

The ALPNAP project – scientific methods for reducing air pollution and noise impact along major Alpine transit arteries

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1 Background

The Alps are a densely populated area in the heart of Europe and at the same time a unique natural preserve. No wonder that counteracting economical and ecological interests are often colliding. Moreover, the barrier function of the Alps and its complex topography lead to a concentration of cross-Alpine road and rail traffic to a limited number of transport corridors. Along these transit routes the environmental stress is particularly pronounced, above all by air pollution and noise with negative consequences for the life quality and health of the neighbouring population and the soundness of the surrounding nature.

The Alpine environment is characterized by various interactions between orography, land use, meteorology, and emissions. In addition, the geometry of traffic-related emission sources can be rather complex (e.g. viaducts, tunnel portals). All this affects the transport of air pollutants and the propagation of noise. Steadily increasing traffic along the main transit routes combined with unfavourable dispersion conditions have led to violations of national and European air pollution standards. The traffic flow of many transit routes exceeds also the thresholds set in the European environmental noise directive such that noise mapping and action plans are required. Authorities have to react, and for example in Tyrol a night-time ban for heavy trucks was introduced. Another line of action has been to promote modal shift from road to rail. New railways are being built or planned for various Alpine transit sections. While a modal shift towards rail transport would certainly improve the air quality, the noise problem continues.

In the contexts of general economic and spatial development and the associated change (usually increase) of traffic volumes, the environmental impact of new infrastructure and/or administrative measures have to be assessed in order to find the best overall solutions among different options. Also, after the realisation of plans, it is necessary to monitor and evaluate the effects. Current modelling standards, however, were developed for more or less flat or at most hilly terrain (e.g. the Gaussian plume model for air pollution). They are not appropriate for the Alps with their large and deep valleys and basins. New developments at universities and research centres are meanwhile much better adapted to irregular terrain.

2 The ALPNAP project

In the view of the aforementioned problems the idea was borne to create a project which would bring together experts in air pollution, meteorology and ambient noise propagation along with environmental health professionals from different Alpine countries. The project has started in January 2005 and will be finished by the end of 2007. It is one of the major intentions of ALPNAP to promote the exploitation of currently available knowledge, investigation methods and modelling tools for the environmental monitoring and impact assessment in the Alpine space. The application of up-to-date, science-based methods will be demonstrated, and these methods will be transferred towards the application side, especially the regional authorities. Therefore, a close cooperation with authorities was implemented through the *Alpine Space* project MONITRAF.

The participating institutions and the responsible scientists of ALPNAP are:

- Germany:
 - Deutsches Zentrum für Luft- u. Raumfahrt (DLR), Institut für Physik der Atmosphäre, Oberpfaffenhofen (Dietrich Heimann)
 - Institut für Meteorologie und Klimaforschung (IMK-IFU) im Forschungszentrum Karlsruhe, Garmisch-Partenkirchen (Peter Suppan).
- France:
 - Centre d'Études Techniques de l'Équipement de Lyon (CETE de Lyon), Lyon (Philippe Gravier)
 - Centre Scientifique et Technique du Bâtiment (CSTB), Saint-Martin-d'Hères (Jérôme Defrance)
- Italy:
 - Agenzia Regionale per la Protezione Ambientale del Piemonte (ARPA), Torino (Francesco Lollobrigida).
 - Istituto di Scienze dell'Atmosfera e del Clima CNR (ISAC), Torino (Silvia Trini Castelli).
 - Università degli Studi di Trento, Dipartimento di Ingegneria Civile ed Ambientale (Massimiliano de Franceschi)
- Austria:
 - Universität Innsbruck, Institut für Meteorologie und Geophysik, Innsbruck (Friedrich Obleitner)
 - Medizinische Universität Innsbruck, Sektion für Sozialmedizin, Innsbruck (Peter Lercher)
 - Technische Universität Graz, Institut für Verbrennungskraftmaschinen und Thermodynamik, Graz (Dietmar Öttl)
 - Universität für Bodenkultur Wien (BOKU), Institut für Meteorologie, Wien (Petra Seibert).

3 Mountain-specific factors for air pollution and noise propagation

The mountains which frame the valleys or basins, reduce the available air volume and guide or even block the air currents. Winds are restricted to circulations along the valleys for most of the time, and are generally weaker than outside the mountains. Autochthonous wind systems develop in the mountains which blow into and up the valleys during the day (especially the afternoon) and out of and down the valleys during night (including the morning hours). Until weather fronts interrupt this situation, the same pattern is repeating day by day. Especially in large valleys long-lasting autochthonous circulations can lead to a critical accumulation of pollutants. Noise is enhanced in the respective downwind area of sound sources. Also weak-wind situations with temperature inversions prevent air pollutants from an effective dispersion and refract sound waves towards the ground. Again high concentrations and a long-range audibility are the consequences. The valley circulations are linked to small-scale thermal wind systems along the slopes. Such slope winds can be locally relevant and complicate the situation, though in the cold season they are not able to efficiently vent the valley atmosphere. Slope winds and the accompanying shallow cold-air layers are also relevant for the propagation of noise, as they may form sound ducts.

4 Methods

The main objective of ALPNAP is the demonstrative application of currently available science-based methods and tools in two selected target areas:

1. The Brenner corridor from Rosenheim (Germany) through Austria to Verona (Italy).
2. The Fréjus corridor from Torino (Italy) through the Val di Susa and the Vallée de la Maurienne to Chambéry (France).

These corridors are the ones with the highest traffic going through the high Alps, and they both have road as well as rail transit routes. In both target areas, smaller sub-target areas have been selected for more detailed studies. The project work combines monitoring data, modelling activities and social-medical investigations. Noise and air pollution will be treated in an integrated fashion wherever and whenever feasible. In the Brenner corridor monitoring data will be supplemented by own measurements during a coordinated field campaign in selected sub-target areas between November 2005 and February 2006.

The project combines conventional instruments with highly sophisticated sensors, such as ultrasonic anemometers, SODARs, ceilometers, air chemistry probes, and binaural artificial-head microphones. Modelling is based primarily on advanced numerical models of meteorology, air pollution transport and noise propagation. They are applied to both target areas in high resolution and with reduced resolution to the whole Alps. Comprehensive acoustical models are also used to demonstrate principle relationships between noise propagation and special meteorological and/or topographical situations.

However, numerical modelling has certain limitations because the fine grid needed to fully resolve the Alpine topography leads to very high computational demands, especially for seasonal simulations. Therefore, a more statistically oriented approach will also be included. This so-called nowcasting approach allows the display of all relevant measurements in near real time. It also enables a simple typing of the topographic sensitivity to air pollution. Simplified but still advanced acoustical methods are used to create noise maps along extended sections of motorways and railway lines. All contributions shall be integrated with the investigation of nuisance and health indicators and be aggregated by means of geographical information systems (GIS).

5 Expected results

The ALPNAP project will result in a comprehensive report which summaries the actual knowledge on meteorology, air pollution, noise and health effects in the Alps. The findings which were gained during the project will be explained and recommendations with respect to the use of monitoring, modelling and social-medical investigation methods will be provided. It is also intended to inform the broader public about principle relationships between natural processes and man-made nuisances in their neighbourhood. The ALPNAP team members intend to sustain the partnership with the authorities also after the project.

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For additional information on ALPNAP visit <http://www.alpnap.org/> or contact the project lead partner <mailto:d.heimann@dlr.de>.