Lohmeyer *aktuell*

Lohmeyer Consulting Engineers **Issue no. 40** **December 2018**

Dear Readers

This year, we celebrated the company's 35th anniversary. Looking back, we are grateful that our company's history has been both eventful and generally successful. In our first article, you'll find a short rundown of our company's history. On behalf of the entire team, I would like to take this opportunity to give thanks to Dr. Bächlin, who is retiring in February 2019, for his many years of dedication. Dr. Bächlin has been instrumental to the company's financial success and ever-growing technical expertise.

We have also selected two of our projects to present to you. A speed limit of 30 km/h and a transformation of the roadway design of Zeppelinstraße were decided as the central mitigation measures of the Potsdam clean air plan. Our office had estimated that this measure would reduce NO_x levels to at least 25% of the additional load. Our second article reveals whether the minimization potential realized by the mitigation measures were in line with our predictions.

In the past few years, drones have been continuously optimized for practical applications and are already being employed in a variety of areas. The German Federal Highway Research Institute has considered the feasibility of using unmanned aircraft to measure air pollutants in the vicinity of traffic routes. You can learn more about the research project related to this topic in our final article.

I hope you find these topics interesting and I wish you all a joyful and peaceful Christmas season and a happy new year.

Yours sincerely

H. Grewe

WE WOULD LIKE TO THANK YOU FOR INTERESTING PROJECTS, INSPIRING DISCUSSIONS AND OUTSTANDING TRUST AND COOPERATION!

MERRY CHRISTMAS AND A HAPPY NEW YEAR!

BRIEF SUMMARY OF CURRENT NEWS

- In February 2019, Dr. Bächlin will be leaving his post of over 26 years as office manager at Lohmeyer Consulting Engineers to enjoy his well-deserved retirement. Dr. Flassak, who has been a research associate at Lohmeyer Consulting Engineers for 23 years, has been named his successor. He already started his new role on August 1, 2018.

- The next colloquium for traffic route air quality (Kolloquium Luftqualität an Straßen) will take place in Bergisch Gladbach from March 27–28, 2019. Lohmeyer Consulting Engineers will be represented at the colloquium with a lecture on "evaluating the impact of the forward projection of the Potsdam clean air plan 2015/2016" and with a poster on the topic of "testing the simplified NO/NO_2 conversion model according to Düring et al. (2011)."

- As part of a project, the Bavarian Environmental Agency (Bayerisches Landesamt für Umwelt, LfU) tested a retrofit kit (BNO_x system) for the reduction of nitrogen oxide emissions in EURO 5-class light duty diesel vehicles. The exhaust measurements showed a Real Driving Emissions (RDE) reduction of approx. 80% in NO_x emissions and approx. 70% in NO_2 emissions. The findings were presented at the "Clean air planning 2018" symposium organized by the Bavarian LfU on October 23, 2018 and have been published. More information on the topic of parts retrofitting for diesel vehicles can be found at www.adac.de/rund-ums-fahrzeug/abgas-diesel-fahrverbote/dieselkauf-abgasnorm/hardware-nachruestungen/ (in German).

CONTENT

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LOHMEYER CONSULTING ENGINEERS CELEBRATES 35 YEARS

This year, there was plenty of reason for celebration as our engineering office entered its 35th year.

The company was founded by Dr. Lohmeyer on April 1, 1983 in Karlsruhe with the purpose of providing consulting services in the areas of air quality management, climate and aerodynamics. At the end of May 1992, a second office was opened near Dresden in Radebeul, which has been under Dr. Düring's direction since 1999.

In 1996, a department for the development and sale of environmental software was set up, which introduced the PROKAS road network model as well as WinMISKAM, a Windows-based version of the microscale predictive flow and dispersion model MISKAM, amongst other things.

The most recent addition to our engineering office's portfolio was an odor measurement department in 2002. The odor measurement department has been approved nation-wide for the area "O-odors" in accordance with Section 29b of the German Federal Immission Control Act (BImSchG). Our testing laboratory has received accreditation from DAkkS (the national accreditation body for the Federal Republic of Germany) confirming our expertise in sampling and measuring emissions as well as measuring odor immissions and our compliance with the German standard DIN EN ISO/IEC 17025:2005.

In 2016, Dr. Lohmeyer turned over the company's direction to Mr. Lorentz, a long-time employee at the Radebeul office, followed by changes at the management level in Karlsruhe. In February 2019, Dr. Bächlin will be leaving his post of over 26 years as office manager at Lohmeyer Consulting Engineers to enjoy his well-deserved retirement, which is why Dr. Flassak already took over the direction of the Karlsruhe office in August of this year.

Our work comprises the areas of air quality management, climate, environmental software, measuring and CFD modeling.

Air quality management is divided into the subject areas of traffic, tunnel ventilation and industrial immission control. Our traffic department prepares expertises on road planning (controlled-access and federal highways, city streets, tunnels), clean air plans and – this year in particular – master plans. The focus lies on emissions and immissions modeling for nitrogen oxide, dust (PM10 and PM2.5), ammonia and nitrogen deposition. This also includes studies of immissions from deep sea and inland navigation as well as rail and air traffic.

In the area of tunnel ventilation, we design ventilation for underpass projects, test and adapt tunnel ventilation systems in existing road tunnels, take immission control into account in tunnel ventilation, create concepts for ventilating tunnels during construction and conduct special flow-technical inspections in tunnels.

Our industrial immission control team assesses the relevance of emissions and immissions produced by industrial, commercial and waste plants and animal housing for approval (on the basis of immission control law). In addition to those mentioned, pollutants such as heavy metals, bio-aerosols and odors are also part of the assessments. Odor emission measurements are conducted to identify emission sources and to provide input data for immission forecasts or to check compliance with emissions limitations. We also carry out on-site inspections to record existing odor levels.

The focus of our climate department lies on all key issues surrounding urban climatology and surveying the microclimate. These could be anything from statements on changes in wind fields to the effects of nocturnal drainage to thermal and wind comfort as well as shading from planned structures.

Based on our experience in technical modeling and aerodynamics, we also develop microscale and mesoscale prognostic wind field libraries.

We use CFD modeling (PHOENICS) for surveying airflow in tunnels and other enclosed spaces.

Our office is responsible for both developing and marketing user-friendly PC programs for use in the areas of immission and odor control/air quality as well as for environmentally sensitive traffic management systems (PROKAS^{online}) and systems for the calculation of air pollutant concentrations during and after accidental releases (SAMS). Our products include WinSTACC, GERDA II, RLuS, WinAUSTAL Pro, Profet and SELMA^{GIS}.

Pictured here are Mr. and Ms. Lohmeyer with all of the employees from both the Karlsruhe and Radebeul branch offices.

ZEPPELINSTRASSE FIELD TEST: ANALYSIS OF EFFECT OVER THE COURSE OF THE FORWARD PROJECTION OF THE POTSDAM CLEAN AIR PLAN 2015/2016

The transformation of the road design of Zeppelinstraße, previously a four-lane road, involved the introduction of a 30 km/h speed limit and was included as a central set of measures in the Potsdam clean air plan. Here is a description of the transformation of the traffic design: On the road leading out of the city, one driving lane was replaced by a bike lane; on some portions of the road leading into the city, trams, busses and cars share a single lane.

In December 2016, we shared **[1]** our emissions-related impact assessment of the reduction of the speed limit from 50 km/h to 30 km/h. The survey was able to demonstrate that the reduced speed limit on Zeppelinstraße can be expected to cut NO_x by approx. 12% on average across the entire surveyed road section (between Kastanienallee and Breite Straße) as well as by approx. 6% in the monitoring station area (between Nansenstraße and Geschwister-Scholl-Straße) **[2]**.

The above-mentioned set of measures was initially implemented in the form of a field test (introduction of new 30 km/h speed limit in July 2016; road marking for redesign of road space concluded in July 2017). The state capital of Potsdam commissioned our office together with SVU Dresden with a traffic and immissions-related investigation into the effects of the implemented set of measures. Amongst other things, this was achieved through a comparative analysis between the NO_x values at the Zeppelinstraße monitoring station before the implementation of the set of measures (zero case prognosis) and the values in two reference periods subsequent to the implementation of the measures. The first reference period (RP1) was in September 2017 and the second (RP2) in November and December of the same year. The measured data show a noticeable NO_x reduction in the two reference periods (see bars in **Fig. 1**).

However, the changes in the measured data have various causes and cannot be attributed to the actions taken alone **[3]**. In both reference periods, the traffic volume intentionally remained below that of the zero case prognosis by approx. 3000 vehicles. The modernization of the vehicle fleet also led to a reduction of the fleet emission factor. Furthermore, meteorological differences were observed in the periods examined (for the impact of wind, see lines in **Fig. 1**).

Previous evaluations indicated that all the changes taken together (reduction of ADT, fleet modernization, 30 km/h speed limit, redesign of street space management) led to an approximate 25% reduction in the additional NO_x load compared to the zero case prognosis - without taking altered wind conditions into consideration. MISKAM will enable us to make detailed microscale calculations to quantify the contribution of each individual impacting factor. These calculations also take into account changed traffic volume, fleet developments and the altered distance between the reading point and the road space with the heaviest emissions. This makes it possible to better estimate the singular impact of the speed limit and compare it with predictions. You can look forward to reading about the findings in one of the following issues.

References:

[1] News from Lohmeyer No. 36 December 2016: http://www.lohmeyer.de/de/system/files/content/download/hauszeitung/ausgabe36.pdf (in German)

[2] https://mlul.brandenburg.de/media_fast/4055/Bericht_Messfahrten_T30.pdf

[3] https://www.potsdam.de/sites/default/files/documents/2017-11-14_potsdam_evaluation_stand171114.pdf

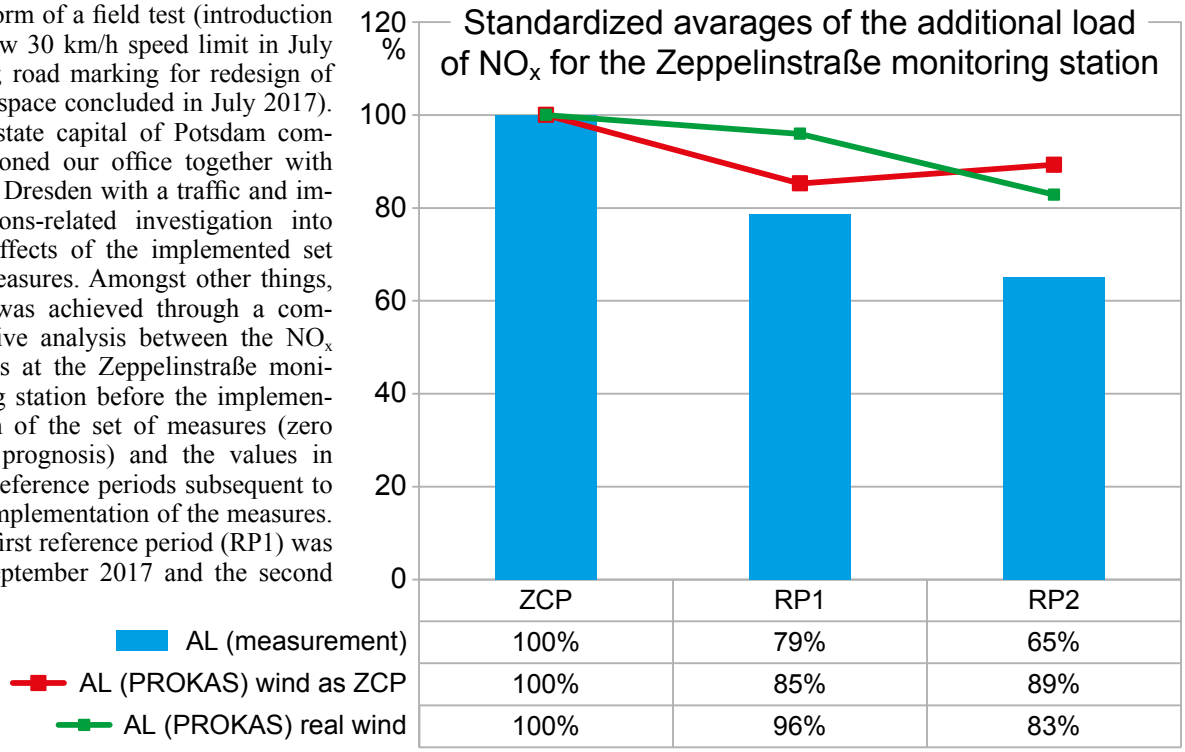

Fig. 1: Standardized averages of the additional load of NO_x for the Zeppelinstraße monitoring station. ZCP: zero case prognosis, AL: additional load of NO_x

STUDY OF TRAFFIC ROUTE AIR QUALITY USING AIR-BORNE EQUIPMENT

In a research project headed by the German Federal Highway Research Institute (BASt), our engineering office collaborated with the Fraunhofer Institute for Transportation and Infrastructure Systems (IVI), Airclip Service GmbH & Co. KG (Airclip) and the Leibnitz Institute for Tropospheric Research e.V. to research the possibilities and limits of using unmanned aircraft with equipment for monitoring air quality near traffic and issue recommendations for their standardized application.

Based on the project partners' experience and information from publications, the existing models of unmanned aircraft were evaluated in terms of applicability and suitability. The analysis included multicopters (see **Fig. 1**) from different manufacturers, ultralight helicopters, fixed-wing aircraft, airships and balloons. Suitability was assessed using the parameters of flight time/

Fig. 1: Octocopter

range, load capacity, 3D-positioning capabilities, boundary conditions of use, complexity of construction and deconstruction, footprint of the take-off area and safety zone, and the difficulty of procuring approval and a license to fly an unmanned aircraft.

The organizational and legal requirements for using unmanned aircraft to measure air pollutants were investigated in a separate work package. The official regulations in Germany's various states were compiled and outlined along with the regulations which apply nationwide. Additionally, the prevailing conditions near road, rail, water and air transportation routes were taken into consideration, and a differentiation was made between private use and research projects commissioned by public authorities.

Different light and compact sensory technologies for the qualitative and quantitative recording of air pollution parameters using unmanned aircraft were identified and compared. The pollutants NO, NO_2, ozone, PM10, PM2.5, PM1, particle number concentrations, carbon black and SO_2 were discussed and evaluated.

The suitability of unmanned aircraft was demonstrated in Germany by measurement flights along the A93 highway near Oberaudorf, the River Rhine near Duisburg and a stretch of rail tracks near Hof used by diesel-fueled engines. The multicopter HORUS was used as a carrier device with a range of different equipment assemblies in order to record the previously mentioned pollutants. As the measurements were taking place, data was collected at points in space at different heights above the ground or water surface.

Fig. 2 provides a good example of this process, as it depicts the particle number concentrations ranging between 9 nm and 2 µm as measured on the River Rhine with a temporal resolution of one second. Each passing ship is clearly reflected as a peak in particle number concentration. The background level of particle number concentrations is between 10,000 #/cm³ and 11,000 #/cm³ (# = number of particles). The concentration rises to 12,000 or even nearly 14,000 #/cm³ when a tanker and small cargo ship is sailing upstream. In the case of a container ship sailing downstream, the concentration increases much more substantially (up to 18,000 #/cm³). A tanker moving downstream generates a peak of up to approx. 14,000 #/cm³.

It should be noted that the peaks in concentration of ships sailing downstream are much slimmer than those of ships sailing upstream. This can be attributed to the shorter period of time necessary for the ship sailing downstream to pass, as well as a smaller exhaust plume expansion. Ships sailing upstream were notably further away from the drone.

The project has been concluded. The findings were published in the periodical "Bautechnik", issue 95 in October 2018.

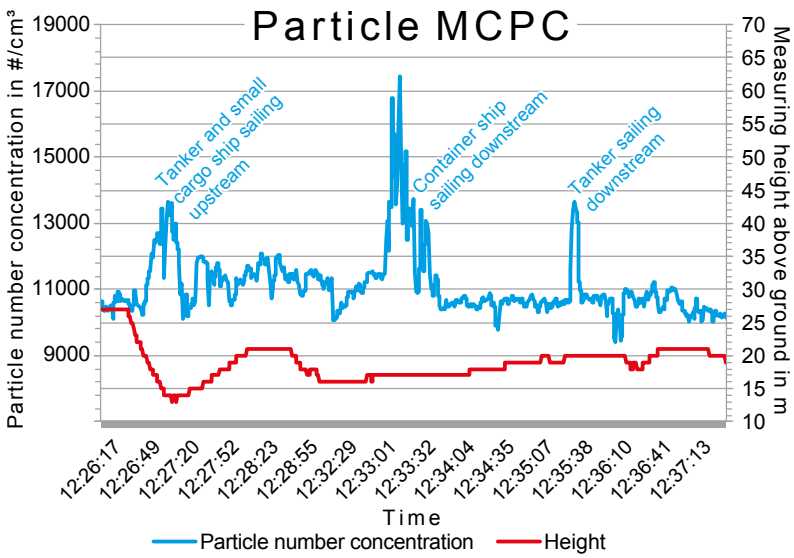

Fig. 2: Particle number concentration measured with the mixing condensation particle counter (MCPC) on the Rhine River ranging in size from 9 nm to 2 µm as well as the corresponding measuring heights in the given period of time