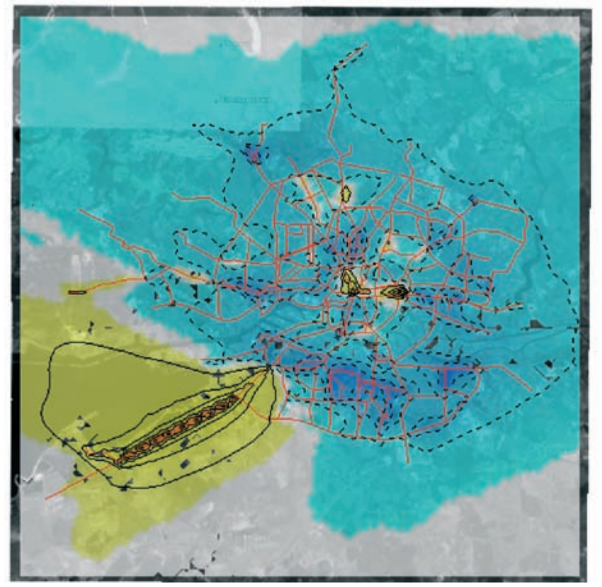
Difference in NO2 concentration (µg/m3) for year 2015 "business as usual" with respect to year 2006

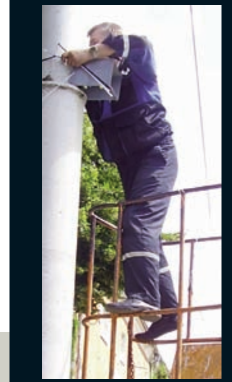


Evaluation of scenarios

Future traffic scenarios in Kaliningrad have been evaluated with the configured ARIA Regional modeling system in order to evaluate various emission abatement strategies to reduce air pollution from traffic. The average target year for the implementation of the different traffic scenarios.
was set to the year 2015.
Six different scenarios were elaborated by grouping the spectrum of policy guidelines emerged during meetings with ECAT and the Stakeholder's reference group (SRG), with the technical support of ARIA and ARIANET experts. Scenario 1 referred to the situation "business as usual" year 2015, while the other scenarios could generally be identified as either measures related to changes in infrastructures and traffic conditions (Scenario 2 to 4) or to improvements in vehicle fleet and fuels (Scenario 5 and 6).
The expected increasing trend in traffic volumes will in the future generate a significant load on the present road network. However, considering pollutant emissions, this effect would to some extent be counterbalanced by the introduction of newer vehicles equipped with more efficient technologies for pollutant reduction.
The measures related to the increase of public transportation (Scenario 4) have revealed the best results, with clear improvements of air quality over a substantial part of the city. Renewal of vehicle fleet and fuels (Scenario 5 and 6) are also expected to lead to improvements of air quality over the whole urban area. The impact observed was generally more significant in the central parts of the city than in the suburbs.
Even though infrastructural upgrades of the network (renewal and construction of bridges, completion of the Kaliningrad ring road), certainly will rationalize the distribution of traffic flow locally, they're not expected to significantly change the overall load on the network.

Passive samplers

Field experiments

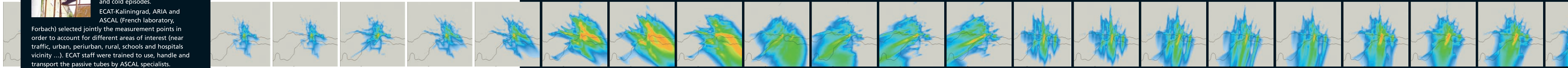


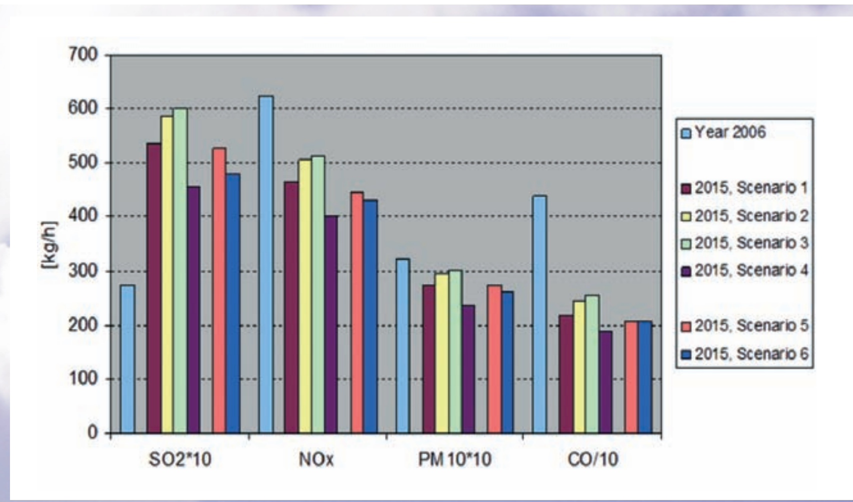
In order to know the actual air pollution situation in various parts of the city, field experiments with passive samplers (diffusion tubes) were carried out at 50 different points. Measurments of NO_2 and BTEX (benzene, toluene, ethylbenzene and xylene) were made during two periods of 15 days chosen in order to represent the typical conditions during both warm and cold episodes.

ECAT-Kaliningrad, ARIA and ASCAL (French laboratory, Forbach) selected jointly the measurement points in order to account for different areas of interest (near traffic, urban, periurban, rural, schools and hospitals vicinity ...). ECAT staff were trained to use, handle and transport the passive tubes by ASCAL specialists.

The passive tubes were then prepared by ASCAL specialists and installed by ECAT at the selected points. At the end of the campaign the samples were analyzed by ASCAL and the results were compared with the European and Russian legislation as well as with modeling results.

Model results were found consistent with the control field experiments with hot spots observed along the main roads and in the city center. The FARM model yields results that are generally close to measurements whereas the model output from ARIA Impact corresponds to approximately 40-50% of the measured concentrations of NO_2. The difference is mainly related to the contribution of industrial sources not included in the study with ARIA Impact. To make a more detailed comparison of model results with measurement data a more complete inventory of the emission sources in Kaliningrad and neighboring regions would have to be carried out, integrating harbor activities, all the main point sources and background concentrations of NO_2 (long distance transport of pollutants). This work was however not included in the scope of the project.





Comparison of total traffic emissions over the road network for scenarios 1 to 6
The selected scenario were :
1. *Business as usual*
2. *Construction and renovation of bridges and bridge passages*
3. *Development of city road network and optimization of traffic flows*
4. *Improvement of public transport*
5. *Renewal and improvement of the Kaliningrad vehicle fleet*
6. *Improvement of fuel quality*

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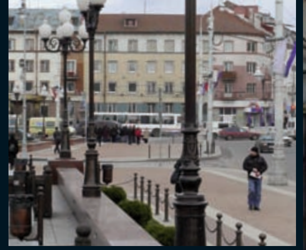






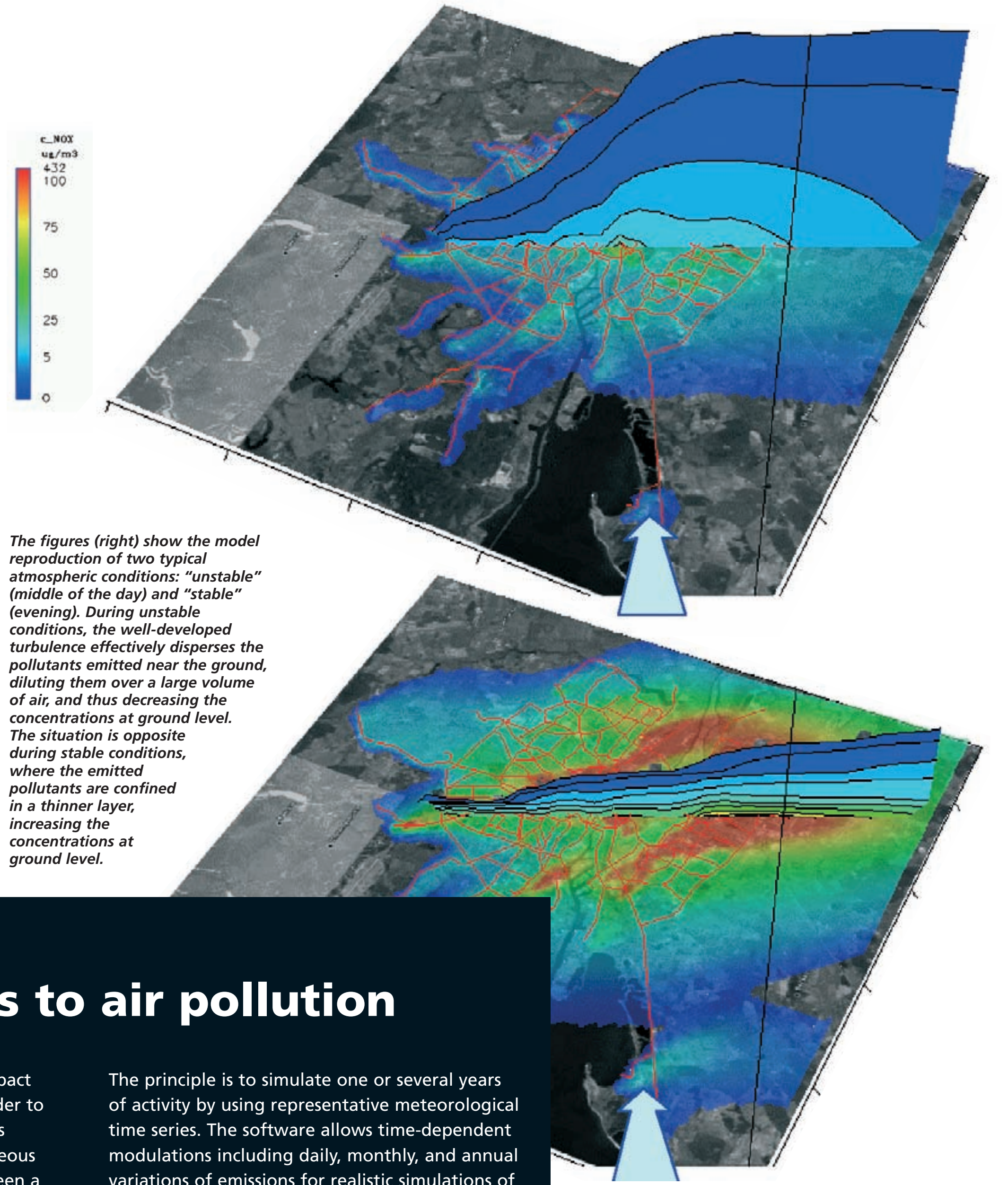

Clean Air for Kaliningrad

Clean Air for Kaliningrad

The urban air pollution induced by traffic in Kaliningrad is raising increasing concern. KALAIR is a LIFE-Third Countries Project, co-funded by the European Community, designed to aid the city in the evaluation of abatement strategies for reducing air pollution caused by traffic. The project was implemented at the Kaliningrad Municipal Environmental Centre, ECAT, in collaboration with ARIA Technologies, during the years 2007-2008.

The main objective of the project was to jointly construct a modeling tool to be used by ECAT in order to study the mechanisms or air pollution induced by traffic in the Kaliningrad environment. The modeling tool has been validated through on-site experiments, involving comparisons with available air pollution datasets from continuous monitoring stations, as well as with specific field experiments using passive samplers (diffusion tubes).
The validated modeling system can be used by ECAT to study the effect of urban management decisions in order to reduce air pollution levels observed in the City, such as changes in fuel composition, improvements in the car fleet quality, increases in public transportation offers, changes in the city traffic scheme and traffic permissions, etc.
An operational modeling system, including a traffic model, a meteorological model, an emission model and air pollution dispersion models were delivered to ECAT. These tools allow the simulation of various emission abatement strategies as well as their consequences on air pollution levels. By comparing the model results with the costs of each reduction strategy the optimal management decisions can thereafter be obtained.
The outcome expected in long-term is a reduction of air pollution levels induced by traffic at the "hot spots" of the city of Kaliningrad, through the application of optimal emission reduction strategies.

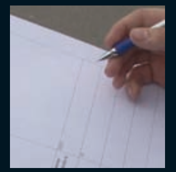
Another key result of the project was the cross-transfer of technology and experiences between European and Russian partners, obtained through extended joint work on data collection, experiments and modeling.
The modeling tools take into account urban effects and site characteristics. Physical geographical data (terrain, land-use) has been gathered in a GIS-type environment, together with geographical data on the road network, urban landscape and human geographical data on population and transportation demand.
Traffic data has been collected, including observations of vehicle flow and statistical data on traffic demand at various times of typical days. These data have been synthesized through a traffic model, adapting the results from traffic demand allocation algorithms to existing measurements on links.
Emissions from traffic flow were computed using the most recent techniques applied in Europe for this type of problem, with a special focus on critical substances and on the correct representation of particles. Dispersion modeling has been performed through a state of the art modeling system, and the output concentration fields have been compared with two categories of data: existing air pollution data at federal monitoring stations, and data from specific field experiments using a network of passive samplers (diffusion tubes) for benzene and NO_2.



The figures (right) show the model reproduction of two typical atmospheric conditions: "unstable" (middle of the day) and "stable" (evening). During unstable conditions, the well-developed turbulence effectively disperses the pollutants emitted near the ground, diluting them over a large volume of air, and thus decreasing the concentrations at ground level. The situation is opposite during stable conditions, where the emitted pollutants are confined in a thinner layer, increasing the concentrations at ground level.

Traffic data

Assessing the traffic

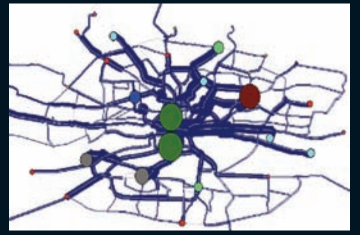


Traffic counting was carried out by ECAT on different roads in Kaliningrad during three different days and at five different time periods of the day. Based on this information the Kalingrad vehicle fleet composition could be defined. The traffic counting was divided into different vehicle categories (cars, trucks, trams, trolleybuses, buses and minibuses). The observations were gathered in a GIS database containing the Kaliningrad road network.

CARUSO

Traffic simulations were realized with the CARUSO (CAR Usage System Optimization) traffic model. The objective was to configure and deliver a flexible PC-based traffic modelling system providing results that could be used further be used for calculating emissions from traffic in the city. CARUSO is a static model based on one of the major algorithms for determining traffic flow on a transport network and to estimate Origin/Destination (O/D) matrixes.

The model was populated with Kaliningrad data, tests of the simulation quality was carried out and ECAT personnel were trained on the theory and practice of using the model. By using real Kaliningrad traffic data, ECAT technicians had the possibility to start working directly on a concrete case and to apply their own experience on the local traffic situation.



Results of CARUSO simulation

The original GIS road network for Kaliningrad was composed of more than 900 streets. According to a hierarchical classification, a subset of 410 streets was selected and integrated in the CARUSO simulation. The traffic density was based on the average vehicle flow taken from traffic counting at three different hours of the day: 08:00, 12:00 and 17:30.

The results from the traffic simulation show that the main trips occur within the city of Kaliningrad and that only a smaller amount is due to the exchange with the surrounding regions.

Emission models

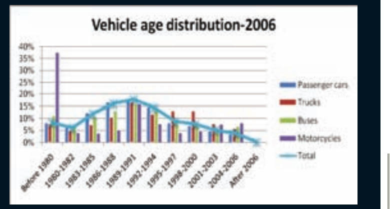
From traffic to emissions

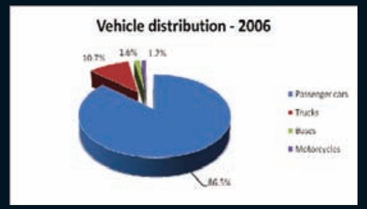
TREFIC

TREFIC ("TRaffic Emission Factor Improved Calculation") has been conceived to answer to the many specific requests which arise when calculating the atmospheric pollutant emissions from on-road vehicles. The model calculates the emissions from traffic for ~120 different pollutants.
It integrates data related to:

- Road Network (including traffic flow, percentage of heavy vehicles, vehicle speed, road type…)
- Fleet distribution (dividing vehicles into more than 100 sub-categories)
- Emission factors (Based on COPERT IV methodology)
- Fuel characteristics (based on annual fuel sales in Kaliningrad)

The calibration of the TREFIC model was performed for a situation corresponding to year 2006 during peak hour in Kaliningrad. The specification of Russian fuels and the Kaliningrad vehicle fleet was based on data provided by the Federal Inspection on Traffic Safety and the Federal Statistical Service in the Kaliningrad Oblast (Kaliningrad Stat).





Results of TREFIC emission modeling for Kaliningrad

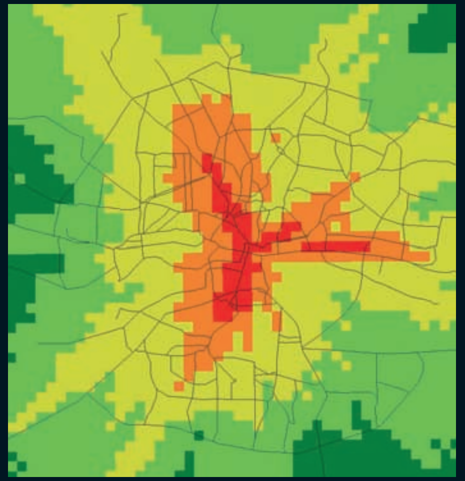
Dispersion models

From emissions to air pollution

Two different dispersion models (ARIA Impact and FARM) have been implemented in order to compute maps of pollutant concentrations induced by traffic emissions. The simultaneous use of two models allows to choose between a quick Gaussian model able to simulate the long-term impact on air quality over one or several years, and a more sophisticated Eulerian model requiring longer CPU times but providing better results in complex situations.

ARIA Impact

ARIA Impact is a Gaussian model developed by ARIA Technologies, designed for evaluating long-term impact of emissions from industrial sites, vehicular traffic and diffuse sources. The model conforms to the norms of the Environment Protection Agency (EPA), United States.



The principle is to simulate one or several years of activity by using representative meteorological time series. The software allows time-dependent modulations including daily, monthly, and annual variations of emissions for realistic simulations of air quality.
Modelling with ARIA Impact over Kaliningrad was performed for the average situation corresponding to year 2006 in order to characterize the long term impact on air quality.
ARIA Impact was configured for the Kaliningrad situation (emissions, topography and meteorological data), tests of the simulation quality was carried out and ECAT personnel were trained on the theory and practice of using the ARIA Impact dispersion model.

ARIA Regional / FARM

The FARM dispersion model was applied for two different meteorological episodes corresponding to "average" and "worst case" conditions. The final goal was to obtain reliable reference simulations of pollutants dispersion over the Kaliningrad area, to be used in the analysis of a set of future emission scenarios related to traffic.
The FARM dispersion model employed is a three-dimensional Eulerian dispersion model including the treatment of chemistry in gas and aerosol phase, developed by ARIANET on the basis of the STEM model, an U.S. academic model with a very long application record in many parts of the world. FARM can be applied in different contexts, from scenario evaluation to daily pollution forecasts, on time scales ranging from national to regional and urban, and it is currently used in Italy to evaluate national-scale policy scenarios, on behalf of Ministry of the Environment.

Dissemination events

The dissemination program of the present project was targeted to the stakeholders involved in the official decision making (responsible for the definition of scenarios), all the institutions and companies dealing with transport issues as well as the broad public. The final project results were presented at a seminar in the Kaliningrad City Hall in October 2008.

A project web-site (www.kalair.ru) has finally been developed including all the project information, detailed description of project activities, presentation of the involved partners, the main deliverables and characteristics of the modeling tools applied.