nevertheless, analyses on regional level showed the highly heterogeneous structure of the Alps even on the lowest spatial levels. In fact, prosperous municipalities often exist close to areas which are becoming depopulated.

Not surprisingly the economically weak regions with a low GDP are mostly also regions with a high unemployment rate. As a consequence the regions with the highest unemployment rate are situated on the peripheral western and eastern border of Alps (Rhône-Alpes, Provence-Alpes-Côte d´Azur, Burgenland) while those with lower unemployment rates are mostly located close to the centre of the Alps.

Role of transport for maintaining agriculture

A good reflection of the various economic conditions and situation in the Alps even on regional level is given by the agricultural sector which is of outstanding relevance for the whole region due to its multifunctional services. In fact, on the one side there are regions with a relatively stable agriculture or a moderate agricultural decrease (e.g. Alto Adige/Südtirol, Swiss and Austrian regions).

On the other side many regions register high farm abandonment rates (e.g. Slovenia, many regions in Italy and France). The exemplary situation of Alto Adige/Südtirol shows that an economically vital region featuring good transport infrastructure and access to jobs is one important prerequisite for a persistence of agriculture. This is confirmed by some authors who see a persistence of part-time-farms in regions where commuting to non-agricultural employment is feasible due to good accessibility to the local road network which permits commuting.

E1.2.2 Tourism

Tourism is an important economic branch in Alpine economy, even if only 9% of Alpine municipalities may be considered as tourism centres (cp. Fig. B4-1). These centres are often ski resorts. According to EU estimates about 80% of tourist journeys to the Alps are driven in private cars. Additional traffic originates from these tourist destinations due to day-trips undertaken by tourists.

A case study for Austria suggests that summer tourists in particular are dependent on individual motor transport during their holiday stays. Bearing in mind that winter tourism might alter due to climate change, special efforts need to be taken to develop measures which encourage the use of public or non-motorised transport in the summer season.

One main issue concerning the field of tourism related transport is the modal split of the journeys to and from the destinations. Both, the figures of the Brenner pass as well as those of the Austrian case study in chapter B4.5 indicate the related high pressures on the road system and subsequently on the Alpine population and environment.

1 Transport infrastructure does not guarantee that the local or regional economy will benefit, because traffic operates in two directions and an improved accessibility may sometimes benefit one and damage another region or city.

In terms of tourism transport, three objectives are mentioned in the Alpine Convention:

- encouraging of measures to reduce dependence on motorised vehicles in tourist resorts [Tourism Protocol Art. 13 (1)],
- promotion of both public and private initiatives to improve access by public transport to resorts and tourist areas and encouraging of tourists to use these services [Tourism Protocol Art. 13 (2)],
- establishment and maintenance of traffic-calmed and traffic-free zones, establishment of car-free tourist destinations, measures of promoting the car free arrival and stay of holiday guests [Transport Protocol Art. 13 (2)].

For the future some questions may be of interest in particular, such as

- Have there been any changes in transport behaviour of tourists after the restructuring of tourist destinations since the mid-nineties?
- How much trans-Alpine tourism traffic is going to other destinations and how can the Alpine destinations influence this traffic?
- Which part of tourism traffic is due to local mobility of tourists when at their destination?

E1.2.3 Effects of transport on the economy

Good accessibility, efficient transport infrastructures and modern mobility concepts can induce employment and consumer well being (and GDP) convergence (Alpencors 2005). Therefore, innovative transport policies could support further economic improvement in the Alpine area.

Difficult assessment of the interrelation of transport and the economy

The economic effects of transport on the Alpine regional development are quite difficult to assess. Different elements contribute to determine the economic well-being of a region and it is complex to isolate single effects with certainty.

A relation between transport development, both in terms of infrastructures and services, and national economic growth as represented by GDP can be identified in regions with less infrastructure, while on the other hand other studies suggest that no correlation exists between transport infrastructure endowment and regional added value per capita. From market theory areas with better access to locations of raw materials and markets will, ceteris paribus, be more competitive than peripheral areas. However, this does not mean that good accessibility guarantees regional economic success and that a poor transport network implies poor economic performance. A transport improvement can successfully open an area to external competition with a negative effect on the local producers. Therefore the effects of transport on local economies can be both positive and negative.

Economic prosperity of a location is also composed by “soft factors” such as the existence or avoidance of environmental problems, efficient governance structures and the perceived quality of life by people at this location.

Transport infrastructures can also induce economic effects in a territory wider than the one they cross or link with. Since the main infrastructures crossing the Alps often have an EU-wide relevance, their economic effects can reach far beyond the EU borders and assume a strategic function, as is the case for the Trans-European-Traffic-Networks (TEN-T) EU policy.

An innovative and well-balanced transport policy can lead to substantial improvements in interregional trade and consumers’ well being, not only according to an economic perspective (lower prices, wider choice of goods and services, faster connections, etc.), but also in terms of social and environmental benefits.

In Western Europe the growth rate of transport services and infrastructures has been slowing down in the last 30–40 years in comparison to economic growth (GDP), even though further development of both freight and passenger transport is expected in the Alpine Space over the next 30 years, according to EU Commission studies. In any case no clear signs of decoupling between economic and traffic growth have been achieved in the Alpine space to date.

External costs of transport

The strong development expected for trade (in monetary value) and transport (in quantity) will also produce undesired effects on local economies, society and the environment which can be expressed economically as the external costs of transport. As long as these external costs are not reflected in transport costs for the end consumers, their mobility behaviour and market choices will not undergo a substantial change. The assessment of these costs is the first step towards their internalisation in the price of goods and services: the studies made in this direction led to an assessment of the relative dimension of external transport costs as being 7.3% compared to GDP of EU15+2 in the year 2000 (INFRAS & IWW 2004).

Through the growing interest in economic tools in the EU and Alpine territory and the adoption of some levies (especially on road transport), a higher degree of internalisation of external environmental and infrastructure costs is still a primary objective to be reached in the Alpine countries.

E1.3 Population and effects on the social sphere

The social sphere is compounded of results from analysis of population development (B1), the effects on the social sphere, particularly the ageing of the Alpine population (chapter C2.2) and effects on human health through air pollution (see chapter C3.1) and noise (see chapter C3.2).

At the European level transport related health effects are reported owing to air pollution and also to greenhouse gas emissions which will indirectly contribute to health effects because of climate change (extreme weather can affect health, as can exposure to flooding and the spread of disease). For people living close to heavily used transport infrastructures, increasing health effects and impacts on

life quality are reported owing to road traffic injuries and noise. Also in urban areas transport related effects lead to increasing psychological and social impacts on health which finally result in a loss of life quality and mobility opportunities (PEP 2004, SRU 2005).

E1.3.1 Population

The population with its different motivational needs for mobility is without doubt the most important driving force for traffic development in and throughout the Alpine arc. All the demographic processes and the change in quality of life and customs influence the quantity and the kind of traffic.

Population growth in the Alps compared to EU-level

Some significant trends characterising the Alpine arc can be derived from the data presented in chapter B1. If compared to the European context the analysis shows a very dynamic population growth. The achieved growth rate of 7.8% exceeds the average rate of the EU-15 (3.2%) and the national values of the Alpine states (Tab. E1-1), too.

However Map B1-1 confirms that this growth, contrary to one of the objectives of article 1 of the Alpine Convention, is not equally distributed over the Alpine arc. Comprehensive studies have detected increasing disparities for the inner Alpine territories (Favry et al. 2004). The modern infrastructure services and the changed personal needs, driving the migration process, have led to a polarisation of booming and depopulated areas in urban and peripheral centres and also in major and minor valleys.

Country	Population change [%]
Austria	2.7
France	4.9
Germany	1.5
Italy	1.8
Liechtenstein	13.1
Slovenia	0.4
Switzerland	5.7
EU-15	3.2
Alpine Convention Area*	7.8

Tab. E1-1: Population growth, comparison between Europe and Alps (1994–2004); data refer to 1991–2001 (see Tab. B1-1); national and European data refer to 1994 and 2004 (Source: Eurostat, http://epp.eurostat.ec.europa.eu).

Spatial patterns of population development

The influence of the neighbouring metropolises (Milano, Torino, München, Wien, Lyon) on municipalities located on the Alpine border is growing and further growth is to be expected. These regions are characterized by their relatively good accessibility. Gradually these municipalities become suburbs of these metropolises. The intense expansion of traffic activities and the implementation of high-speed railways will probably support the establishment of commuter centres in the inner Alps.

Municipalities in the peripheral areas of the inner Alps following the “tertiarisation” of jobs (particularly in tourism) will benefit from this growth potential. However, the municipalities of the southern Alpine arc are not the only areas to be negatively affected.

An Alpine wide analysis detected also an increasing urbanisation along the central traffic corridors in the great inner Alpine valleys. These areas are characterised by strong dynamics. Due to their good accessibility, particularly from outside the Alpine arc, these areas are favoured locations for living in and for economic activities. Some examples are the valleys of Inn, Adige, Rhône, Valle d’Aosta, Venosta and Pusteria.

E1.3.2 Effects on the social sphere

Spatial segregation of living and working

As a benefit, transport enables access to basic services like education, work, shopping and leisure activities, which are essential for economic and social activities.

Over the last decades individual motorised traffic has gained a leading role in transport and society has been transformed along the way. Shops have moved out of the town centres to shopping malls, workplaces and living places can be further apart, giving individuals a broader choice of where to live, where to work and where to spend their leisure time. This results in a separation of living, working and shopping locations. For some regions this may help to slow down a depopulation trend by giving the people the opportunity to commute.

An increasing number of elderly people will require attention

The present analysis was focused on the particular category of elderly people. Old people form a consistent percentage of the Alpine arc population, in particular in the Italian Alps and in the Principality of Monaco. The analysis of the distribution of the old age index confirms the strong tendency to shift toward older ages of the Italian population in particular. This is caused by the emigration of the young people and the declining birth rate. The municipalities which suffer more from over-aging are the most and the least populated ones.

Although the closer the proximity to the central chain of the Alps, the more the old-age index increases, no significant correlation has been detected between accessibility and the old-age index. In other words good accessibility alone does not guarantee a well-balanced social structure in the Alpine municipalities.

Children, elderly and disabled people are disadvantaged by individual car traffic

Together with this spatial segregation, the limited public transport supply in mountain areas leads to high car-dependence. Many individuals benefit from the possibilities gained mainly by private cars.

But some social groups, who do not have access to a car, benefit less or are even disadvantaged by individual motorised traffic. These groups are mainly children, elderly and disabled persons and all people who are unable to drive. The decline in public transport, together with the moving out of basic services from residential areas, reduces their life quality. As elderly people constitute an increasing percentage of the population, it is necessary to identify and meet their requirements.

Modal split differs between urban and rural areas (see chapter A3), with a significantly higher degree of public transport in urban areas. The present transport situation means an inequitable distribution of advantage between rural and urban citizens as well as between different generations.

In consideration of the increasing share of elderly people the assurance of mobility by an adequate public transport system for local as well as for long distance traffic will become more and more important.

Decline of public services

The low use of infrastructures and services due to depopulation in many peripheral mountain areas may constitute a further problem. The decline of shops and supply services within walking distance is a disadvantage not only for those people in peripheral areas who are not mobile but it also negatively affects the attractiveness of the municipalities themselves. The decline in public services in local centres is then reinforced by the decrease in population which also lowers service provision and weakens the local economy. This leads to a kind of vicious circle, as shown in Fig. E1-2.

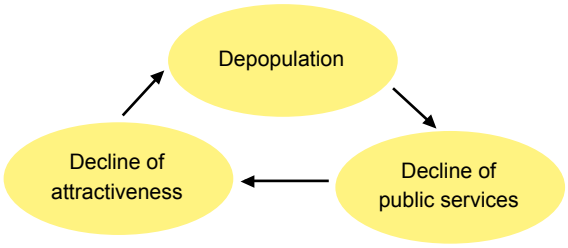

Fig. E1-2: Circle of demographic change and public services (Graphic: ifuplan).

As a consequence, in these municipalities quality of life diminishes. This creates an additional motivation for the local young people to leave. As the older people, who constitute a considerable and still growing part of society, are physically less mobile, alternative supply systems such as E-commerce and other home delivery services will become of greater significance for them in their everyday lives.

However, in order to maintain a well-balanced demographic structure and avoid the exclusion of any social or age group, adequate political and economic measures and cultural stimuli are needed for mountain areas. One way of solving these problems may lie at least partly in a better integration of transport and spatial planning.

The increase in programmes[2] and projects[3] for the development of mountain regions which aim at improving the quality of life in less-favoured regions demonstrates how this issue of vital mountain regions has become of real political relevance.

Spatial effects on social life quality

Transport infrastructure can constitute not only a barrier for wildlife, but also for humans, by separating valleys or even communities. Also social life and social interactions near to much-frequented streets are less than in quiet residential areas. These effects sometimes lead, in a cumulative or synergistic manner together with air pollution and noise (see E1.3.3), to a decrease of life quality.

E1.3.3 Health risks from air pollution and traffic noise

Studies show that the same traffic load contributes to a concentration of nitrogen oxides in the ambient air in mountainous areas which is three times higher than in lowlands owing to meteorological particularities (EEA 2001). Because of the topography, the ambient air quality along steep valleys with high traffic loads is often as bad as in urban areas.

Apart from individual motorised traffic, transport and traffic in general (irrespective of whether public or private, transit or intra-Alpine, freight or persons) has several effects on humans. People living close to traffic infrastructure suffer from air pollution and noise, both of which can lead to health problems or even diseases like respiratory and allergy problems, sleep and concentration disturbance, heart diseases or psychological symptoms. The weakest section of the population – children, elderly and disabled people – are often the most affected group (cp. chapters C3.1, C3.2).

NO_2 immissions as an indicator of acidifying and eutrophing substances were in decline until the mid 1990s. However since 1995 immissions are no longer declining, but slightly increasing. Analyses of air quality show that the 2010 EU limit values for NO_2 are exceeded in annual means (up to 32% of stations) as well as for short term peaks (see chapters C3.1 and C3.2).

Ozone concentration increases particularly in high remote areas, frequently exceeding their EU limit values (2002/3/EC) under extreme conditions (up to 93% in 2003). These are less at urban traffic stations. Exposure to PM10 occurs in particular at urban and urban background stations and also significantly overruns the EU limit values (see chap. C3.1.3).

Beneath the higher pressures from air pollution, the inhabitants of traffic-loaded Alpine valleys also suffer from traffic noise, the distribution of which also differs here significantly from flatlands (see chapter C3.2.3).

As well as the indirect health effects of traffic via air pollution and noise direct health effects occur through traffic accidents.

2 E.g. EU-regulation N° 1698/2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).

3 E.g.: IMALP – Implementation of sustainable agriculture and rural development in Alpine mountains (2003–2006).

E1.4 Land use change and environmental effects

Close interactions have been identified between land-use change and transport (chapter B3). Land use which determines where settlement areas are, is also steering effects on air quality (chapter C3.1) and noise (chapter C3.2).

In Europe, land use has been identified as an important driver for loss of natural habitats, change of landscape amenities and loss or degradation of recreation areas (EEA 2004).

The emission of air pollutants is declining in general, but in cities in particular air pollution remains problematic. The GHG emissions are still rising although technological improvements have been achieved but in many cases have been overcompensated for by transport increase (EEA 2004, 2006). In consequence in the mid-term effects of changing natural hazards owing to climate change may be expected.

It is expected that greater use of alternative biofuels and fuel development will contribute to emission reduction (EEA 2006), however this will not affect the question of land take for further transport infrastructure.

E1.4.1 Land use

Densely settled areas experience a trend towards greater increase of settlement and traffic infrastructure areas – "infrastructure and people attract further infrastructure". The area resource is mainly drawn from cultivated area. Except for Italy, in most regions forest is increasing too, also mainly drawing on cultivated area. So there are two transformations of cultivated area: in densely settled regions it flows to further settlement and infrastructure, whereas in other regions it is more likely to flow to forest.

If one recalls former economic and social reasons for the extension of areas of human settlement into some Alpine regions, some central question arise:

- Can a stable population in the Alps be maintained for the whole Alpine area in future at any costs?
- Will this be a sustainable objective with regard to environmental and economic equity for other parts of the population?
- Do we perhaps have to accept population decline in some areas as an adaptation towards modern economic conditions?

The rate of loss of cultivated area per year is fairly low in the eastern and northern Alps (Austria, Germany, parts of Switzerland), whereas in the southern and western Alps (parts of Switzerland, France, Italy) it is much higher.

Interrelation of land use and population change

The concentration of settlements and different kinds of regional development (dynamic central regions versus marginal and peripheral regions) has a twofold impact on mobility needs: on the one hand there is not much political force to develop the traffic infrastructure of large peripheral areas, because of the demographic decline. Decreasing infrastructure and accessibility, along with decreasing possibilities to generate income in return drives people to move into more central areas. This in turn contradicts the objectives of the Alpine Convention [§2, 2(a)], which strive to secure the whole Alpine area as a living space for people.

On the other hand, growing population in certain (central) regions increases the need for traffic connections between those regions. The construction of high quality roads usually tries to meet those needs. This is contrary to the objectives of transport protocol [§1, 1(a)], which explicitly gives preference to railway connections over roads.

Transport development supports the polarisation of functions

The preferences are presently clearly set out to concentrate effective transportation facilities between the central regions. However, from a viewpoint committed to sustainability, such a polarisation of land-use development is not the target. Polarisation and functional separation of regions induces growing traffic, along with its associated problems for the environment, health, living quality, and social systems. According to the Alpine Convention Art. 2 § 2(b), the "harmonious development of the whole region", specifically mentioned that the "avoidance of over- or under-use" should be supported.

The mutual dependency of infrastructure development and land use changes requires an integrated approach to regional development. To increase the accessibility of peripheral regions it is more important to develop possibilities for gaining income than to extend traffic infrastructure.

E1.4.2 Effects on air quality

Air pollution and the deposition of pollutants from traffic contribute to acidification and eutrophication in terrestrial and aquatic ecosystems. Ozone acts as a cytotoxin and can in higher concentration cause damage to crops and forest trees as well as to wild plants.

Summer ozone concentrations in the Alps have slowly increased since 1995, but in most areas not significantly. Ozone concentrations have frequently (up to 87% in the extreme summer 2003) exceeded the EU target values (AOT40) for the protection of vegetation at background stations in almost all Alpine countries (see Fig. C3-8). Owing to the process of ozone generation, remote areas are much more affected by high ozone concentrations than are areas close to traffic emissions.

Whereas immissions at motorways and in towns are caused by local and regional emissions, extensive remote areas of the Alpine regions are affected especially by ozone and deposition of acidifying and eutrophying substances formed outside the Alps.

- Art. 2 (2c) of the Alpine Convention contains general regulations for the prevention of air pollution. The objective is "to drastically reduce the emission of pollutants and pollution problems in the Alpine region, together with inputs of harmful substances from outside the region, to a level which is not harmful to man, animals and plants".

More precise (qualitative) objectives directly oriented on traffic emissions are part of the Transport Protocol.

- Art. 7 (2) focuses on the step-by-step reduction of contaminant emissions of all traffic carriers. Art. 3 (1a) requires the limitation of the input of substances from the atmosphere to a level which avoids damage of ecological structures and natural material cycles.
- Special attention to transboundary air pollutants is given in the Protocol on Mountain Forests (Art. 2a). The reduction of the input of substances from the atmosphere will prevent forest damages.

The Alpine Convention objectives comply with the agreed objectives of the European legal framework, but are not as detailed.

With respect to incidences where present and future European limit and target values for NO_2, NOx, PM10 and ozone are severely exeeded in parts of the Alpine region, further it has to be stated that measures will be necessary to fulfil the objectives of the Alpine Convention.

E1.4.3 Effects on noise

Noise – traffic noise in particular – has a serious impact on human health. It may cause – as described at the beginning of this chapter – several diseases and also has psychological effects (e.g. loss of concentration, nervousness, bad mood etc.). Besides this it also influences social life by disturbing communication and even social behaviour, e.g. reduced helpfulness. The social structure of residential areas is also affected by (traffic) noise, because residential areas which are known as quiet are more expensive than areas close to main traffic roads, airports or railways. There is less social life and fewer social interactions in noisy neighbourhoods than in quiet ones.

But (traffic) noise also has economic effects such as costs for health impairments and costs due to noise-induced losses of work efficiency. Further noise means a decline in value for real estate and houses and finally costs of noise abatement measures cause high additional expenditure.

The environmental effects of noise cause a loss of quality of quiet recreation areas and remote landscapes. The effects on fauna, and on birds in particular, are reported in scientific studies, but are not much considered as serious effects in transport planning.

Noise emission and noise propagation in mountainous regions is remarkably different from in lowland areas. This not generally known fact highlights the importance of this topic for the Alps. Therefore joint efforts by all member states are required to change the recent direction of ever-increasing traffic noise.

The relevant AC objectives of the Traffic protocol demand that measures are enforced for noise abatement (Art. 3d) and to reduce step by step the noise emissions of all transport systems [Art. 7, (2)].

Measures for noise abatement have been taken up in the member states at strategic and project level, however an evaluation for the AC area is not feasible due to limited data availability. An achievement of step-wise reduction of noise emissions cannot be proved, as comparison of noise levels at the Alpine space is not feasible at the moment. But an increase in noise emission must be regarded as evident due to remarkable rise in traffic flows and the extension of transport infrastructures.

E1.5 Synthesis

Observation at expert level have identified different drivers which trigger the development of traffic which then causes desired and undesired effects.

- The main drivers identified in this report are the growth and the ageing of population, economic growth, and land use change with spatial development.
- Traffic will react to the drivers by modal shifts, technological developments and further infrastructure development.
- The effects of transport are expected to be felt on transport itself by congestion, prolongation of travel times and external costs. But it will also cause environmental changes, have economic effects and influence quality of life, in positive and negative ways.

For the future a further increase in transport as well as an increase of some of its drivers (e.g. tourism), is predicted. Without a substantial change in transport policies, negative effects will be severe, sometimes triggering self-amplifying cause-effect relations (such as the concentration of population and infrastructure).

Coming back to the model of drivers and transport underlying this report, it might give some indications where solutions can be found to maintain or even improve mobility. The question arises of how a decoupling can be identified systematically between these drivers and traffic as well as between traffic and its adverse effects.

- Dealing with the interrelation of drivers and transport some important strategies will lie in the decoupling of economic growth from traffic growth in particular through a fair pricing system internalising external costs, but also through incentives to support modal shift and the correction of existing subsidies which contradict the objectives for the Alpine area. The link between population development, land-use changes and transport requires serious recognition in the spatial development of regions and municipalities.
- The avoidance of adverse transport effects can take place at the level of infrastructures and of technology: Technological improvement of vehicles (cars, trucks, trains, etc.) can reduce emissions of air pollutants and noise, may further improve safety for passengers and might offer better intermodal transport possibilities. Infrastructures as well can be improved in terms of land take, fragmentation effects, noise abatement or upgrade of transport effectiveness.

Also at European level, and from an integrated consideration of transport the call exists to define strategies for a traffic turnaround, traffic abatement, modal shift and technical optimisation. For this objectives are needed in terms of traffic safety, air pollution, noise, life quality, nature and landscape conservation, and climate change. This may be conceptualised at project level through an Economic Impact Report, for identification of winners and losers of transport development, or by a Health Impact Report for stronger consideration of the effects of transport on health (SACTRA 1999, SRU2005, PEP 2004).

The long-term measures and trans-European policies promoted at the EU level should be coupled with economic policies developed at national and lower levels in the Alpine area. These additional measures should aim to improve regional development, either building or strengthening existing networks to ensure better connections to the main infrastructures crossing the Alpine space. The appropriate level of policies to provide possible solutions will be elaborated in more depth in the chapter E2.

It is most probable that there will not be one big and simple solution. But maybe small changes at the different levels of drivers and cause-effect chains will offer efficient solutions which in their combination will mean progress towards the objectives of the Alpine Convention.

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E2 The Main Challenges for the Future

This final part of the report adopts a different perspective from the previous ones: making use of all the foregoing descriptions and explanations it tries to formulate the key issues for future political action on the basis of the principles of Alpine and European policy that have been developed in the last decades.

For systematically identifying the main political challenges that result from the foregoing overall analysis, this final part of the report

- recalls the overall policy objectives and frame conditions any policy in this realm has to respect
- goes back to the basic service functions that Alpine transport is supposed to fulfil and identifies the specific challenges from the perspective of these functions
- compares these perspectives and gives examples for cross-cutting measures and policy packages
- identifies and describes the big challenges for Alpine transport in the next ten years

E2.1 Overall objectives and frame conditions

E2.1.1 Sustainable development of the Alps – the Alpine Convention obligations

In the Alpine Convention (framework treaty) the Contracting Parties commit themselves to developing an integrated policy for the conservation and protection of the Alps and the sustainable use of resources, observing

- the principle of prevention,
- the principle that the party responsible is liable for the damage and
- the principle of cooperation.

In doing so they will take into account in an equilibrated way the interests of all Alpine states, their Alpine regions and the European Community.

Concerning transport, the frame convention requires measures which aim to reduce nuisances and risks caused by intra-Alpine and cross-Alpine transport to a level that is "supportable for humans, animals and plants and their living space", "among other measures through a stronger modal shift to the rail, especially for freight, mainly through the realisation of appropriate infrastructures and market-conform incentives, without discrimination on the basis of nationality". The provisions in the sections concerning Population and Culture, Spatial Planning, Air Quality, Soil Protection, Nature Protection and Tourism also point in this direction.

The Transport protocol asks for a coordinated transport policy by the contracting parties concerning all modes of transport, aiming for "sustainable development of the living space and the economic activities of the population living in the Alpine territory". In detailed provisions it calls for the requirements of the environment, of society and of the economy to be taken into account. It stresses the importance of the railways and bans the construction of new major roads for cross-Alpine transport. Concerning other policies it requires the transport policy objectives to be taken into account.

The protocol on Spatial Planning and Sustainable Development puts the transport issue in the larger context of spatial development, equally emphasising the importance of an integrated approach, of improving public transport and – if necessary – limiting motorised road traffic.

The protocol on Tourism also deals with transport issues, asking for support for measures to limit motorised transport in tourist resorts and for initiatives that boost the provision and the use of public transport for and by tourists.

European interests and EU policy objectives

The EU policy objectives are an important frame condition for a joint Alpine Transport Policy. The main cornerstones have been described in chapter D3.

E2.1.2 The embeddedness of the Alps in the European and the global economy

More generally than in the sense of the above legal frameworks, it has to be taken into account that due to national, European and global economic integration, the Alps are ever more strongly embedded in a larger context that sets limits to independent developments in the Alps.

As part of the European transport system, the Alpine transport system has to fulfil a series of important functions. It provides essential connections for the European economies and more specifically for the Alpine countries. This means also that technical and organisational interoperability of the road and rail systems has to be guaranteed. Moreover, the Alpine transport system is to a large extent dependent on technology development at international level.

Finally, most aspects of the Alpine economy are exposed to international competition. Hypothetical additional costs for businesses due to Alpine-specific sustainable mobility policies would have to be limited, or compensated for, by other competitive advantages such as attractive environment, better image, higher quality offers in the tourism industry, etc.

E2.2 Providing services in the framework of sustainable development

In order to identify the political challenges that result from the manifold and multi-layered picture that this report has drawn, it is helpful to ask the basic question: Which fundamental service functions is Alpine transport supposed to fulfil or to contribute to?

Five basic service functions related to the Alpine transport system can be distinguished in this context. Two of them mainly serve interests from outside the Alps:

- Ensuring freight transit and
- Ensuring passenger transit.

Two others correspond to intrinsic interests of the Alpine population:

- Ensuring access to services, goods and jobs for the Alpine population and
- Ensuring access to services and goods for the Alpine economy.

The last one combines external and internal interests:

- Ensuring long-range accessibility and local mobility for Alpine tourism.

The question is, how can these service functions be fulfilled in the framework of sustainable development, carefully taking into account the particularly sensitive Alpine environment?

E2.2.1 Ensuring freight transit

With increasing European integration freight transit through the Alps has become more and more important – for the whole European economy. However, the strong increase in the number of transiting trucks over the last decades has led to protests and intense political debates. (See chapters A1, A2, D6, E1.1.2)

Points to be considered

Most Alpine freight transit occurs on the road and causes more nuisance to nature, the landscape and the population of the Alps than does the equivalent freight transit on the railway.

Freight transit is expected to continue to grow considerably in the next decades – however, not to the same extent on all corridors. A further increase in road freight transport meets strong opposition in the concerned corridors and the transport protocol bans new major roads for cross-Alpine transit. Decreasing noxious gaseous emissions by trucks on the big corridors due to technical progress and stricter norms do not diminish other environmental impacts or public opposition.

Differences in road prices and traffic regulations between the Alpine countries as well as bottlenecks lead to considerable detours in long-range truck itineraries.

The economic potential of rail connections over long distances is far from being exploited. Freight transit on the rail is growing, but more slowly than on the road (with exceptions in Switzerland). Present competitive disadvantages of the rail include:

- lack of flexibility and coordination between the historical national railway companies and rail systems,
- unsufficient reliability of present services,
- old, steep railway lines,
- lack of multimodal terminals, for example in some areas of Italy;
- strongly road-based logistics systems, inter-modal switching hindered by low degree of container use
- High costs of simple truck-transport systems (highway on the rail)

Four new base tunnels across the Alps are being built or planned in order to considerably increase rail transit capacity in both north-south and east-west directions. Two of them are under construction in Switzerland (Lötschberg, completion 2007/08; Gotthard, completion 2015/16,). Two more (Brenner, Lyon-Torino) are in the preparation phase for starting the construction of the main tunnels.

Specific challenges are..

- improving the rail transit infrastructure to allow for low operational costs, short travel times and high capacity on all main corridors,
- adjusting road and rail pricing in such a way that
  - » rail has a good competitive chance,
  - » freight flows are reasonably distributed between corridors, avoiding detour traffic, and
  - » the impact of road freight traffic remains below reasonable and jointly agreed limits,
- promoting multi-modal transport by
  - » providing appropriate terminal infrastructure and international connections,
  - » encouraging containerisation, and
  - » encouraging SMEs to use modern logistics systems,
- curbing the transport intensity of European economies by
  - » internalising external costs of the different modes,
  - » using up-to-date logistics, and
  - » reducing material flows and accelerating the shift towards service economies,
- developing alternatives to Alpine transit using marine routes.

E2.2.2 Ensuring passenger transit

Passenger transit through the Alps is essential for the European economy as well as for cultural exchange and social cohesion in Europe. Tourism traditionally makes up a large part of Alpine passenger transit. With the integration of European economies, cross-boundary and therefore cross-Alpine business travel, apart from tourism, increases in importance. Moreover, with the tertiarisation of European economies, business travel becomes even more important. The improvement of road and rail passenger connections has helped considerably to facilitate European integration (see chapters A1, A3, B4, E1.2.2).

Points to be considered

Most passenger transit occurs on the road and causes more nuisances than benefits to the Alpine population.

Peak loads exceed capacities on road and rail.

Present cross-border railway links are not well coordinated between national railway companies.

Specific challenges

- To improve technical interoperability and coordination between rail companies and to enhance competition between international passenger train companies
- To increase frequencies of public transport and improve upstream and downstream connections
- To improve the rail infrastructure for higher speed and higher capacity
- To improve international tariff and booking systems
- To smoothen peak loads
- To eliminate road bottlenecks in heavily populated areas

E2.2.3 Ensuring access to services, goods and jobs for the Alpine population

Ensuring and maintaining a certain degree of accessibility to services, goods and jobs is essential for living in the Alps. As well as transport, local provision of services and goods, education and labour market policies, urban planning, increased use of Information and Computing Technology (ICT) and local initiatives can all contribute to providing this access. Integrated approaches need to take into account the evolving needs of different parts of the population (see chapters B1, C2, D7, E1.3).

Points to be considered

Several factors have considerably improved the access of the Alpine population to services, goods and jobs over the last 50 years:

- the improvement of the road infrastructure
- the greatly increased ownership of private cars
- the internal migration to larger settlements

At the same time other factors have contributed to a sharp increase in the demand for such accessibilities:

- the decline of traditional Alpine economies and ways of life along with the increasing spread of urban lifestyles
- rising levels of education
- increasing specialisation in the labour market
- structural changes of urban functions in the EU as well as in the Alpine area

For those who do not own a private car, accessibility has often decreased because of the withdrawal of local public services, the decline of local trade and the decline of public transport.

In many peripheral areas decreasing population as well as ever tighter public budgets increase the pressure to cut spending on public infrastructure. The increasing risk of more frequent and stronger natural hazards and extreme weather events, as a possible consequence of climate change, affects the costs of transport infrastructure.

Marked differences in the local provision of services and goods between different areas with similar population densities show that considerable improvements might be possible through policies at different levels. The potential of ICT is far from being fully exploited.

In peripheral areas, improving the transport infrastructure without ensuring a sufficient level of local attractions (services, jobs etc.) has often resulted in economic and demographic decline.

Public transport services differ strongly between Alpine regions. Cross-border services in particular are often neglected. Railway connections linking destinations within the Alps are generally less well developed than those linking to the peri-Alpine centres.

Internal migration in the Alps has partially led to extended suburbanisation. The opportunities for considerably lowering the need for individual motorised transport in this relocation process have not been fully exploited. Best practice examples show that appropriate urban planning could make a difference.

Specific challenges are..

- improving the local availability of public and private services, also by a greater use of ICT,
- defining transparent and reliable accessibility standards for different categories of territories,
- lowering the need for individual motorised transport by appropriate urban planning,
- strengthening public transport in the Alps by improving
  - » the accessibility of peripheral areas,
  - » the mobility in agglomerations,
  - » the local cross-border connections,
  - » the connections between Alpine cities, and
- strengthening the exchange of experiences and joint learning processes across the whole Alpine bow in order to enhance the development of appropriate new models for living in the Alps.

Many of the challenges listed under “Ensuring passenger transit” are linked to challenges mentioned under E2.2.3 and could be mentioned here too.

E2.2.4 Ensuring access to services and goods for the Alpine economy

The accessibility needs of the Alpine economy are shifting as structural change progresses. Bulk transport of heavy goods is still important for the wood, mining and construction industries. But the increasingly important small, often high-tech industries and, even more so, the service sector have other needs: rapid and reliable transport of smaller freight and of passengers. ICT has an increasingly important role.

To ensure spatial access to services, goods and the labour market for the Alpine economy remains an essential objective of Alpine policies (see chapters B2, C1, A2, D6, E1.2).

Points to be considered

Intra-Alpine freight transport (including transport with its source or destination in the Alps, as defined by the Transport protocol; see introduction part A), with its associated negative impacts, makes up the largest part of freight transport in the Alps.

The share of intra-Alpine freight transport that goes by rail varies considerably between countries and does not only depend on the industries' freight structure: Switzerland has succeeded in maintaining a relatively strong role for rail.

Since the creation of the internal market, cross-border freight and passenger transport has considerably gained in importance also for the local economy. Whereas the road network has been able to meet this demand, the rail network is lagging behind.

Increasing specialisation leads to larger and increasingly cross-border labour market areas. Public passenger transport is not always keeping up with this development.

Compared to other regions in Europe, the physical accessibility by road of most parts of the Alps is rather good today. Better intra-Alpine rail and bus connections along the Alpine bow could facilitate the integration of Alpine economies.

Specific challenges are..

- encouraging structural change towards less material-intensive industries,
- improving freight connections on the railways, making use of the transit infrastructure,
- encouraging and facilitating increased use of ICT as a substitute for passenger transport and reaching a wider audience and
- improving public passenger transport connections on short, medium and long distances.

E2.2.5 Ensuring long-range accessibility and local mobility for Alpine tourism

Tourism is an important sector for the Alpine economy and the Alpine labour market. On important corridors and in large parts of the Alps, tourism accounts for a large proportion of passenger transport. Peak loads on weekends in holiday times regularly lead to congestions and severe delays for cars and trucks on the road, and to overcrowded trains. Therefore, looking for alternatives in this sector is an important issue (see chapters A3, B4, D7.2, E1.2.2).

Points to be considered

The overwhelming majority of tourists travel by car. This is particularly true for the summer season.

Many tourist destinations are located in remote areas and are poorly connected to public transport systems.

For many tourists, flexible mobility at their destination is a major reason for taking the car for the whole journey.

Ever shorter duration of stay leads to increased traffic.

Climate change will most likely bring some transformations in the tourism sector.

The increasing number of non-European visitors usually arrives by plane. Good public transport can be an argument for attracting them.

Best practice examples show that good sustainable mobility offers can be very successful.

Specific challenges are..

- guaranteeing easy accessibility of tourism destinations in the Alps by public transport from all European origins,
- ensuring mobility of tourists at their destination in the Alps with attractive public transport,
- developing offers, incentives and information systems for effectively promoting sustainable mobility, and
- levelling out peak traffic loads by staggering holidays in Europe and promoting appropriate offers in Alpine tourism.

E2.3 The need for integrated approaches

Looking at these challenges altogether, and formulating specific measures and programmes to meet them, two main observations emerge:

- The challenges emerging from the individual perspectives are in most cases complementary. Measures and programmes aiming at one service function would mostly have positive effects on the others.
- Physical transport is not the only solution for providing these services. Therefore, transport policy is not the only policy addressed by these challenges; other policies can and have to contribute. They are essential for reducing or containing the negative impacts of the transport system.

Considering transport issues from the perspective of sustainable development leads to asking for more integrated approaches compared to traditional transport policy. Integrating different territory-related policies at different levels becomes essential for success.

Three examples of measures may illustrate this:

- Investing in rail infrastructure and improving the international interoperability of railways will help to facilitate freight and passenger transit through the Alps and will reduce the traffic load on the road transit corridors.
- Enhancing access to broadband connections and improving people's ability to use the Internet will facilitate access to services both for individuals and for companies in remote areas.
- Urban planning, providing basic services within walking distance and allowing for easy access to public transport for large parts of the population would reduce the need to use private car and boost the local economy.

There are no single answers to these challenges. The variety of approaches that have been adopted in the Alpine countries and regions show that different combinations of measures are possible. However, they also show that efforts and success vary largely and there is a huge potential for mutual learning through cooperation and exchange.

In order to develop satisfactory and economically viable solutions, appropriate policy packages combining different kinds of users, investments and regulations, incentives and educational efforts are needed. Simple restrictive measures in one territory may cause problems in neighbouring ones.

Horizontal and vertical cooperation in a system of multi-level international governance thus becomes essential for tackling the transport problems in the Alps. An important task for the Alpine Convention will be to help develop appropriate instruments and cooperation networks.

E2.4 Towards a common Alpine transport policy for the next ten years

Combined policy approaches for reconciling seemingly contradictory demands

Alpine transport policy has to conciliate:

- the requests for accessibility at various scales and in various fields, such as long-range freight, intra-Alpine freight, tourist attractiveness, everyday life….
- the difficulty of mobilising funds for very large public infrastructure investments
- and the need to take into consideration the specific Alpine environment, the need to reduce all kinds of negative impacts of transport.

Different approaches will have to contribute to the solution of this problem:

- the promotion of less harmful modes of transport for passengers and goods
- the reduction of the structural needs for transport – fulfilling the requested services in another way
- the more efficient organisation of transport

A series of obstacles

Policies for sustainable transport and mobility in the Alps will have to propose innovative solutions for overcoming difficult obstacles. Some examples:

- the need to update the Alpine railway system in a difficult topographical context is leading to build four new tunnels and some new railway lines,
- the cost of such big investments, which requires the organisation of specific and considerable funding, using innovative methods such as PPP (Public Private Partnership), RPLP (Capacity-linked levy on heavy goods vehicles) at the very moment when there is high pressure on public finances and limited European funds,
- the large variety of national situations and interests, especially concerning freight transport:
  - » high road traffic growth rates on some corridors (Brenner, Ventimiglia) in particular,
  - » low share of the rail traffic on the corridors Austria/Italy and France/Italy, compared to a much higher share in Switzerland, and
  - » some Alpine countries directly linked to big European axes, others in a more peripheral situation;
- the objective difference between a country like Italy, for whom passing through the Alps is strategic, and countries like Austria or Switzerland, confronted with an important transit flow.

The five main challenges

For the next ten or fifteen years, Alpine countries will have to face the following five main challenges:

- **To develop a coherent inter-modal policy aiming at reducing road freight traffic.** It will have to include the implementation of big new rail infrastructures as well as pricing and regulation measures taking account of environmental and other external costs.
- **To ensure the safety of transport in the Alps, for each mode, both for the infrastructures and the services.**
- **To improve public passenger transport across and within the Alps.** Inter-City connections, urban transport, cross-border links, access to rural areas – all are necessary for reducing congestion and pollution while ensuring a high level of personal mobility. Best practice examples show how high levels can be attained.
- **To promote sustainable mobility in the Alpine Area, with specific policies for tourism mobility.** Best practice examples show the considerable potential for business and for the quality of life of the local populations, for example through cooperation between public transport companies, local authorities and tourism operators.
- **To develop integrated spatial planning policies, considering the strategic objective of reducing the structural needs of transport.** They will have to enhance the local provision of services and goods by various means. Better coordination of settlement patterns and infrastructures should also facilitate the accessibility and the efficiency of public transport.

Cooperation is essential for success

These challenges invite Alpine countries to develop specific and concrete cooperation, both between themselves and with the European Union:

- No real progress will be made without a general agreement between Alpine countries on concrete actions concerning these issues on the scale of the whole Alpine space.
- Important measures of an Alpine transport policy will have to use European policy instruments – such as the Eurovignette – and to take account of European principles – such as the principle of free circulation and the protection of the environment.
- An Alpine transport policy has to be linked to the European policy framework aiming at interoperability for increasing the capacity, quality and reliability of the rail system.
- Because of the inter-relation between the different Alpine corridors any regulation policy in one place has an impact on others. This is an important issue to be considered when discussing proposals such as tradable transit certificates.
- Cooperation needs commitment: in view of the step-by-step completion of the four new base tunnels between 2007 and 2020, a precise calendar for the implementation of an overall Alpine freight transport regime is very important. The Swiss constitution requires reducing truck transit by 50% two years after the completion of the new Lötschberg connection – only some few years ahead. In order to adapt their planning, transport operators need to know coming restrictions precisely and well in advance.

Annex A2

Country	Mode	1994	1999	2004
France	Total	44.6	49.0	48.7
	Rail	8.6	9.4	6.8
	Road	36.0	39.6	41.9
Switzer-land	Total	24.1	26.8	34.9
	Rail	17.9	18.4	22.4
	Road	6.2	8.4	12.5
Austria	Total	63.7	85.9	108.1
	Rail	24.0	27.8	33.4
	Road	39.7	58.1	74.7
Total	Total	132.4	161.7	191.7
	Rail	50.5	55.6	62.6
	Road	81.9	106.1	129.1

Annex A2-1: Modal split of freight transport of selected Alpine countries in Mio tonnes per year (Source: CAFT 2004 Survey).

Country	Alpine Crossing	Mode	Year		
			1994	1999	2004
France	Ventimiglia	Rail	1.0	1.0	0.5
		Road	9.4	12.9	18.1
	Montgenèvre	Road		1.6	0.4
	Fréjus	Road	12.2	22.8	16.8
	Mt. Cenis	Rail	7.6	8.4	6.3
	Mt. Blanc	Road	14.3	2.9	5.2
Switzer-land	Gran San Bernardo	Road	0.4	0.4	0.6
	Simplon	Rail	4.7	3.5	6.8
		Road	0.1	0.2	0.7
	San Gottardo	Rail	13.2	14.9	15.6
		Road	5.1	7.0	9.9
	San Bernardino	Road	0.6	0.8	1.3
Austria	Reschen	Road	0.8	1.2	2.0
	Brennero	Rail	8.3	8.2	10.2
		Road	17.6	25.2	31.5
	Tauern	Rail	5.3	5.6	8.0
		Road	4.7	8.2	12.2
	Schoberpass	Rail	4.0	4.6	5.4
		Road	6.9	11.2	14.6
	Semmering	Rail	6.1	9.3	9.6
		Road	3.7	4.0	5.6
	Wechsel	Rail	0.4	0.1	0.2
		Road	6.0	8.2	8.8

Annex A2-2: Road and rail transport volumes on Alpine crossings in Mio tonnes (Source: CAFT 2004 Survey).

Country	Alpine crossing	Road (Mio t)	Rail (Mio t)	Modal split road/rail (in %)	Total (Mio t)
France	Ventimiglia	11.6		100/0	11.6
	Modane		1.1	0/100	1.1
	Fréjus	4		100/0	4
	Mt. Blanc	1.8		100/0	1.8
Switzer-land	Simplon	0.3	6.2	5/95	6.5
	Gran San Bernardo	0.3		100/0	0.3
	San Bernardino	0.8		100/0	0.8
	San Gottardo	6.2	13.5	31/69	19.7
Austria	Brennero	27.9	9.4	75/25	37.3
	Tauern	7.2		100/0	7.2

Annex A2-3: Road and rail crossing transit traffic in 2004 in Mio tonnes (Source: Alpinfo 2004).

Alpine crossing	Country	Share of Alpine-crossing traffic
Ventimiglia	France-Italy	13%
Fréjus / Mt. Cenis	France-Italy	11%
Mt. Blanc	France-Italy	3%
Gran San Bernardo	Italy-Switzerland	1%
Simplon	Italy-Switzerland	1%
Gotthard	Italy-Switzerland	9%
San Bernardino	Switzerland	1%
Reschen	Austria-Italy	1%
Brennero	Austria-Italy	19%
Tauern	Austria	13%
Schoberpass	Austria	12%
Semmering	Austria	5%
Wechsel	Germany	9%
Total		**98%**

Annex A2-4: Share of Alpine crossings in total cross-Alpine freight traffic on roads in 2004 (Sources: CAFT 2004 Survey).

Route	Daily flow of HDV	Freight rate (in %)	Freight rate increase (in %) 1995 – 2005
E52 München-Bad Reichenhall	7,000–9,000	15–18	25–27
E45 Brenner road axis Innsbruck-Bolzano	11,000	28–32	35
E70 Chambéry-Lyon	5,500	16	28
E43 Lainate-Como-Chiasso	12,500	18	22
E55 Pesnica-Maribor	5,000	12	35

Annex A2-5: Freight traffic flows on main Alpine motorways.

NUTS-2 region	Vehicle movements with origin in NUTS-2 region (Number of vehicle movements 2004)	Vehicle movements with destination in NUTS-2 region (Number of vehicle movements 2004)
Steiermark	854,000	926,000
Lombardia	851,000	925,000
Veneto	450,000	396,000
Piemonte	433,000	417,000
Niederösterreich	379,000	350,000
Oberösterreich	269,000	249,000
Kärnten	236,000	221,000
Provence-Alpes-Côte d'Azur	220,000	188,000
Wien	211,000	192,000
Rhône-Alpes	204,000	210,000
Tirol	204,000	190,000
Oberbayern	190,000	175,000
Slovenia	187,000	177,000
Salzburg	164,000	165,000
Province of Bolzano/ Bozen	151,000	161,000
Other NUTS-2 regions that at least partly overlap with AC area	930,593	923,076
NUTS-2 regions that do not overlap with AC area	4,264,392	4,311,930

Annex A2-6: Alpine NUTS-2 regions as origin and destination of traffic.

NUTS-2 regions generating traffic	NUTS-2 destinations of traffic	Vehicle movements in 2004
Steiermark	Niederösterreich	199,000
	Steiermark	132,000
	Oberösterreich	115,000
	Salzburg	35,000
	Other Alpine Regions	88,000
	Non-Alpine Regions	285,000
	TOTAL	854,000
Lombardia	Rhone-Alpes	52,000
	Provence-Alpes-Côte d'Azur	36,000
	Oberbayern	27,000
	Zürich	14,000
	Other Alpine Regions	97,000
	Non-Alpine Regions	625,000
	TOTAL	851,000
Veneto	Oberbayern	22,000
	Rhone-Alpes	17,000
	Provence-Alpes-Côte d'Azur	11,000
	Tirol	10,000
	Other Alpine Regions	54,000
	Non-Alpine Regions	336,000
	TOTAL	450,000
Piemonte	Rhone-Alpes	61,000
	Provence-Alpes-Côte d'Azur	28,000
	Region Lemanique	8,000
	Espace Mittelland	6,000
	Other Alpine Regions	27,000
	Non-Alpine Regions	303,000
	TOTAL	433,000
Niederösterreich	Steiermark	201,000
	Kärnten	37,000
	Burgenland	31,000
	Niederösterreich	24,000
	Other Alpine Regions	57,000
	Non-Alpine Regions	29,000
	TOTAL	379,000

Annex A2-7: NUTS-2 regions with highest volumes of generated traffic (CAFT 2004).

Origin intermodal platform	Country of origin	Destination	Destination country
Aarau	CH	Graz – Wien	AT
Basel	CH	Graz – Linz	AT
Brescia	IT	München	DE
Busto Arsizio	IT	Frankfurt	DE
Chiasso	CH	Singen	DE
Genova	IT	Zürich	CH
Graz	AT	Basel Koper	CH SLO
Hall in Tirol	AT	Verona	IT
Koper	SLO	Graz – Linz – Salzburg – Wien	AT
La Spezia	IT	Zürich	CH
Linz	AT	Zürich – Basel Koper – Ljubljana	CH SLO
Ljubljana	SLO	München Wien	DE AT
Milano Certosa	IT	Singen	DE
Munich-Riem	DE	Verona	IT
Salzburg	AT	Ljubljana – Koper	SLO
Singen	DE	Milano	IT
Trento	IT	Nürnberg	DE
Verona	IT	München Nürnberg	DE
Villach	AT	Koper – Ljubljana Trieste – Verona	SLO IT
Wien	AT	Koper – Ljubljana Verona	SLO IT
Zürich	CH	Genova La Spezia	IT

Annex A2-8: Rail transport O/D-pairs with highest volumes (Source: ISTAT Railflows 2004)

Origin	Destination	Number of vehicle movements
Lombardia	Germany	1,840,000
Lombardia	France	770,000
Emilia Romagna	Germany	637,000
Lombardia	Switzerland	604,000
Friuli V,G	Austria	470,000
Piemonte	Germany	305,000
Friuli V,G	Switzerland	290,000
Lombardia	Austria	278,000
Piemonte	France	204,000
Friuli V,G	Germany	120,000
Trentino A,A	Austria	104,000

Annex A2-9: Number of vehicle movements between Italian NUTS-2 regions and Alpine countries in 2004.

Case study: Freight traffic crossing the Slovenian-Italian border

In 2004, the total freight traffic regarding main Slovenian border-crossings towards the Alpine Convention area amounted to about 36.5 Mio tonnes per year.

	Rail (Mio t)	Road (Mio t)	Road (number of trucks)	TOTAL (Mio t)	Share of road
N.Gorica / Gorizia *	0.1	9.1	580,000	9.2	99%
Fernetiči / Fernetti *	1.2	8.6	550,000	9.8	88%
Šentilj / Spielfeld*	4.7	5.6	358,000	10.3	54%
Karavanke / Karawanken	3.5	3.7	237,000	7.2	51%
TOTAL	9.5	27.0	1,725,000	36.5	72%

Annex A2-10: Freight traffic on Slovenian Alpine border crossings. (* Not within the Alpine Convention Area.)

On the border between Italy and Slovenia the number of trucks has been increasing rapidly over the last few years. From 2000 to 2004 it rose from around 700,000 to over 1.1 Mio which constitutes an increase of 59.7%. In the period from 1995 to 2003 the share was higher for the Nova Gorica/Gorizia border-crossing.

The increasing traffic through the border-crossings of Fernetiči/Fernetti and Nova Gorica/Gorizia derives from two main factors:

- *it is the road connection from Italy to growing markets in Central and Eastern Europe,*
- *it is an alternative to the Tarvisio corridor.*

After the EU enlargement to 25 Member States in 2004, an extremely sharp increase of freight traffic was observed along the route of Corridor V across Slovenia. Some of this increase is already noticeable in the data for the Fernetiči/Fernetti and Nova Gorica/Gorizia border-crossings for the year 2004.

Regarding the modal split, it is interesting that the share of rail transport is much lower on the border between Slovenia and Italy than between Slovenia and Austria. While the share of rail traffic going to Italy is only around 7%, towards Austria it is around 47%. One of the reasons for such a difference derives from the different structure of freight; a considerable share of freight going to Austria is dry bulk cargo.

With respect to the mountain passes in Slovenia it is also interesting to consider the data for the Postojna pass, being just outside of the Alpine Convention area, defining the eastern sub-Alpine passage similarly to Ventimiglia on the western side. The total volume of traffic in 2004 was over 30 Mio tonnes, 9.8 million of which was on rail (32%) and around 21 million on road (68%).

Source: Ministry of Transport of the Republic of Slovenia

Annex B3

Country	Content	Level	National data source, method	Years	Provider and original data owner
AT	Cultivated area, forests, settlement and traffic infrastructure, area of permanent settlement	LAU-2	Regionalinformation des BEV, aggregated from cadastral data	2001, 2006	AC Umweltbundesamt, (based on BEV data)
CH	Cultivated area, forests, settlement and traffic infrastructure, area of permanent settlement	LAU-2	Area statistics: Every 4 years, 17 land use categories, survey among municipalities	1979-85, 1992-97	AC BFS
DE	Cultivated area, forests, settlement and traffic infrastructure, area of permanent settlement	LAU-2	Area statistics: Every 4 years, 17 land use categories, survey among all municipalities	2000, 2004	AC LfstaD
LI	Cultivated area, forests, settlement and traffic infrastructure, area of permanent settlement	Country-level	Area statistics, aerial photo with one sample point / ha	1996, 2002	AC Amt für Wald, Natur und Landschaft, Vaduz
FR	Forests, settlement and traffic infrastructure	LAU-2	CLC	1990, 2000	AC IFEN
FR	Cultivated area	NUTS-3	annual statistics	1993, 2003	AC Ministere Agriculture (SCEES)
IT	Cultivated area, forests; no settlement data	NUTS-3	method unknown, forest nomenclature only in Italian, Forest (Pioppeti and Boschi)	1990, 2000	AC APAT, ISTAT
SL	Cultivated area, forests, settlement and traffic infrastructure, area of permanent settlement	NUTS-3	Interpretation of Satellite Data (LANDSAT) and auxiliary data	Cultivated area only 2001 1997, 2001	AC Statistical Office of the Republic of Slovenia

Annex B3-1: Data sources and basic method by nation.

Metadata have not been provided sufficiently in all cases.

Calculation of land-use transformation matrices

Because land use is a phenomenon based on location, in any case of change we can always talk about transformations of land use. Any site of analysis can change its land use from type 1 to type 2. The changes in a larger defined area can be displayed within a cross table, which shows in rows the area of the different land-use classes at time 1, compared to the columns with the area of the different land-use classes at time 2. The cells of the table indicate the amount of area with land-use change from land use "x" at time 1 to "y" at time 2 or "a" at time 1 to "y" at time 2, respectively, within the given area.

		Time 2			
		Forest	**Agricul-ture**	**Settle-ment**	**Sum time 1**
Time 1	**Forest**	35	10	5	50
	Agriculture	5	15	10	30
	Settlement		5	15	20
	Sum time 2	40	30	30	

In this imaginary example one can see how many areas of new settlement have come from forest (5 units), and how many have come from agriculture (10 units). In this example one can also see that 5 units of agriculture changed to forest, whereas 10 units of forest are under agricultural use at time 2. Another 5 units went from settlement to agriculture, which is quite unrealistic, but good enough for this example.

For the actual case the statistical changes are collected for the smallest available land units (LAU-2), and these are treated as the sample points. Thus the land-use transformation is depicted for each of these units, and then the transformation values are aggregated to a higher level. This procedure sharpens the image of land-use change, because on every aggregation level it is still possible to report the share of transformation from each land-use class to each other class. For sake of generalisation of inherent errors, this method requires at least one aggregation level between the sample level and the flow analysis. For example, if the base data have a resolution of LAU-2, then the flows should not be depicted finer than NUTS-2 level.

For each municipality (LAU-2 Level) the status of two time steps is collected. This is still the statistical representation, but in high resolution compared to the result level (NUTS-2). Using certain assumptions and rules, the flows of land use can be inferred from those data:

One single "winner type" compensates all losses of the others; differences are adjusted so that the lower sum is the valid one, the higher sum is accounted to an "unknown" class.

One single "loser type" provides the gains of all others; again differences are adjusted so that the lower sum is the valid one, the higher sum is accounted to an "unknown" class.

If the sum of the total area differs remarkably between the years, a substantial change in the method of land-use assessment is assumed. In this case either the methodological differences can be resolved or the case has to be excluded from analysis.

If no transfer between land-use classes is detectable, i.e. all three classes gain or all of them lose area, the changes are assumed to be due to the changes in an unknown additional class. No change of land use is reported in this case for the three "known" classes.

These rules result in corrected tables of land-use class area, which are equal in total for both years. On this basis the main land-use flows are calculated per LAU2-unit, and aggregated per region, so that one matrix-table displays the land-use transformation for one region (maybe also for the whole nation).

Annex D7

European Expert Conference "Environmentally Friendly Travelling in Europe" – Final Document

The European Expert Conference, "Environmentally Friendly Travelling in Europe – Challenges and Innovations Facing Environment, Transport and Tourism", took place on 30 and 31 January 2006 in Vienna, mounted by the Federal Ministry of Agriculture, Forestry, Environment and Water Management, the Federal Ministry for Transport, Innovation and Technology and the Federal Ministry of Economics and Labour within the framework of the Austrian EU-Presidency and the Austrian Presidency of the Alpine Convention.

The conference focused on good practice examples of soft mobility measures in the fields of environment, transport and tourism, including the EU projects, ALPS MOBILITY II – Alpine Pearls, Alpine Awareness, mobilAlp, and Environmentally Sustainable Transport and Tourism in Sensitive Areas –Lake Neusiedl/Fertö-tó Region. As demonstrated by the award-winning projects in the European Contest held in conjunction with the conference a number of local and regional entrepreneurial initiatives are already under way in Europe; the range extends from trans-sectoral traffic calming measures, the improvement of travel to and mobility in the holiday region by public transport, to the use of innovative transport technologies, awareness raising and mobility management. The recommendations derived from the above-mentioned projects, the contest and the results of the conference need to be seen against the backdrop of the following political objectives in Europe:

- The March 2000 EU Lisbon Strategy of the European Council, targeting employment, economic reform and social cohesion;
- the "European Sustainable Development Strategy" (EU-SDS), June 2001;
- the "Kyoto-Protocol", which came into force in February 2005;
- the Transport White Paper "European Transport Policy for 2010: Time to decide" of the European Commission, September 2001;
- the Communication of the European Commission, "Basic orientations for the sustainability of European tourism", November 2003;
- the 6th Environment Action Programme of the European Union
- the technology platforms ERRAC (European Rail Research Advisory Council) and ERTRAC (European Road Transport Research Advisory Council) set up at the initiative of the European Commission, 2001 and 2002;
- the Alpine Convention and its protocols.

Recommendations issued by the European Expert Conference

The principles of sustainable mobility and sustainable tourism need to be integrated into as many tourism products as possible, taking account of all the three pillars of sustainability, i.e. economy, ecology and social aspects. In the implementation of the following proposals, close cooperation between stakeholders in the sectors of environment, transport, tourism and regional policy at destinations is a precondition for attaining improved products and problem solutions.

Recommendations to the transport sector:

- Guarantee the provision and funding of public transport in the regions for both the local population and for tourists,
- guarantee easy accessibility of tourism destinations by public transport (railway, bus and ship) in all seasons,
- upgrade and extend cross-border passenger transport through direct connections (railway – also considering the options offered by the liberalisation foreseen in the Third Railway Package – and bus) to scheduled transport, including attractive special package offers combining public transport with cycling,
- create consumer-friendly products and integrated tariff-systems, including all means of public transport, to give better access to the entire environmentally friendly transport system,
- create consumer-friendly logistic chains for smoother intermodal travel to and from destinations (including provisions for luggage transport),
- eliminate consumer-unfriendly institutional and technical barriers to cross-border rail and bus passenger transport,
- promote increased use of new transport technologies, such as efficient alternative propulsion, eco-friendly fuels and vehicle technologies, and
- use new information and communication technologies in public transport for optimum customer information, with a view to stimulating demand.

Recommendations to the tourism industry:

- Enhance integration and consider environmentally friendly mobility solutions when designing tourism products,
- integrate environmentally friendly mobility into existing product labels – ecolabels,
- develop attractive offerings and enhance implementation of measures with a view to extending the length of stay – thus counter-acting current trends and increasing year-round-tourism as far as possible,
- promote initiatives that raise awareness of sustainable tourism and sustainable mobility, and
- consider soft mobility as a USP (Unique Selling Proposition) in the marketing of tourism products.

Recommendations to destinations:

- Develop strategies for regional sustainable development (e.g. Local Agenda 21) and sustainable tourism as well as measures for their implementation,
- develop an easy-to-apply system for monitoring the status quo and the ongoing process of sustainable development,
- conduct research designed to improve socio-economic market surveys with a view to developing target-group-specific tourism products,
- integrate ecological requirements and criteria of sustainable tourism as well as the promotion of environmentally friendly transport modes in the regions and in the origin/destination transport chain into the tourism and travel concepts, policies and marketing strategies of all destinations,
- develop and promote cooperation between destinations specially dedicated to sustainable development with a focus on soft mobility and sustainable lifestyle values, such as the Alpine Pearls initiative,
- manage mobility for destinations (e.g. traffic-calming and car-free zones, local demand-oriented public transport systems as well as human-powered mobility),
- establish an origin/destination service chain and create special products, taking into account car-free travel to and car-free stays at resorts,
- sensitise visitors and create incentives for the increased use of public transport,
- create strategic partnerships between tourism industry and transport enterprises, tourism destinations and places of origin, with a view to jointly launching attractive, environmentally friendly products, which give tourists a door-to-door mobility guarantee, and
- take account of soft-mobility issues in tourism marketing and in the marketing of destinations (quality of travel experience, event-character or advantages of soft mobility ect).

Recommendations to policy-makers and the administration:

- Take into account the principle of fair pricing in transport and internalise external costs as a contribution to fair competition between the different transport modes (road, rail, aviation),
- set up a framework for enhancing the harmonisation and integration (e.g. technical standards, cross-border licences, user-friendly equipment and guiding systems, …) of European public transport, in particular for railway systems, with a view to improving cross-border railway connections,
- promote efforts with the objective of a Europe-wide, co-ordinated staggering of holiday periods,
- gain reliable data on travel behaviour through appropriate amendment of tourism statistics,
- consider environmentally friendly mobility in the forthcoming “Agenda 21 for European Tourism”,
- support environmentally friendly mobility management in tourism and leisure, to promote the use of environmentally sound vehicle technologies and fuels, particularly fuels derived from renewable energies (e.g. bio fuels and biogas) and further tighten the emission standards for vehicles powered by combustion engines (e.g. EURO 5, 6),
- create an appropriate instrument which enables the limitation of greenhouse gas emissions from air transport within the EU and between EU and third countries, taking into account the conclusions of the Environment Council of 02/12/2005; further enforce, at the international level the integration of climate-damaging emissions of international aviation into the Kyoto-Protocol,
- promote innovative, application-oriented projects for the implementation of environmentally friendly transport concepts for leisure and tourism as well as targeted cooperation between the environment, transport and tourism sectors under the programmes of the Structural Funds (Interreg, Urban, Leader, Equal) and under national development programmes,
- increase investment into research and development of innovative transport technologies under the 7th European Union Framework Programme for Research and Development, as well as into national research programmes, in order to pave the way for innovations and to realise an integrated, more environmentally friendly and more intelligent Europe-wide transport system,
- develop and promote an award and a labelling system for destinations that is oriented towards sustainable development, including soft mobility and lifestyle values, such as the Alpine Pearls initiative, and examine the options of Europe-wide application,
- promote existing labels for the successful placement of destinations on the tourism market and integrate criteria of sustainable tourism into the day-to-day business of successfully positioned destinations. Support the regular monitoring of destination branding and labelling and create the required databases, and
- integrate sustainable tourism and soft mobility issues into all forms of tourism-related education and life-long learning initiatives.

Recommendations to destinations facing special challenges

- Many European countries, in particular the new member states and candidate countries as well as the South-East European and Balkan countries, still have untouched and ecologically sensitive areas which could provide a good starting point for the development of sustainable tourism.
- Effective solutions in ecologically sensitive areas require cross-sectoral approaches.
- In destinations facing special challenges the external costs of environmental impacts should be considered in pricing (e.g. surcharges), in order to allow cross-funding of sustainable mobility in these areas.

- National and European funding instruments, such as the Structural Funds, should focus on the requirements of destinations facing special challenges and include soft mobility measures as well as support cross-border and transnational activities.
- The special challenges posed by the sensitivity of these areas should be communicated to tourists and to the local population in order to raise acceptance of specific protective measures.

Mountains:

- Due to the fact that environmental impacts are enhanced by the special topography, the climate conditions and the restricted living space, specific measures are required, particularly in transport. As measures at the destination alone may not be sufficient to reduce the environmental impact of transport, sustainable transport has to be promoted also in the source countries.
- Instruments such as the Alpine Convention and the Carpathian Convention have already highlighted the specific needs and proposed measures for sustainable development. The pertinent implementation procedures could serve as a model at international and global level. However, each mountain region must work out its own type of political contract based on the prevailing conditions and making a special allowance for an integrated approach to transport/tourism.
- Signing and ratification of the Transport Protocol of the Alpine Convention and subsequent increased efforts to ensure its implementation by the European Community and its Member States.

Wetlands:

- Since rivers and lakes divide as well as connect countries, a cross-country approach is called for.
- As the shores of rivers and lakes are usually flat areas, they have good potential for cycling; therefore package tours combining cycling with public transport (bus, rail, ship) should be promoted.
- Rivers and lakes need also to be considered as waterways. Therefore environmentally sustainable solutions for inland shipping and leisure and sport boating should be implemented, including the use of cleaner fuels and the renewal of the boat fleets as well as traffic restrictions in sensitive sections of lakes and rivers.

Urban areas:

- Leisure and tourism transport should be considered in the EU thematic strategy on urban environment and in its implementation.
- The EU thematic strategy on urban environment and its implementation should take into account the interaction between urban areas and their hinterland, focusing on leisure traffic flows of residents to recreation areas and the requirements for an environmentally sustainable origin/destination transport chain. Cooperation between urban areas and the recreation areas.
- of their residents should be promoted in order to enforce sustainable leisure mobility.

Coastal areas:

- Induce a modal shift to coastal shipping, especially in areas with land use constraints and conflicts.
- Promote and increase the use of cleaner fuels for vessels as well as alternative propulsion and renewal of fleets.
- Adapt land use planning in coastal areas in order to protect these zones and prevent new heavy infrastructure.

The participants in the European Expert Conference, “Environmentally Friendly Travelling in Europe – Challenges and Innovations Facing Environment, Transport and Tourism”.

Vienna, January 2006

Annex: List of the indicators

Data for the following Indicators were requested from the Contracting Parties of the Alpine Convention. Not all data were available and not all data have been used.

B1-1 Population

B1-3 Var Age structure classes

B1-4 Natural growth rate of the population

B1-5 Balance of migration (immigration minus emigration)

B1-6 Persons with a university degree (or/and doctorate degree, bachelor's degree, master's degree)

B2-1 Gross domestic product

B2-5 Unemployment rate

B3-3 Age of Employees in Agriculture

B3-4 Number of full time farms owned by natural persons

B3-4.1 Number of farms subdivided in classes according to the cultivated area

B3-4.2 Number of farms subdivided to types (full-time, part-time)

B3-5 Cultivated land

B3-5 Cultivated land above 1.500m

B3-10 Farms with agrotourism

B4-1 Forest area

B6-1 Settlement and traffic area

B7-3 Network load due to cars and trucks at automatic traffic meters (AVZ) in the Alpine region

B7-4 Passengers conveyed by train

B7-5 Passengers conveyed by regional bus

B7-6 Number of municipalities with regular or on-demand services

B7-8 Number of commuters in a municipality

B7-8.1 Number of commuters inflowing a municipality

B7-8.2 Number of commuters outflowing a municipality

B7-9 Modal split – case studies

B7-9.1 Modal split – case studies LAU-2 municipalities

B7-9.2 Modal split – case studies NUTS-2 regions

B8-1 Number of guest beds in hotel and para-hotel sectors per inhabitant

B8-1.1 Number of tourist beds per inhabitant summer season

B8-1.2 Number of tourist beds per inhabitant winter season

B8-1.3 Number of tourist beds per inhabitant annual average

B8-2 Proportion of guest beds in second homes

B8-2 Var Bed-places in second homes

B8-3 Seasonal overnight stays in the hotel and para-hotel sectors per inhabitant

B8-3.1 Number of tourist nights per inhabitant summer season

B8-3.2 Number of tourist nights per inhabitant winter season

B8-3.3 Number of tourist nights per inhabitant annual data

B8-4 Seasonal arrivals in the hotel and para-hotel sectors per inhabitant

B8-4.1 Number of tourist arrivals per inhabitant summer season

B8-4.2 Number of tourist arrivals per inhabitant winter season

B8-4.3 Tourist arrivals annual data

B8-5 Number of all ski lifts (diversified by type)

B8-6 Transport performance of all ski lifts

B8-9 Capacity of overnight stays of accommodation divided by category

Air quality measuring stations:

C1-10 NO_2 immission

C1-10Var NOx immission

C1-15 Ozone peak exposure

C1-16 Time of ozone exposure

C1-17 PM10 concentration

Air quality monitoring sites PM10:

C1-18 PM10 concentration exceedance

C8-2 Percentage of priority biotopes

C9-1 Emissions of road traffic noise

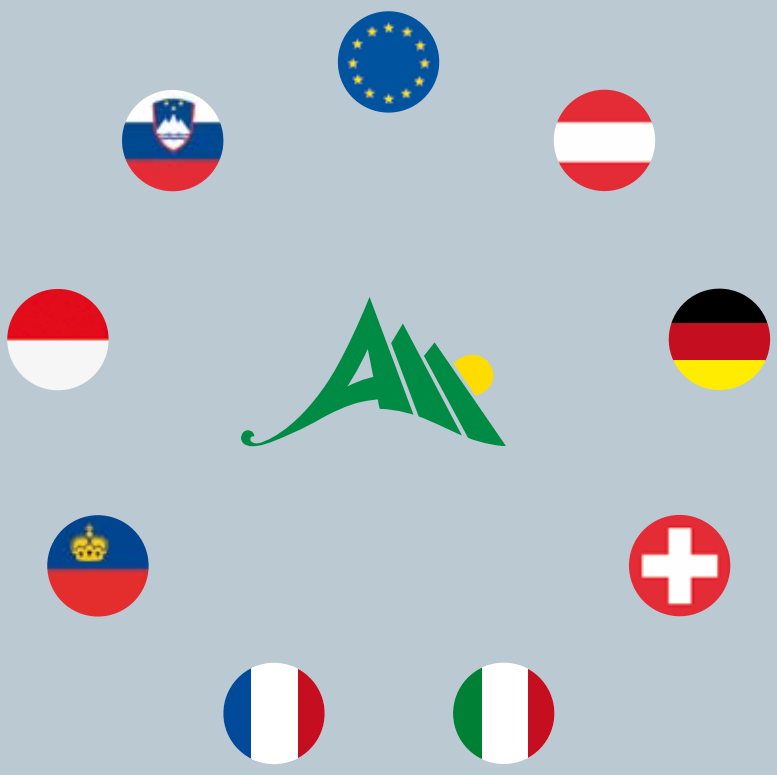
C9-1.1 Noise emission by railways

C9-1.2 Noise emission by airports

C9-2 Noise immissions based on LUCAS field data

C9-3 Expenditure on noise abatement measures along main thoroughfares

A questionnaire about the *status quo (February 2006)* regarding the Directive on Environmental Noise 2002/49/EC and expenses for measures of noise protection at high ranked roads, railways and airports.



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