ALPNAP – A NEW PROJECT ON TRAFFIC-INDUCED NOISE AND AIR POLLUTION ALONG TRANSPORT ROUTES IN THE ALPS

Petra Seibert[1], Dietrich Heimann[2], Peter Suppan[3]

[1] Institut für Meteorologie, Universität für Bodenkultur Wien, Peter-Jordan-Str. 82, 1190 Wien, Austria
[2] Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt, Oberpfaffenhofen, 82234 Weßling, Germany
[3] Institut für Meteorologie und Klimaforschung, Atmosphärische Umweltforschung (IMK-IFU), Forschungszentrum Karlsruhe, Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen, Germany
E-Mail: *petra.seibert@boku.ac.at*

Abstract. ALPNAP (Monitoring and Minimisation of Traffic-Induced Noise and Air Pollution Along Major Alpine Transport Routes) is a new project financed under the EU Interreg III B Alpine Space Programme. It will run from 2005-2007. A network of eleven institutions has been formed with DLR Institute of Atmospheric Physics as the lead partner. The project aims at the integrated use of advanced science-based methods to monitor, assess, and predict air pollution and noise and their impact on the environment, quality of life and health along major transport routes. These methods are adapted to the Alpine topography and its specific meteorological phenomena which often amplify the levels of concentration and noise. The purpose of the project is to promote these methods to regional and local authorities, to supplement standard methods towards more reliable predictions and scenario assessments, to quantify the limits of emissions if given air quality and noise standards are to be met, and to assess the environmental impact of traffic flow changes due to regulations, new infrastructure, or modal shifts.

Previous work has shown that the conditions for the propagation of noise and the dispersion of air pollutants in Alpine valleys are quite different, and often considerably more unfavourable than in flat terrain. Standard models which are still applied in such environments, too, are not adequate. The project aims at demonstrating the advantage of more advanced methods taking into account state-of-the-art scientific tools.

Keywords—*Alps, valleys, air pollution, noise, road traffic, rail*

1. INTRODUCTION

There is a long history of studies of air pollution in mountainous areas and especially in valleys and basins. It is known that they are prone to frequent and strong inversions especially in the cold season, often combined with weak winds and calm periods. All this can lead to very high concentrations of pollutants in this environment. While many of the polluting factories in Alpine valleys have either been closed down or their emissions have been drastically reduced by appropriate technological measures, road traffic has become more important. It is a source of nitrogen oxides (mainly emitted as NO, but oxidised more or less quickly to the more toxic NO_2 and fine particles (PM). Sulphur dioxide emission from diesel fuel is of minor concern. These pollutants, especially PM, are also emitted from domestic sources, especially as single wood-burning stoves are quite common in the Alps.

Increasing amounts of traffic along the main transit routes combined with the unfavourable dispersion conditions have led to exceedances of air pollution standards set by the European Union. The traffic flow of many transit routes exceeds 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 traffic was introduced. Questions arise such as how effective different possible measures would be, how the effect of measures taken can be assessed under the boundary condition of ever-changing meteorological conditions, and what the consequences of projected future traffic volumes would be.

Another line of action has been to promote modal shift from road to rail. New railways are being built and planned for various Alpine transit sections. While such a shift no doubt improves the air quality, there

	Corridor	No. of lorries per year (2003)
1	**Fréjus**	**1,250,000**
2	Mont Blanc	270,000
3	Sankt Gotthard	1,000,000
4	**Brenner**	**1,650,000**
5	Tauern	930 000
6	Pyhrn	1,050,000

Figure 1: Major transit corridors in the Alps. Source: APA/BMVIT

is also a severe noise problem along Alpine transit routes, both from road and rail. Thermal wind systems, especially slope winds, transport noise, and inversion layers may lead to downward sound refraction and thus to higher sound levels. Topographic factors render the classical noise protection walls much less effective. Therefore, a comprehensive assessment of environmental consequences of traffi c measures must include noise issues, and especially under Alpine conditions they are closely linked with meteorology.

Therefore the idea was borne to create a project which would bring together experts in these fi elds from different Alpine countries and to transfer the state of the art in scientifi c methods towards the application side, especially the regional authorities. This idea was realised as an EU Interreg III B project in the context of the "Alpine Space" programme (see *http://www.alpinespace.org/* for more information on this programme). Cooperation with authorities is implemented through another Interreg III B project in the Alps, MONITRAF, which is a network of regional authorities from four Alpine countries (A, CH, I, F).

2. PARTICIPATING INSTITUTIONS

The participating institutions and the responsible scientists are:

• Germany:
– Dt. Zentrum f. Luft- u. Raumfahrt (DLR), Inst. f. Physik d. Atmosphäre, Oberpfaffenhofen (D. Heimann).
– Inst. f. atmosphärische Umweltforschung im FZK (IMK-IFU), Garmisch-Partenkirchen (Peter Suppan).

• France:
– Centre d'Études Techniques de l'Équipement de Lyon (CETE de Lyon), Lyon (Eric Premat).
– Centre Scientifi que 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-TO), Torino (Silvia Trini Castelli).
– Università degli Studi di Trento, Dip. di Ingegneria Civile ed Ambientale (UNITN; M. de Franceschi)

• Austria:
– Universität Innsbruck, Institut für Meteorologie und Geophysik (IMGI), Innsbruck (Friedrich Obleitner).
– Medizinische Universität Innsbruck, Sektion für Sozialmedizin (MUI-IHS), Innsbruck (Peter Lercher).
– TU Graz, Inst. f. Verbrennungskraftmaschinen und Thermodynamik (TU-GRAZ), Graz (Dietmar Öttl).
– Universität für Bodenkultur Wien, Institut für Meteorologie (BOKU), Wien (Petra Seibert).

3. WORK PLAN

3.1. Outline

The project will focus on two regional target areas. One is the Brenner corridor from Rosenheim (Germany) through Austria to Verona (Italy). The other one is the Fréjus corridor. It includes the Val di Susa from Torino towards the Montcenis (Italy) and in France it includes the Maurienne valley. These corridors are the ones with the highest traffi c going through the high Alps (see Fig. 2.), and they both have road as well as rail transit routes. In both target areas, smaller sub-target areas will be selected for more detailed studies. In Austria, the lower Inn Valley near Jenbach will be one of them.

The project will apply detailed numerical modelling on one hand and measurement campaigns on the other hand. The finest nests of the models and the campaigns will focus on the sub-target areas. Integrated measurements of meteorology, air pollution and noise as well as interviews in the population to assess the nuisance will be carried out at least in one campaign. Next to more traditional instruments such as fixed and mobile stations for meteorology and air chemistry, IMK-IFU plans to operate its instrumented ultra-light aircraft and a sodar (see Fig. 3.1.).

Figure 2: IMK-IFU's instrumented ultra-light aircraft.

The following paragraphs give a brief outline of some major contributions, but they are not an exhaustive description of the work plan and each partner's activities.

3.2. Emissions

TUG will create very detailed emission data for the road traffic emissions, based on recent measurements of heavy-duty vehicles under real traffic conditions. These measurements showed that the NOx emissions of such vehicles are relatively high even if they are certified according to the last EURO-norms. The emission model includes the steepness of the road and actual traffic flow data at counting stations. IMK-IFU will prepare detailed gridded biogenic and anthropogenic emission inventories for use in numerical modelling.

3.3. Meteorology

Meteorological input is needed both for air pollution modelling and for noise propagation modelling. Models such as MM5/MCCM and RAMS will be used in nested versions (mainly by IMK-IFU and ISAC-TO), going down into the km-range, to simulate episodes and – by IMK-IFU – up to a whole year, nudged to operational analysis data. UNITN will apply the mass-consistent wind model CALMET. Another track is the climatological analysis of existing data and the development of simpler methods than full numerical models to determine the representativity of stations and critical parameters such as the mixing height. This line of action is pursued mainly by IMGI and BOKU. Many partners will contribute to the measurements.

3.4. Air pollution

While IMK-IFU will perform air quality simulation with its MCCM model system (version of MM5 with on-line chemistry), other project partners will use various off-line models to simulate the transport and diffusion (but not primarily the chemistry) of pollutants. CNR-ISAC will apply the MIRS-SPRAY modelling system, a Lagrangian particle model with special turbulence parameterisation for complex terrain. TUGRAZ will apply another, very small-scale Lagrangian particle model (GRAL) for resolutions down to 10 m. UNITN will apply CALGRID and CALINE; the CAL-tools are simpler than other models and will allow a comparison. Models of different scale shall be coupled. The track of statistical and conceptual modelling is also pursued here. IMGI will create a nowcasting tool on this base. BOKU will work on simple indices to characterise the sensitivity of areas with respect to unfavourable dispersion conditions.

3.5. Noise

CSTB, CETE and DLR will operate noise models of different complexity. Standard models are compared with more complex numerical models which take into account detailed meteorological and topographical features. MUI will provide bi-aural noise measurements during one of the campaigns. Studies will demonstrate how typical Alpine geometries (e. g., noise sources or receivers on slopes, elevated sources on viaducts, tunnel portals) influence the sound propagation and how resulting noise levels differ from estimates using standard methods.

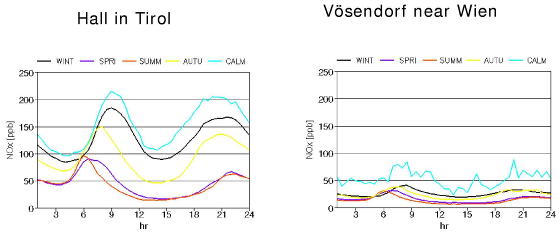

Figure 3: Diurnal variation of the NOx concentration in the four seasons and under calm winter conditions at a site in the lower Inn Valley (Hall) and near Vienna (Vösendorf). From Wotawa et al. (2000)

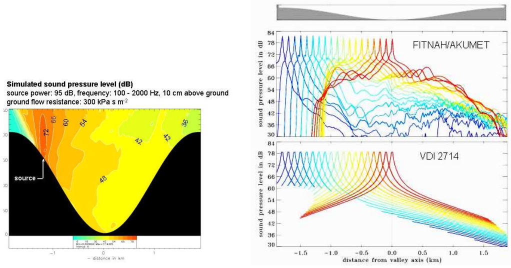

Figure 4: Modelled noise level distribution in a 2D valley cross section (left) and comparison between numerical and standard noise propagation model (right). From Heimann and Groß, 1999).

3.6. Impacts

Results from other work packages will be integrated with GIS methods. This will allow to determine, e. g., the number of exposed inhabitants. Many partners will contribute here. MUI will conduct a study on health impacts, especially noise-related ones.

4. PREVIOUS RESULTS

4.1. Air pollution

Wotawa et al. (2000) studied statistically the air pollution by NOx in the Inn Valley. Compared to a site near Vienna with even larger traffi c emissions (Vösendorf), the NOx concentrations in the Inn Valley (Hall) are strongly increased especially in winter and even more so under near-calm conditions (Fig. 3). This shows clearly the much lower dilution potential in the valley atmosphere compared to the plains.

4.2. Noise

Using numerical models of the atmosphere and the noise propagation, it is possible to obtain more realistic representations of the noise fi eld in the surroundings of noise sources in complex terrain. Figure 4 (left) shows the noise level fi eld calculated in this way for a nocturnal situation with downslope winds (Heimann and Groß, 1999). Downward refraction by the inversion, down-wind propagation and the formation of a sound duct for up-wind propagation in the shallow slope wind layer increase the sound levels near the surface across the valley. Figure 4 (right) compares the idealised calculations which are normally used with the numerical model chain.

5. OUTLOOK

Information about the project plan, the ongoing work and the results will be published on the ALPNAP web site (presumably *http://www.alpnap.org/* or *http://www.alpnap-project.org/*). ALPNAP is interested in information exchange and possibly cooperation.

Acknowledgements: *The project ALPNAP is implemented through financial assistance from funds of the European Community Initiative Programme “Interreg III B Alpine Space”. Co-financing by the Austrian BMLFUW Ministry (BOKU) and the Helmholtz Society, funded by BMBF, (IMK-IFU) is acknowledged.*

REFERENCES

Heimann, D. and Groß, D. (1999): Coupled simulation of meteorological parameters and sound level in a narrow valley. *Appl. Acoustics*, **56**, 73-100.

Wotawa, G., Seibert, P., Kromp-Kolb, H., and Hirschberg, M. (2000): Verkehrsbedingte Stickoxid-Belastung im Inntal: Einfluss meteorologischer und topographischer Faktoren. Final report, Project No. 6983 of ÖNB-Jubil¨aumsfonds, Wien, 28 pp. On-line at *http://www.boku.ac.at/imp/envmet/Inntal-Bericht.pdf*.