Mega Region Transport System for China (METRASYS)

Final Report -
Period under report 01.03.2009 – 31.08.2013

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18. abstract

The project METRASYS – Mega Region Transport System for China is one of ten projects funded by the German Federal Ministry of Education and Research as part of the scientific program "Research for Sustainable Development of the Mega Cities of Tomorrow – Energy and Climate Efficient Structures in Urban Growth Centres". With the topic of mobility and transportation in its focus, the project deals with one of the most exigent problems of current and future mega cities and metropolitan regions. The main objectives are to protect climate and to develop sustainable mobility in highly dynamic economic and urban regions with a widespread traffic management system. Experimentally, in close cooperation with the Chinese local partners, a comprehensive traffic management system was developed, implemented and applied for the city of Hefei, one of the numerous, and growing in number, 'second-tier' cities. Furthermore, the traffic management system was to be integrated into the overall city planning, transportation planning and transportation policy. This traffic management system is one part of sustainable planning process, including the Clean Development Mechanism as a method of the emission trade, for the development of sustainable mobility in Hefei. According to transportation experts, traffic management measures sum up to 15 to 25% of energy reduction compared to the current situation. In contrast to the optimization of vehicles, the effectiveness of traffic management systems is quite high. It is hoped that the findings from Hefei may be transferable to other cities worldwide. Through its modular design it is adaptable to other regions and open for future extensions. The large growth of Hefei enables a quick efficiency control of the novel systems to be implemented. It can easily be assessed in a convincing manner. A range of transport policies and measures has been identified in this project that has the potential to meet multiple goals for sustainability for Megacities of Tomorrow.

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18. Kurzfassung
Das Projekt METRASYS – Sustainable Mobility for Megacities ist eines von zehn Projekten, die durch das Bundesministerium für Bildung und Forschung (BMBF) im Rahmen des Förderschwerpunktes "Forschung für nachhaltige Entwicklung der Megastädte von morgen - Energie- und klimaeffiziente Strukturen in urbanen Wachstumszentren" gefördert werden. Es bearbeitet mit dem Bereich Mobilität und Verkehr eines der drängendsten Probleme in heutigen und zukünftigen Megastadt-Regionen. Ziele des Projekts METRASYS sind der Klimaschutz, eine nachhaltige Entwicklung und die Sicherung der Mobilität in hochdynamischen Wirtschaftsräumen. Beispielsweise wurde in enger Zusammenarbeit mit den chinesischen Partnern vor Ort, ein umfassendes Verkehrsmanagementsystem entwickelt und für die Stadt Hefei, einer der schnell wachsenden Städten, "Second-Tier“ – Städten, umgesetzt. Außerdem wurde das Verkehrsmanagementsystem in die Gesamtstadtplanung und in die Verkehrsplanung sowie in die Verkehrspolitik integriert. Die so erarbeiteten Ergebnisse sind die Grundlage für den Aufbau eines Verkehrsmanagements nach neuesten Erkenntnissen der Wissenschaft und für eine nachhaltige Stadt- und Verkehrsentwicklungsplanung unter Berücksichtigung der Finanzierbarkeit auch durch den Clean Development Mechanism (CDM), einer Methode des Emissions-handels. Die von der internationalen Fachwelt diskutierten Einsparungspotentiale von Verkehrsmanagementmaßnahmen liegen zwischen 15 % und 25 % zu dem derzeitigen Zustand. Gegenüber Optimierungen am Fahrzeug tritt die Wirkung bei Verkehrsmanagementsystemen relativ schnell ein; die Fahrzeugflotte wird unmittelbar und umfassend beeinflusst. Es ist davon auszugehen, dass die Ergebnisse der Untersuchungen in Hefei auf andere Städte weltweit anwendbar sind. Aufgrund des modularen Aufbaus ist das entwickelte Verkehrsmanagementsystem auch auf andere Städte übertragbar und zukünftige Erweiterungen des Systems sind möglich. Die starke Wachstumsdynamik von Hefei bietet eine schnelle Effizienzkontrolle der neu implementierten Systeme. Somit kann schnell eine umfassende und aussagekräftige Bilanz gezogen werden. Eine Reihe von verkehrspolitischen Maßnahmen wurde innerhalb des Projektes erkannt, die das Potenzial haben, den Zielen einer nachhaltigen Entwicklung von künftigen Megastädten gerecht zu werden.

19. Schlagwörter
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I. Short description / report

1. Topics / Task

The METRASYS project addresses the topic of mobility in Hefei, the provincial capital of Anhui Province in China and a second-tier city experiencing rapid urbanization, which, alongside many other second-tier cities, is a route to joining the growing ranks of Chinese mega cities. The main objectives are to protect climate and to develop sustainable mobility in highly dynamic economic and urban regions like Hefei. In close cooperation with the Chinese local partners, the German project partners are going to evaluate the current planning processes for the city and transportation development. Regular workshops, presentations and lectures provide a platform to develop and achieve a common understanding of the current panning situation in Hefei. Moreover, the cooperation of the German and Chinese partners is the basis for the further development of a traffic management system. This traffic management system is one part of sustainable planning process, including the Clean Development Mechanism (CDM) as a method of the emission trade, for the development of sustainable mobility in Hefei.
To this end, the Chinese and German project partners have worked out a series of topics during the project phase (2009-2013), those topics are:

- Energy efficiency and reduction of greenhouse emissions as well as sustainable urban mobility (This also includes the provision of secure, clean, affordable and low noise mobility as well as the accessibility to transportation.)
- Adaptation and/or development of new concepts and technologies which account for the different mobility needs of diverse users (user friendliness, acceptability) as well as for the socio-economic and regulative conditions (political and public awareness)
- Realization of effective and sustainable concepts as well as demonstration and implementation of technologies and measures in the traffic management center in Hefei
- Feasibility study of the Clean Development Mechanism (CDM) as alternative finance source for the traffic management systems and other measures aiming at an energy efficient traffic system
- Accompanying the planning processes of city development and transportation in Hefei and the region aiming at capacity building (political education, initiation of processes, institutions, participation in the transformation of the Chinese society)
- Transfer of transportation measures to other Chinese mega cities and worldwide for the increase of energy efficiency and for the reduction of negative environmental impacts of transportation.

The scientific objective of the METRASYS project was to gain comprehensive knowledge of energy efficient structures for the sustainable development of future mega cities. The gained knowledge is used to develop a strategy for the development of Hefei on its way to a future mega city. The project integrates different disciplines, e.g. spatial planning, transport science, engineering science and political science, in order to contribute to the mitigation of climate change and to the increase of energy efficiency.

2. Prerequisites

The successful finished Project METRASYS I - the orientation and planning phase (2006-2008) was based on a balanced, high profile consortium of Chinese and German experts from established institutions offering complementary skills to tackle the complex problem of sustainable urban development. On top of that, important Chinese decision-makers were involved in the project planning from early on in order to achieve the best possible results.

The excellent contacts the consortium has with decision makers in Hefei and in control amities is expressed by the founding of an "International Cooperation Base for Science and Technology of the Ministry of Science and Technology China(MOST)" and by funding commitments of the Chinese side. As one of the results of the pre-phase, the Ministry of Science and Technology (MOST) was co-financing ASEC (Research Center for Software Engineering Technology of Anhui Province) for the investigation in several technical solutions planned for METRASYS II. These actions underpinned the high acceptance of the project in China. Not to mention the successful project phase of METRASYS I.

Furthermore, one work package during the orientation and planning phase was the analysis of the political, social and economic conditions as well as a feasibility study of sustainable mobility concepts and technological solutions. Those were based on a close cooperation and knowledge exchange between the Chinese and German partners. Based on the technological potentials, an evaluation and assessment of technological solutions as well as organizational solutions, e.g. traffic management system, was conducted in this phase. In the second phase of the METRASYS project (2009-2013), the solutions were implemented.

3. Planning and process of the project

The METRASYS project addresses both planning and operational aspects of the transport sector, supported by the deployment of a sophisticated geographic information system and an advanced traffic management system. This setup not only allows for intelligent traffic management, but also feeds an emission and pollution dispersion model, which facilitates environmental evaluation and analysis. This in turn provides a valuable feedback loop, which sends data and analysis back into the transport and urban planning process. The output is further used to explore opportunities in climate finance providing additional incentives for sustainable transport development. These efforts contribute to a constructive and concrete stakeholder dialogue bringing together all relevant parties and thereby holistically addressing the challenges of sustainable mobility. The project work was distributed in four different working areas, each containing several work packages:

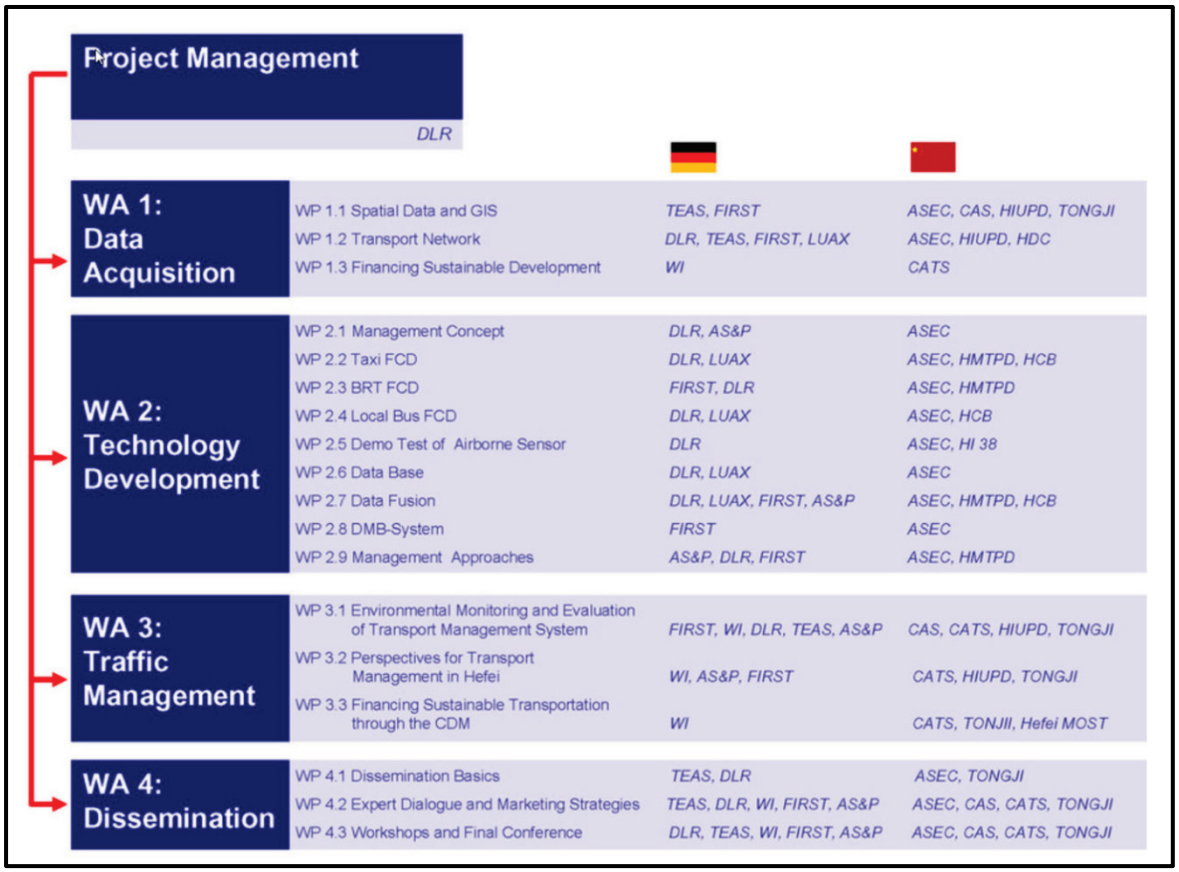


Figure 1: Work packages and allocation to the partners

WA 1: Data Acquisition and Set Up of a Geographic Information System (GIS)
Data on the traffic in Hefei as well as data on the land use and emissions were incorporated into the GIS. The validated data is the basis for the traffic management system, the emission modeling, and the assessment of the political and institutional framework for an alternative transportation system and its financing. Thus, the acquisition, provision and management of qualified, adequate, reliable and resilient data were crucial for the success of the METRASYS project. The GIS was used for the scenario development and assessment (WA 3). Work Area 1 was headed by TEAS and involved DLR, FIRST/FOKUS, WI, LUAX as well as the Chinese partners ASEC, CAS, BHUP, CATS, TONJI and BHT. For the abbreviations of the project-partners see chapter 4. Partners, page 7.

WA 2: Technology Development
DLR and LUAX developed a Floating Car Data-System (FCD) in cooperation with ASEC, DHTP and BHT. The system serves for the measurement of the traffic flows in Hefei. Taxis, busses and express busses were equipped with GPS responders and on-board units. Thus, a large-scale and dynamic measurement of the traffic flows in Hefei is possible. The equipped vehicles transmit their GPS position, time, speed and driving direction. On an aggregated level, the transmitted data provides an overview of the complete traffic situation in Hefei.

At first, the live data of the traffic flows in Hefei were transmitted to the traffic management center of the Hefei Municipal Traffic Police Department, the traffic control laboratory of ASEC and the Radio Anhui station. In a second step the incoming data was redistributed to all road users through Digital Media Broadcasting (DMB) and Variable Message Signs (VMS).

WA 3: Traffic Management and the Environment
After developing technologies in WA 2, the German and Chinese project partners evaluated the environmental impacts of the traffic management system in Hefei. For the assessment of the environmental and climate impacts of the traffic management system in Hefei, FIRST/FOKUS and the WI developed a traffic emission model and an air pollutants dispersion model. The Anhui CDM Technology Service Centre of the Anhui Productivity Promotion Centre (CDM Service Center), Hefei Environmental Monitoring Center and CAS collaborated in the development of those models. Furthermore, different scenarios were created and the emission impact of each scenario was calculated in the models. In conjunction with the scenarios, the feasibility of financing sustainable mobility through Clean Development Mechanism (CDM) was analyzed. The developed traffic management system is integrated into the general transportation planning and transportation policy scheme in Hefei, thus linking climate protection and energy efficiency with other governmental responsibilities.

WA 4: Dissemination
WA 4 focused primarily on public relations and includes activities aiming at the communication of the project as well as at the dissemination of project results via internet, flyers, presentations and papers. It also included marketing strategies as well as the dialogue with experts, the scientific community and the public. DLR, TEAS, AS&P and FIRST/FOKUS as well as ASEC, CAS, CATS and TONJI were responsible for WA 4.

The project consists of two phases, the orientation and planning phase (2006-2008) as well as the development and realization phase (2009-2013). The latter is distributed in four phases.

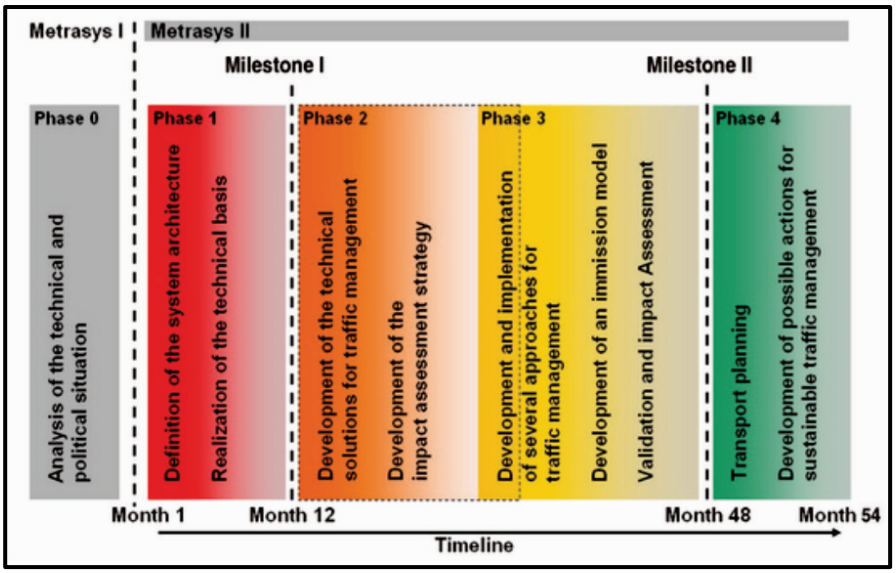


Figure 2 : Time line of the project METRASYS

4. Partners

The METRASYS project is headed by the Institute of Transportation Systems at the German Aerospace Center (DLR).

The further German project partners are:

Wuppertal Institute for Climate, Environment and Energy (WI),

AS&P - Albert Speer & Partner GmbH (AS&P),

Fraunhofer FIRST and from 2012 Fraunhofer FOKUS (FIRST/FOKUS),

Freie Universität Berlin (TEAS) and

LUAX Software Consultancy (LUAX).

The Chinese project partners are:

Research Centre for Software Engineering Technology (ASEC),

Chinese Academy of Transportation Science (CATS) Beijing,

Tongji University Shanghai (TONGJI),

Chinese Academy of Science (CAS),

Hefei City People's Government Hefei (City-Hefei).

5. Cooperation with other agencies

The METRASYS project aims at providing decision-makers with the means to effectively implement and efficiently guide sustainable transport in the city of Hefei. A comprehensive approach was devised and is being implemented in close cooperation with relevant Chinese stakeholders. The cooperation has yielded valuable insight into the development of Hefei and guided an evolving approach to integrate transport and urban planning with the support of local decision-makers. The project consortium is composed of highly relevant and specialized project partners all working on interrelated components geared at creating solutions and tools, which address Chinese circumstances and can be applied in a rapidly changing environment. For that reason, the project partners were chosen to bring a wide range of competences into the project.

On the local level of Hefei, the following partners are involved:
The Bureau of Hefei Science and Technology (BHST),
The Department of Hefei Traffic Police (DHTP),
The Bureau of Hefei Urban Planning (BHUP),
The Bureau of Hefei Transportation (BHT),
The Bureau of Hefei Environmental Protection (BHEP),
The School of Architecture and Urban Planning at Anhui University of Architecture,
The Department of Transportation Engineering at Nanjing University of Science & Technology
Southeast University

II. Comprehensive / Full description / Report

1. Deliverables of every working area

The progress documented in this chapter is a demonstration of the close cooperation between the German and Chinese partners and the excellent results such a close cooperation can lead to.

During the phase of the METRASYS project, several meetings and workshops took place in China and in Germany. Due to these meetings and due to excellent connections to China of the project team, a close relationship between national and local (Anhui province and the city of Hefei) institutions in China and METRASYS were built. The participation of all project partners, as well as Chinese politicians and decision-makers facilitated that good relations between project participants could be established and start-up problems could be solved. Impressive is also the participation of high-ranking city representatives in Anhui province and in Hefei, the government as well as the mayor of the city participated in the meetings, discussions and in the assignment of the studies. This underlines the importance of the projects approach.

METRASYS enjoys also a good reputation and strong support up to the ministerial level in China. As one of the most recent results of METRASYS I, the Ministry of Science and Technology (MOST) is co-financing ASEC for the investigation in several technical solutions planned for METRASYS II.

As a sign for recognition of the METRASYS project the bestowal of the „Science and Technology Award 2012"from the Anhui Provincial People's Government and from the Government of Hefei were given to the project coordinator DLR-TS for the excellent cooperation in the Project.

Following, the results of every working area will be reported shortly:

1.1. WA1: Data Acquisition / Setup GIS

This working area consists mainly of data collection and establishing a Geographic Information System (GIS). In particular, it was crucial to obtain data on the spatial structure, the emissions and the transport system of the study area Hefei. The validated data is the basis for the traffic management system, the immission modeling, and the assessment of the political and institutional framework for alternative transport system development and financing. Thus, the acquisition, provision and management of qualified, adequate, reliable and robust data were crucial for the success of the METRASYS project. The GIS has also been used for scenario development and assessment (see WA 3).

1.1.1. Spatial Data and GIS (Work Package 1.1)

The provision of spatial data and the configuration of a Geographic Information System (GIS) for the city of Hefei have been the main objectives of work package 1.1. The spatial information (residential areas, industrial zones, etc.) has been essential for the development of the emission dispersion model and transport model. In addition to data provided by our Chinese partners and

a satellite image analysis, further field work was conducted. The main results of the field work are ground control points for the adjustment of the satellite imagery as well as land use characteristics.

Set up of a geographic information system:
TEAS selected and used three different software and computer programs for the set up and application of the Geographic Information System. This system has formed the basis for a emission dispersion model and the transport model for Hefei.

The Chinese partners and TEAS use ArcGIS 9.3 developed by ESRI for the data preparation and visualization of all spatial data, which has been further processed in the METRASYS project. For a better provision of data within the project, the free and for every partner accessible programs ArcReader and ArcExplorer as well as open source software like QGIS have been selected.
In order to process the satellite images, TEAS has selected two remote sensing programs: ERDAS IMAGINE® 9.1 and Definiens Developer. ERDAS IMAGINE® allows simple spectral analysis. The possible applications of ERDAS IMAGINE® for the segmentation of satellite images and for the classification are however quite limited. Thus, TEAS purchased two licenses for the Definiens Developer software. In contrast to ERDAS IMAGE®, Definiens Developer allows for high-performance processing of high-resolution satellite images and for expeditious object-based image analysis (see also 2.1.1.2 for further explanations).

During the first kick-off meeting in Hefei in June 2009, TEAS introduced a proposal for the structure of the GIS. The proposal was discussed in depth among the project partners. The proposal primarily comprises of two priorities for the provision of data (see Figure 3):
Data collection, processing and provision of data for the transport model;

- Data collection, processing and provision of data for the 3-layer pollutant dispersion model.

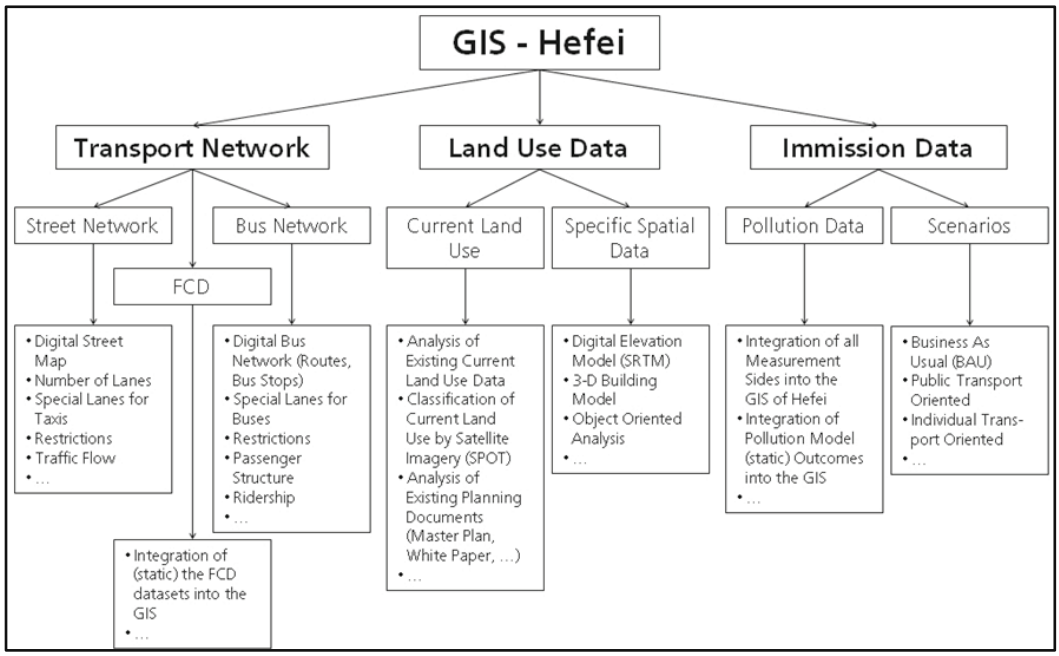


Figure 3: Design of the Geographic Information System (GIS); source: TEAS

TEAS adapted the structure of the GIS. The structure was discussed among all project partners and finally agreed.
The following GIS-Layers are currently available:
Border layer (China frontier, province border, Hefei city expansion border, Hefei municipality border),

- Traffic layer (bus lines, city roads, expressways, railways, airport, waterways),
- Historical data of Hefei's urban development provided by Prof. Dr. Chu (an analyzed planning document from 1945 till 2005),
- Digital Elevation Models (ASTER DEM, SRTM DEM),
- Officially published maps of Hefei and the Anhui Province (city map of Hefei, traffic map of the Anhui Province, etc.),
- Planning maps (city development, transportation, public transport, etc.),
- SPOT satellite image (year: 2009, solution: 2,5 m),
- Landsat satellite images (years: 1989, 1995, 1999, 2001, 2003, 2006, 2008 solution: 30m),
- Urban growth of Hefei layers (years: 1949, 1978, 1989, 1995, 1999, 2001, 2003, 2006, 2009),
- Land use data
    - Current land use from 1989 until 2006 (classification of Landsat satellite images) and 2009 (classification of a SPOT satellite image),
    - Specific land use data for the dispersion model (five classes, 500*500m grid),
- Climate stations in Hefei and in Anhui Province.

In a subsequent step, TEAS analysed and visualised the results of the household survey and the floating car data in close cooperation with DLR, LUAX and WI. The results of this analysis have been added to the GIS. The data is thus available for all project partners.

Current land use:
TEAS and the Anhui University of Architecture, Institute of Architecture & Urban Planning cooperated closely on the collection of current land use data. The collected database serves as an input for the development of the transport model. The current land use data are also input parameters for the emission dispersion model. All data have been provided to the project partners. All data were then added to the Geographical Information System without encountering any problems.

TEAS contacted Prof. Dr. Chu from the Anhui University of Architecture, Institute of Architecture & Urban Planning, and invited him as local partner in the project. In June and September 2009, two workshops on Geographic Information Systems were held together with Prof. Dr. Chu. Both took place in Hefei. Prof. Dr. Chu is an expert on the historical and current urban development of Hefei. He provided substantial GIS data of Hefei's urban development. The data set contains information from the early 1950s onwards and was provided free-of-charge to the METRASYS project.

TEAS collected data on the current land use in different ways. Initially, historic and current planning documents were analyzed, digitized and incorporated into the GIS. Next, TEAS classified land uses on different satellite images. The analysis and processing of the planning documents was conducted in close cooperation with Prof. Dr. Chu working group. He provided land use data of Hefei from different time periods. In addition to the historic land use data,

TEAS incorporated current land use documents into the GIS. The Hefei Institute of Urban Planning and Design provided the current land use documents.

At first, the classification of land use was conducted on free Landsat satellite images. Later, a current SPOT satellite image was used for the land use classification. Applying the ERDAS IMAGINE® 9.1 software, the analysis of the current land use on the Landsat satellite images was conducted by means of an unsupervised 8-class classification and by means of a supervised classification. In the case of the supervised classification, four land use classes were classified for all satellite images (see data DVD).

The following step efforts have been on the analysis of SPOT satellite images taken on January 27th, 2009. Applying different methods (Fuzzy-Classification, Maximum Likelihood etc.), the supervised classification of the SPOT image was conducted with 15 classes, which were later reduced to 9 classes.

Classifying the land use through the application of the ERDAS IMAGINE® 9.1 software, the objects (buildings, streets, green areas etc.) on the satellite images could not be identified properly. Generally, the ERDAS IMAGINE® 9.1 software conducts the classification on the basis of pixels of the satellite image. Hardly any distinction is possible between different types of land uses (buildings, streets, green areas etc.) because the classification is based on the spectral characteristics and not on the geometrical forms. Additionally, the resolution of the SPOT satellite image is insufficient. Therefore, it was difficult to extract clear edges and thus assign pixels to a distinctive object.

To solve this problem, TEAS used the remote sensing software Definiens Developer. This software facilitates the identification and classification of objects on the basis of their geometrical structure. In order to do so, it is necessary that the user assembles its own algorithms. All in all, the self-constructed algorithms improve the land use classification considerably. With the help of the spot image, TEAS developed different analysis algorithms. They provide more detailed information for the emission and pollution dispersion model.

Specific land use attributes:
The primary objective of work package 1.1.3 was the data collection of specific spatial land use attributes for the emission and pollution dispersion model. It includes the provision of an elevation model, the calculation of the building height and the classification of specific land uses.

During the stay in Hefei in June and September 2009, TEAS and FIRST/FOKUS discussed data requirements with the Hefei Institute of Urban Planning and Design (HIUPD) and other Chinese project partners in the context of several workshops. The topic of data collection was further discussed among the project partners. Additionally, TEAS and FIRST/FOKUS met in Berlin in September 2009 and agreed on the required input data for the dispersion model and generated a catalogue of required data and the specific land use classes.

For the dispersion model, TEAS processes land use data (see data DVD). The data corresponds to the resolution of the calculated grid that is composed of 500 to 500 meter cells. For the calculation of the model, TEAS provided the data to FIRST/FOKUS. The basis of the specific land use classes is the purchased SPOT satellite image and the Landsat satellite image of 2006. Five land use classes were distinguished. For each cell, the percentage of each land use class on the total area of the cell is calculated. The five land use classes are as follows:

- Fallow land, grassland, acres and other agricultural land,
- Fruit-growing and forest land,
- Areas with low density of development and suburbs,
- Closed core areas, downtown areas and industrial land,
- Water surfaces and mudflat area.

TEAS incorporated SRTM and ASTER elevation models of Hefei into the GIS. For the calculation of the dispersion model, the GIS layer was provided to FIRST/FOKUS.

Pollution Measurements:
Methods and technical equipment to measure pollution concentrations and meteorological parameters were discussed in depth with Chinese partners at project meetings, visits of project staff, to China and via email, in particular, with Anhui Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences (CAS). The Chinese partners proposed a number of technologies available to them, which could potentially be applied in the context of the project. Further adjustments took place on the characteristics of measured parameters (e.g. temporal and spatial resolution) and possible application domains of the data gathered data.

The measured data give values in measuring points at or near the surface or aggregated (summed up) over vertical columns characteristics (cf. measurement methods available at CAS, interim report of METRASYS 2009). Simulation with the transport and chemistry model is performed in a 500*500 m resolution. Consequently, the results of these simulation runs are a three dimensional array of simulation results representing mean values of specific spatial boxes (pollution concentrations, temperature, etc.). These two types of data cannot be readily compared. The analysis requires a post processing of values. The possibility to perform mobile measurements is preferential, also with respect to measurements according to wind direction (downwind or leeward). The application of these additional mobile measurements is under discussion between FIRST/FOKUS, ASEC and CAS.

ASEC provided Immission data for SO_2 and NO_X in four locations in the area of Hefei: SanLiJie, HuPoShanZhuang, MingZhu and DongPu. These measuring points are situated at different locations around the city center of Hefei and thus will allow estimation of simulation results for different wind directions. ASEC was the contact point for provision of these data for the selected analysis periods.

FIRST/FOKUS closely cooperated with ASEC and CAS on the data gathering for the emission model. ASEC facilitated the implementation of gathering additional climate data that is not readily available in Hefei. CAS Institute of Optics undertook several balloon measurements to gather data on the vertical atmospheric profile and measurements of particular carbon species.

Satellite data acquisition and analysis:
TEAS screened fee-based image archives of satellite images with a higher resolution. Finally, TEAS purchased a satellite image from the French company Spot Images S.A. The satellite image was taken on January 27th, 2009. It originates from the SPOT 5 satellite and has a resolution of 2.5 meters on all channels. Since the image was taken during the winter period, the low altitude of the sun results in many shades of the buildings. Thus, the satellite image is only partially applicable for analysis. However, a preliminary analysis was possible with this satellite image. The acquisition of ground control points notably increased the quality of the analysis.

In addition, TEAS ordered a KOMPSAT 2 satellite image of 2010 with a pixel resolution of 1 meter. Due to the delayed start of the METRASYS project, the order of a satellite image for the summer of 2009 was too late. The provider of the KOMPSAT 2 satellite image was also not able to confirm later orders due to a high demand for satellite images and weather conditions in Hefei. The image could not be delivered. The land use information was conducted based on a field campaign in 2011.

Evaluation of land use data:
During field trips to Hefei in September 2009 and June 2010, TEAS evaluated a first set of the classified land use data. The collected land use data are characterized by high position accuracy. TEAS evaluated the final land use data set in a second step on a field campaign in 2012.

1.1.2. Transport Network (Work Package 1.2)

This work package aims to establish the data basis for the all transport network related activities. This data is the basis most technology developments in WP 2 as well as for analysis and impact assessments in WP3.

Street network and its Attribute:
The acquisition of a useful digital street map of Hefei was a big challenge for the METRASYS project. Based on available digital online maps such as Google Maps (http://maps.google.com/) or Open Streetmap (http://www.openstreetmap.org/), a first street map was developed for the METRASYS project.

It is crucial that the same digital street map will be used for all different software modules. This is the only way to guarantee that all modules will fit together. However, the parameters, which have to be part of a digital street map for the calculation of optimal results, are different from module to module. In Table 1, the most important parameters of a street map are listed. Not all parameters are available from local partners, but a number of them could have been extracted from the floating car data (FCD).

Table 1: Attributes of the digital street map

Number	Parameter	Unit	Notes
1	Geo coordinates	WGS84	
2	Length of a segment	Meter	
3	Driving direction	-	Orientation
4	Number of carriageways	-	
5	Number of lanes	-	
6	Width of street	Centimetre	
7	Center line	-	
8	Slope	Percent	
9	Center line object	-	
10	Category of the area beside the road	Classification	Information about buildings or natural cover
11	Position, size and shape of	-	Bridges, sign

	objects above the street		
12	Allowed speed	Km/h	
13	Statistical mean of the driven speed	Km/h	
14	Street category	Classification	
15	Elevation over the area	Meter	Elevated Roads
16	Restrictions at intersections	-	
17	Street name	-	
18	Affiliation of street to transport cell	-	
19	Lane sharing with public transport	-	Busses, city rail, BRT.

This map is incomplete, but nevertheless it is useful for the development and the progress of the current tasks of the project. High-resolution satellite data and floating car data are used to complement this rough map step by step over the course of the project. A comparison of the attributes of the different network versions is shown in Table 2.

Table 2: Comparison of the Hefei Road Network between 2009 and 2011

Important attributes for the project work	**Old Version-2009**	**New Version-2011**
Number of Edges	11089	16663
Length	Available	Available
Road name	Available	Available
Longitude of the edge	Longitude of the center point	Longitude of the START_POINT and END_POINT
Latitude of edge	Latitude of the center point	Latitude of the START_POINT and END_POINT
District	Not available	Available
Street type	4 classes according to the "SPEED_LIMIT" (20, 40, 60, 80)	9 classes (0-8) according to the type of road grading
Direction of the Street	Only 1 possible direction	4 possible directions (closed, one-way, one-way opposite, both directions)
Number of lanes	Not available	Available
Road-shape	Not available	12 possible road-shapes

Bus Network:
In accordance with the tasks of WP 2.4 "floating car data and local bus system" the work of this task started with collecting detailed information about the bus network. For the use of the results see also chapter 1.2.4.

Conversion and interpretation of Floating Car Data (FCD):
The goal of this task was to calculate the number of cars (traffic volume) for each link (street section) based on the measured travel speed via FCD. The calculated number of cars would be used later within the emission model.

DLR developed a mathematical model based on the Van Aerde model, which was implemented by ASEC at the server system in Hefei, so the processing chain from the averages of speed to the traffic volume was up and running automatically. A handover to the immission model was implemented. The results were evaluated by comparison with measured data. Finally, the possibility to visualize traffic Volumes calculated from FCD was implemented in the METRASYS Traffic Viewer Software. A screenshot is shown in Figure 4.

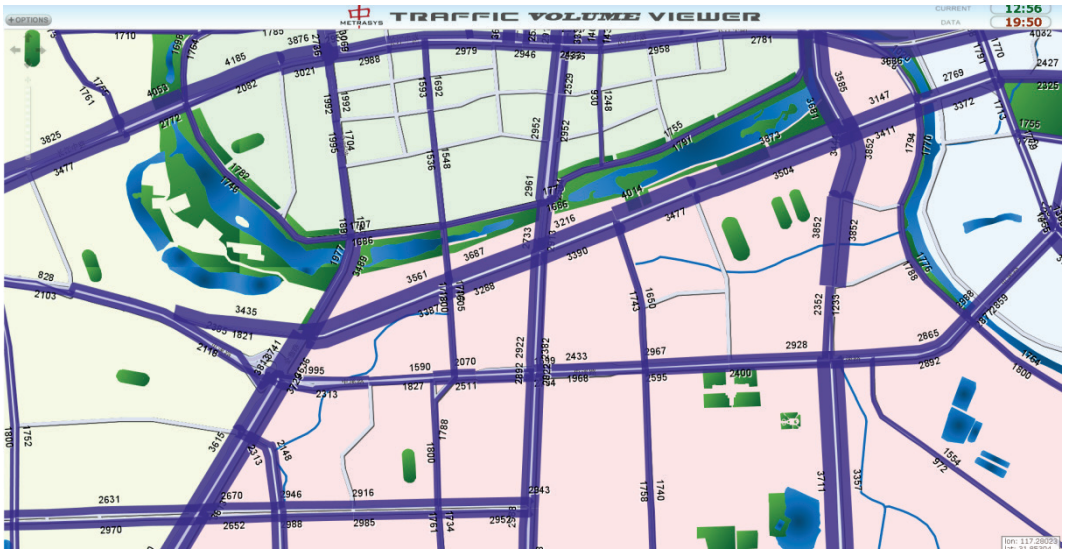


Figure 4: Traffic Volumes online in METRASYS Traffic Viewer (Vehicles / hour)

1.1.3. Financing Sustainable Transport (Work Package 1.3)

This work package assessed the institutional framework for transportation system development and finance in Hefei. It is based on the knowledge generated in the first phase of the METRASYS project, summarized also in the master thesis by Adriana Vivan de Souza (in particular the chapters on the political and planning framework as well as on the administrative structures). The WI undertook a detailed review of the institutional set-up and decision-making structures for urban transport development in China. Starting with the administrative reform in April 2008, the review focuses mainly on the analysis of the current local situation in Hefei (task 1.3.1), whereas the pre-phase focused on Jiading district in Shanghai. The analysis is largely based on a literature review and discussions with local experts from CATS and Tongji University. It also draws on the interviews conducted for task 1.3.2 (see below). Findings were communicated to the METRASYS project team during several meetings with the city government and in a report "Transportation policy and decision-making in Hefei" (Beckmann /Liang 2009). The analysis revealed inter alia that Hefei pursues a multi-departmental approach to coordinating the responsibilities in the urban transport sector. The main institutions in charge

of urban transport in Hefei are the Planning Bureau (BHUP), the Transport Bureau (formerly the Municipal Ministry of Communications) (BHT), the Public Security Bureau, the Construction Commission and Environmental Protection Bureau (BHEP) (see Figure 5; the Construction Commission is omitted in the below figure because infrastructure construction is approached in the METRASYS project as a consequence of transport planning decisions and the Construction Commission is therefore not one of the main partners).

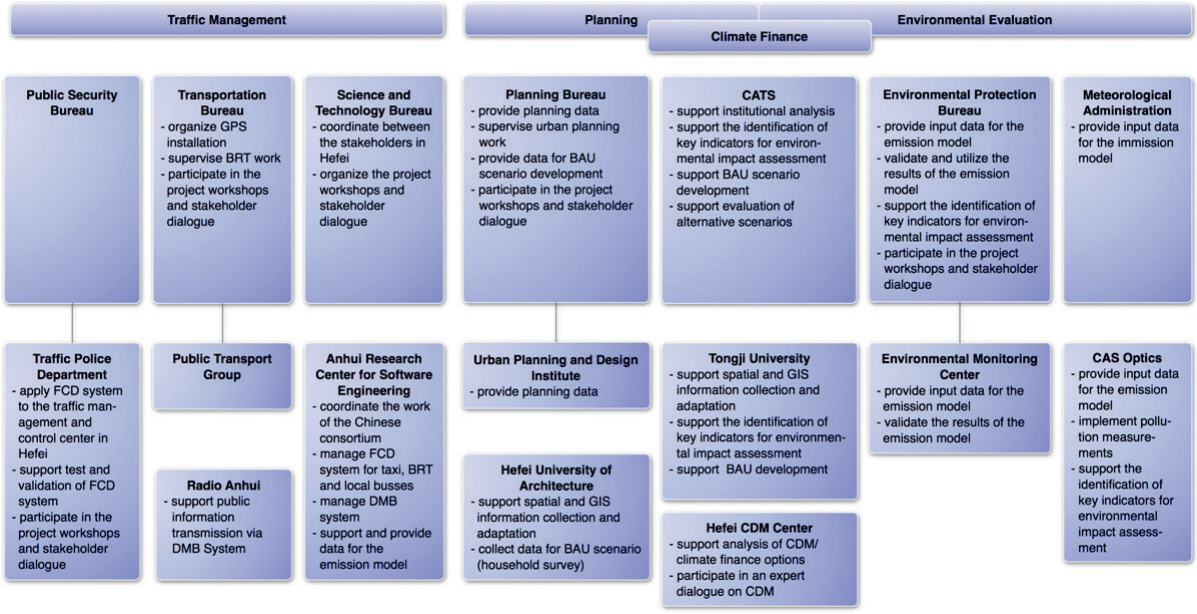


Figure 5: Overview of Chinese partners and their responsibilities, grouped by main activity in METRASYS, i.e. traffic management, transport and urban planning, environmental evaluation of transport impacts or climate finance.

The WI developed a second paper on "Financing urban transport in China – a case study of Hefei" (Beckmann/Liang 2009) (task 1.3.2). During a field trip to Hefei in September 2009 and parallel to the second METRASYS Workshop on Sustainable Transport and Urban Planning, semi-structured interviews were conducted with representatives of Hefei Planning Bureau (BHUP), Hefei Construction Commission, Hefei Municipal Bureau of Finance, Hefei Environmental Monitoring Center (BHEP), Hefei Construction Investment and Holding Co. Ltd. and Hefei Public Transport Group Co. Ltd. as well as academic experts from Anhui University of Architecture, Hefei City Planning and Design Institute, Hefei University of Technology and Tongji University. In addition, interviews were conducted with representatives of the World Bank Transport Department and the GTZ (German Technical Cooperation) to find out about international finance for urban transport development in China. Work on tasks 1.3.1 and 1.3.2 were strongly supported by Prof. Gu from Tongji University, Dr. Jiang Yulin from CATS and Prof. Fang from ASEC. Ms. Yan from the Hefei Planning Bureau (BHUP) helped the partners to contact the Hefei Construction Investment and Holding Co., Ltd., which supported the gathering of crucial data on urban transport finance in Hefei. Mr. Yao from Hefei City Planning and Design Institute provided valuable information on Hefei's transport sector including urban planning documents. Mr. Zheng of Hefei Public Transport Group Co. Ltd also provided information on urban transport in Hefei.

Urban transport in China is primarily financed by local governments with some support from the Central Government. In most Chinese cities, funds collected through land leasing and loans

from policy banks are the main sources for financing urban infrastructure. Other sources include government revenue, ticket fees, issuing urban construction bonds, transferring exclusive rights and rights to operate assets, or direct investments of companies. In Hefei, most transport infrastructure investments are handled through the Hefei Construction Investment and Holding Co Ltd. – a non-governmental body set up under the municipal government. Funding for public transport, however, falls short of what is required. In Hefei, less than 0.2 % of its GDP are invested in public transport. Public transport is exclusively operated by Hefei Public Transport Group. Fuel prices account for 40 % of operational costs and are bound to rise. Before 2006, the company had to bear the full burden of vehicle purchases and station construction, which lead to soaring debt levels. Since 2006, much of the burden was shifted to the Hefei Construction Investment and Holding Co Ltd. Ticket fees are a main source of income for the Public Transport Group. However, prices are set by the city government and public transport pricing is subject to regulations set out by the Chinese Pricing Management System. The price for a bus ticket was set at 1 RMB/person/ride in 1997 and has not changed since. As fuel prices have increased alongside other operating costs, subsidies have had to be raised to cover for the financial losses. Underfunding of public transport remains an issue in Hefei; new and additional finance sources are needed.

In reaction to the first interim evaluation, which asked to extend the consideration of innovative financial mechanisms beyond the Clean Development Mechanism (CDM), the Wuppertal Institute assessed commonly used financial instruments for their applicability at the local level in China, namely: vehicle taxes; fuel taxes; road pricing, including congestion charging and parking pricing.

A SWOT analysis showed that vehicle and fuel taxes could not be used to alleviate Hefei's current situation. In China, vehicle and fuel taxes accrue to the national budget and Hefei city government has no influence on their design. Road pricing on the other hand is a generally effective tool that can be designed to meet local requirements. Nonetheless, optimal design is not easily achieved and road-pricing systems, including congestion charging, can be very expensive as well as politically challenging. If public vehicles were exempted from road pricing, the effectiveness of the entire system could be jeopardized. However, in general terms the planning bureau showed genuine interest in this measure in the discussions during a workshop in 2012 and they confirmed that road-pricing may eventually appear on the political agenda, when congestion reduction is more eminent.

Parking pricing is the financial instrument that appears most feasible and easy to implement at the local level. Revenues from parking could be earmarked for public or non-motorized transport developments. Parking pricing (as well as road pricing) systems could be based on the intelligent transport system developed in the METRASYS project.

Evaluation of transport network data:
It is important that all different software modules are based on the same digital street map. This is the only way to guarantee that all modules will fit together. Due to limitations in the transport modelling software, the original street network had to be reduced to a generalized version, which contains only the main roads. After the major update of the street network in 2011 this was the second major revision of the road network. All necessary parameters for the data exchange of transport model and emission model have been available after the second revision.

1.2. WA2: Technology Development

Working Area 2 "Technology Development" contains all technically oriented work packages and started with the beginning of the project. An intelligent transportation system (ITS) for traffic management was developed and implemented in this working area. With the development of the FCD system and the DMB technology the first tasks set up the technical base of all following studies.

The work in the work package 2.5 "Demo Test of Airborne Sensor" was revised in coordination with the BMBF during the project time. Because of political and technical conditions there was no possibility to realize an Airborne Sensor. Based on the Chinese partner's request, a new work package "Intersection Monitoring" was created, on which the research work focused in the year 2012.

1.2.1. Management Concept (Work Package 2.1)

To develop a traffic management concept several workshops with all relevant agencies were held in a first step. In numerous presentations, the contents, the positions and the technological requirements were presented in detail. In total, there were 13 lectures given in a series of 9 events. During the workshops available technologies and possible approaches for traffic planning and traffic control were discussed. A holistic concept was developed and the procedures of the project were concretized.

The project proposal, including the work package description and the time, were the basis of the „Technical Work Plan". These documents were compared with the results of the Development of a „Traffic Management Concept". In this process significant changes compared to the original planning were documented only at two points:

- The work in the work package "Demo Test of Airborne Sensor"(WP2.5) was modified, DLR and the Chinese partners have decided to put the effort on another important traffic monitoring work, the intersection monitoring.
- Plans related to city planning were brought forward at the request of the Chinese partners, which considered a change in the operating schedule as essential (WP2.9).

None of these two changes affected the work plan or the project plan adversely.

1.2.2. Taxi Floating Car Data ((Work Package 2.2)

One of the first steps in METRASYS project was the development and implementation of an up-to-date traffic management system including traffic data collection and digital multimedia broad cast of traffic information for traffic operators, travelers and drivers.

The operational traffic management is based on a closed loop driver information system. In the first step the current traffic situation is detected with floating cars. At the beginning of the project the Chinese partner ASEC could convince a private operated taxi company to participate in the project. Beyond that the ASEC also invested the finance for the equipment of 600 taxis with GPS receivers. By the engagement of ASEC the traffic police of Hefei provided additional 200 police cars. The government of Hefei valued this engagement highly by authorizing the equipment of 1200 construction vehicles with analogous GPS receivers. In the end of the project all in Hefei operated taxis (7000 Taxis) are linked to the METRASYS system. The FCD software system for data collection, map matching, routing, and data fusion is installed on a server in

Hefei at the traffic police commando center. This server is also linked to the radio station of Anhui Radio were the DAB sender for the broadcasting of the information is located. At the police station a workstation is located; at this terminal special traffic information (for example accidents, incidents, events, weather- and congestion information) can be compiled by policemen. This information together with the traffic service derived from the FCD travel speed are subsequently encoded in the TPEG standard and broadcast by Radio Anhui through Digital Multimedia Broadcasting (DMB).

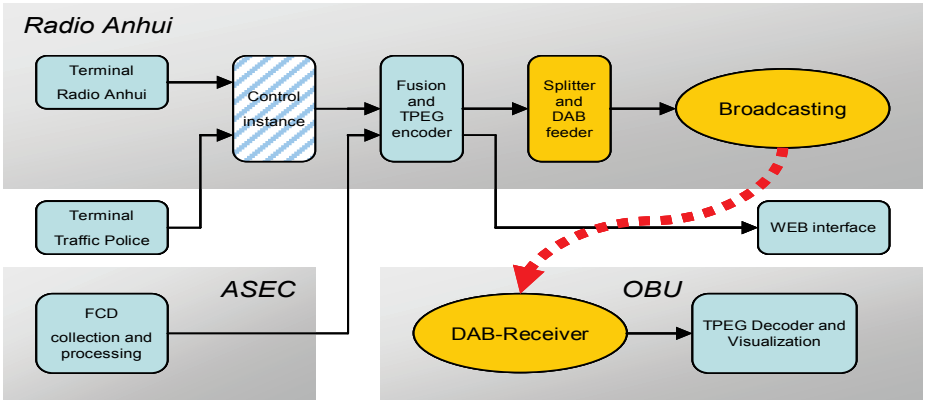


Figure 6: METRASYS service chain using DMB and TPEG-standard

1.2.3. BRT Floating Car Data (Work Package 2.3)

Work package 2.3 was mainly conducted by ASEC. Bus Rapid Transit (BRT) as a quick, safe, comfortable, convenient, large-capacity and low-cost public transport has been built at Huizhou Road in Hefei, and has entered the stage of trial operation. The data of the BRT system is linked to the METRASYS open data platform.

1.2.4. Local Bus Floating Car Data (Work Package 2.4)

To further enhance intelligent transportation construction in Hefei city, in April 2010, the second stage of intelligent transportation project was planned. The stage II project involves traffic information collection, traffic signal control, intelligent bus transit system, supervision system for transportation industry and monitoring center for taxis. Due to the fruitful result and significant effect of the METRASYS project, Hefei government invites us to provide technical solution. This documentation is completed with the consultation of DLR experts. The implementation work was carried out in September 2010.
The designed scope mainly includes following contents:

1. The infrastructure of bus transit data center and dispatch center, including network and storage architecture.
2. System Security Design
3. On-vehicle device and control system
4. Bus stop information system
5. Operation Dispatch and Surveillance
6. Management System
7. Electronic Bus Stop Information Board

The technical concept and the system architecture for local bus FCD are developed by ASEC in cooperation with DLR. The technical realization and the implementation are done by ASEC in

2010. Equal to BRT FCD, the data of the local bus system is linked to the METRASYS open data platform.

1.2.5. Intersection Monitoring (Work Package 2.5)

The work in the work package "Demo Test of Airborne Sensor"was modified, due to the lack of flight-opportunities in the Chinese airspace, which is heavily controlled by Chinese military. After thoughtful discussions with the consideration of the critical traffic issues in Hefei, the DLR and the Chinese partners have decided to put the effort on another important traffic monitoring work called "Intersection Monitoring" using stationary video cameras. Aim of this work package was to analyze an intersection by collecting traffic related data over a long term period (3-6 months) to study the behavior of the different means of transport.

In the WP "Intersection Monitoring", a test intersection Tianzhi-Huangshan Road, which locates in the ITS test field of the Chinese partner ASEC in Hefei, has been equipped with a camera (see Figure 7). Moreover, a Chinese camera manufacturer was chosen to produce the respective camera so that the transfer of such technology to other intersections in China is ensured. This camera was prepared and calibrated for application by the optical laboratory at DLR-TS prior to the final installation. ASEC has obtained the permission for installing the camera at the roof of the building next to the intersection. The data connections between ASEC's development laboratory and the camera as well as the remote connection to DLR in Germany have been carried out well. All participants have now the access to the data. DLR has further developed this system and executed the corresponding final calibration. The system was brought in operational state at the end of 2012, when the first results were already analyzed as well. The smooth progress of the installation process significantly pointed out the good cooperation between the German and Chinese partners.

Figure 7: Tianzhi-Huangshan Road in Hefei: left: Camera view showing the detected vehicles; right: bird's view on the intersection (©GoogleMaps)

The main features of the "Intersection Monitoring System" are:

- Macroscopic and microscopic traffic detection:
  Detection, counting and classification of traffic objects, derivation of macroscopic traffic parameters (e.g. distributions of average velocities, direction-specific traffic flows, journey times) and microscopic traffic parameters (e.g. traffic object classes, loss times, distances, relative velocities, vehicle delays) (Figure 8),
- Tracking (Trajectory determination and prediction): the kinematic parameters (position, velocity, acceleration) of traffic objects are measured and predicted (Figure 8),

- Traffic safety detection: surrogate safety measures, i.e. parameters of the traffic conflict technique, are measured: time to collision (TTC), post encroachment time (PET), collision probability (Figure 9),
- Situation assessment and incident detection: traffic incidents, such as near misses and accidents can be detected by automatically by the derived surrogate safety measures,
- Determination of further parameters: for enforcement reasons red light violations and infrastructure violations can be measured if databases for traffic light control are available and connected to the system,
- Data recording: the system is connected to a database, where all trajectories are stored. Further, incident data are stored as compressed videos to enable a second analysis

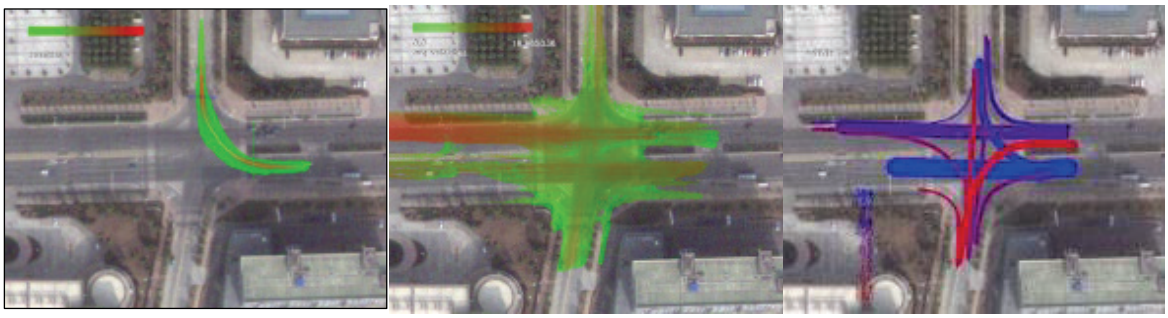


Figure 8: Visualizations of traffic parameters and trajectories of Tianzhi-Huangshan Road in Hefei: left: route distribution for left turning vehicles, middle: velocity distribution, number of detected vehicles per traffic relation (©GoogleMaps)

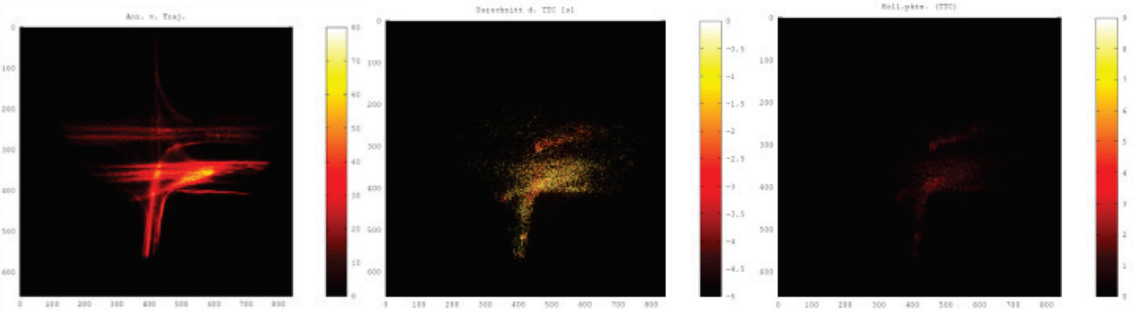


Figure 9: Visualizations of critical parameters of Tianzhi-Huangshan Road in Hefei: left: trajectories of normal and critical situations; middle: positions of low TTC values; right: conflict points (©GoogleMaps)

1.2.6. Data Base (Work Package 2.6)

In a first approach the data base concept for the floating car data was defined. This concept can be extended by modules in the case that METRASYS gets more different data sources. In addition to the ASEC Database, the team created a second database on a METRASYS Server, located in the ASEC facility in Hefei. This database can be managed and controlled by the German partners via remote connection. The METRASYS database grants access to the digital street network of Hefei, the current Floating Car Data and saves all created traffic massages in the TPEG format and the data of the Intersection Monitoring System. Also tables for historical data with support by ASEC are in progress. Direct access to this data are useful for validations, research and student studies.

ASEC was supporting the work of DLR regarding the implementation of the data base concept. In addition to that ASEC was providing the remote connection to the data base for DLR.

1.2.7. Data Fusion (Work Package 2.7)

The DLR and LUAX developed a new predicting model for routing relevant travel speed information. This method uses averaged historical FCD, sorted in weekdays and daytime sequences. According to the time distance of the target forecast time, the current travel speeds are weighted and then fused with the historical data of the target time sequence.
These algorithms are implemented for the traffic viewer applications routing functionalities. Also an additional functionality for routings on an editable weekday and daytime are possible. In order to permit a better utilization for Chinese users and to offer a possibility to validate the "Traffic Viewer" (also version of the OBU) software applications for the Chinese partners, the implementations have been translated into Chinese language. With the target to carry sustainability, the maintenance for the METRASYS web application has to be minimized. To assure this, the web application system, consisting of web server software, the METRASYS database, the "Traffic Viewer Online" application and some java scripts for handling the data exchange, has to start up automatically by booting up the server.

Figure 10: Traffic Viewer Online and OBU Traffic Viewer - Chinese Version, source: METRASYS

The task of WP2.7.12 and 2.7.13 was to set up a variable message sign (VMS), which is displaying traffic information from the traffic management system in Hefei. The basis of this information is real-time traffic data from floating cars in Hefei (FCD). Other data sources are the road network configuration, the traffic jam characteristics and the characteristics between junctions and their traffic environment. Furthermore the displayed information follows the city guidance strategy to make the provided information reasonable and efficient. So traffic jams and travel times of drivers can be reduced. ASEC built up an ITS laboratory in Hefei's High-Tech Zone. The ITS laboratory contains the main street network in the High-Tech Zone. The work here in the project was carried on the basis of the platform of the ITS laboratory. The city of Hefei installed up to now 43 variable message signs in the urban area. One of these VMS is located in the Hefei High-Tech Zone, which is supplied with information based on the above traffic-guide-plans.

1.2.8. DMB System (Work Package 2.8)

The aim of this work package was to set up or accomplish the prerequisites for use of an existing broadcast medium for the transmission of the dynamic traffic data. It was decided that the protocol of the „Digital Multimedia Broadcast (DAB) "standard should be used. DAB was specially supported by the Chinese Government. The Ministry of Science and Technology (MOST) secures financing of the Chinese partners in METRASYS through a Chinese project called "Traffic Information Issuing based on Digital Multimedia Broadcast (DMB) Technology" with 860,000 RMB for a duration of 17 months.

As in China the use of radio technology is subject to specific regulations and restrictions, the physical placement of some components according to their functional role are affected as well.

FIRST/FOKUS has determined these stipulations with ASEC, the local traffic police (DHTP) and with Radio Anhui, which operates not only as technology provider, but as users as well. Information disseminated through radio is subject to censoring in China. An immediate transmission is not permitted, as the supervisory authority would be undermined by this. Therefore, the data flows are organized in such a way that can be exercised at an appropriate point before the final broadcast dispatch of this information stream. This control instance itself was not a working item within the project, but the organization of the data paths must be able to implement this requirement for the METRASYS information system to be realized and allowed for operation.

As a coding standard for individual information TPEG has been elected. Furthermore TPEG can be signaled in the DMB/DAB system. Therefore, here is already a basic framework given that the requirements combine the functionality of METRASYS with established distribution procedures. FIRST/FOKUS has made a selection out of the amount of all TPEG applications for the relevant ones for METRASYS in detail.

To minimize the data flow from the input terminal at the traffic police stations and at Radio Anhui a specially reduced metrasysML has been developed as a foundation that, according to tpegML only includes all entries and commands of the users. Care has been taken to ensure that this specification is open enough to integrate as easy as possible later emerging needs of the operators for enhancements and modifications. This has evidence from the aspect of the completely new system and therefore a lack of familiarity as an urgent desire of the later users during the various meetings in China.

The test runs took place right in the building of Radio Anhui and later at ASEC. It was a DMB signal on-air, so it was done with the real operation of the transmitter.

Hefei can be seen as a typical example for the dissemination and usage of traffic information in China. The infrastructure chosen here can therefore serve as a model for similar information systems in other Chinese cities. The architecture of the system – beside the addition of the mandatory supervisory body in China - is transferrable to even various sites that focus comparable information sources into a unified information propagation using this innovative standards.

1.2.9. Management / Planning Approach (Work Package 2.9)

The scope for this WP involved the "development of bus management" and "development of cross-traffic coordination for BRT", with the relevant trials for each. Back in the 2009 workshops, it emerged that the technical implementation of the planned BRT largely incorporated the management approaches envisaged in this WP. This meant the priority of the BRT at traffic-light-regulated junctions was already implemented, and the monitoring of the timetable situation and the thus possible information on actual arrival times were already in an advanced stage of implementation.

In the spring and autumn workshops of 2009 and during the visit by the Chinese delegation to Germany in summer 2010, which addressed the subject of local public transport as well as transport and urban planning, close exchange with the local Chinese partners, particularly the Hefei City Planning Bureau, demonstrated that what was really required was strategic consultation with regard to sustainable transport and city planning.

Terms such as "walkable city" were adopted and are being used as a defining principle for the identity of certain areas. This led to discussion of sustainability ideas, particularly in relation to the historic center. Linked to this was a new awareness of how to approach the car-oriented road layout to provide more room for pedestrians and cyclists, as well as greater awareness of how to deal more carefully with existing elements of urban planning that are worth preserving. Existing plans were discussed again and there was a shift in thinking.

In 2010 the consortium decided, therefore, in close collaboration with the Chinese partners, to do justice to the findings revealed and to change the WP 2.9. As part of the project evaluation in October 2010, the expert's report recommended that innovative and sustainable transport planning and traffic management should be promoted for the city of Hefei. This resulted in the adoption of the work packages "Historic Center", "Hefei High-Speed Area" and "Guidelines" in agreement with the project management agency.

In 2009 the project team was asked to assist with an environmentally and climate-friendly urban and transport development concept for a district of Hefei. This offered the METRASYS project a chance to play an active role in sustainable and climate-friendly development in Hefei. With the help of a case study, a master plan concept was developed for the area around the planned high-speed railway station, which covered around 85 hectares. Together with the transport planning and city planning authorities of Hefei, the idea was developed to create a typical and, at the same time, quick-to-implement concept for linking up private and public transport in this area. The aim was to create a comprehensive, modally staggered and frequent public transport offering, which would reduce private transport measurably and significantly with the aim of saving resources. Best-practice comparison projects were also described and outlined in the study. Sample cross-sections of streets as well as approaches to arranging the public space and stationary traffic were also provided. With the help of sketches, plans and illustrations, a proposal was presented for the development of the area. The proposals contained in the study regarding organization, usage and design of the space were used as guidelines for the subsequent urban planning competition.

For the downtown area, the project team was asked to hold a student competition in Germany in 2009/2010. A competition was organized in 2010 in close cooperation with the Hefei City Planning Bureau. Students in Germany were asked to address the issue of "sustainable urban development planning for megacities", taking into account the areas of transport, open space planning and urban construction. Under the leadership of the Faculty of Architecture and Urbanism of Stuttgart's University, students from the Anhui University of Architecture, the Hefei University of Technology and the University of Stuttgart itself took part in a workshop in 2011 to develop an analysis as well as initial strategies and concepts for the inner city of Hefei. On the basis of the first concepts developed in Hefei, the Stuttgart students began more detailed work in Germany on the subjects of the "Ring Park", "public spaces", "sound – noisy and quiet places", "identity/orientation in the inner city" and "mobility", and went on to develop strategies and visions. In November 2011 the results of the University of Stuttgart's work was presented in a workshop in Hefei before representatives of the Hefei City Planning Bureau, the Hefei University of Technology and the Anhui University of Architecture. The results of "Hefei Slow Motion – Strategic Design for Walkable Cities" were received extremely positively by the Chinese partners. The concept of the "Ring Park" is set to flow into and be considered as part of the city's own deliberations, which are already underway. The competition themes of "public spaces" and "identity/orientation" are likewise to be incorporated into the city authorities' consideration.

As efforts continued as part of the student workshop in Hefei, several other workshops took place with the city's planning authority. During the discussions, examples of transport planning were requested, with a particular interest expressed in planning and dealing with existing traffic infrastructure. In agreement with the Chinese partners, the decision was taken to develop a "Transport Planning Guidelines" and an "Urban Planning Guidelines" with the aim of using German and international examples to make a contribution to sustainable development in Hefei. Taking examples from Europe, the USA and Asia, the "Transport Planning Guidelines" offers organizational solutions on the issues of pedestrian traffic, bicycle traffic, motor vehicle traffic and local public transport. In the "Urban Planning Guidelines", seven strategies were used to demonstrate sustainable approaches to planning and construction in cities in the future. Using examples from Europe and the USA, development structures and block sizes were shown and city networks compared with one another. Block sizes in Chinese city structures, which strongly influence the development of sustainable mobility, were analyzed and an "Urban Design Proposal" was created using the example of PingGuo community in Beijing.

The guidelines were presented at various workshops in Hefei and submitted to the head of the city's planning authority. The Hefei City Planning Bureau had planned to produce guidelines for various areas such as traffic management, transport planning and urban building, which would then be used for the further development of the city. The Chinese and German partners worked together to ensure that the METRASYS guidelines found their way into the Chinese guidelines. In mid-2013 the Hefei City Planning Bureau and the Hefei Planning and Design Institute produced a set of guidelines with the title "Hefei Green Traffic Planning and Design Guidelines". Essential elements of the METRASYS guidelines were brought to bear in the Chinese guidelines.

1.3. WA3: Traffic Management and the Environment

WA 3 focused on the evaluation of the environmental impacts of the traffic management system throughout the project duration (1.3.1) as well as the assessment of expected impacts in case of a "Business-as-Usual" development in Hefei and the discussion of alternative development paths (1.3.2). In addition, the potential climate finance options for traffic management and wider sustainable transport solutions were analyzed in 1.3.2 and 1.3.3.

1.3.1. Environmental Monitoring and Evaluation of TMS (Work Package 3.1)

This work package aimed to develop necessary preconditions and tools investigating long and short term environmental impacts of different traffic management scenarios. According to the original tasks the following objectives had been reached:

- Indicators for environmental impacts of the transportation system in cooperation with local stakeholders
- Development and implementation of an environmental toolset consisting of a traffic emission model (TEM) and an air pollution dispersion model (AIM)
- Design and implementation of a spatial impact monitoring system based on FCD and emission modelling.
- Validation of the environmental models against measured data of different substances.

During the project period it came up that for the Business-as-usual (BAU) scenarios (see 1.3.2) a traffic assignment with a precise OD-matrix is necessary. A team of Chinese Partners consisting of The Department of Transportation Engineering at Nanjing University of Science & Technology

and The SOUTHEAST UNIVERSITY in Nanjing took over to provide the results of a traffic assignment model. This model had been linked with the Traffic Emission Model. New interfaces to couple both models had to be defined and implemented by FIRST/FOKUS (Figure 11).

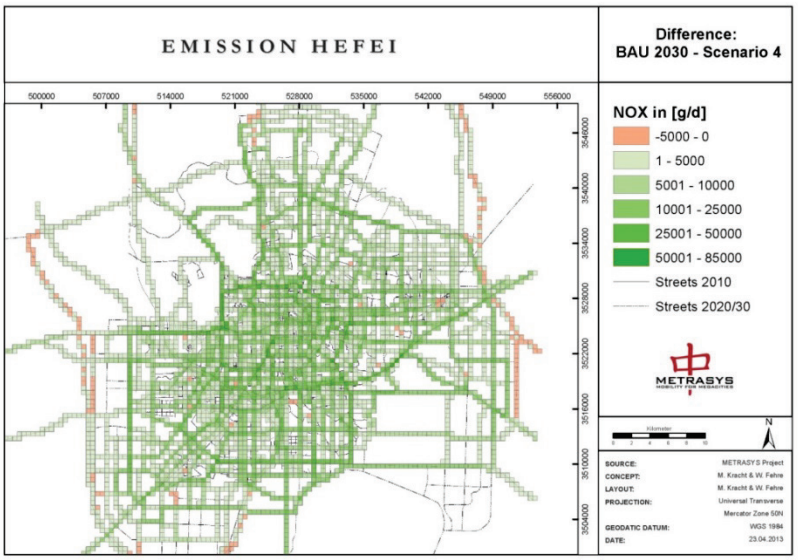
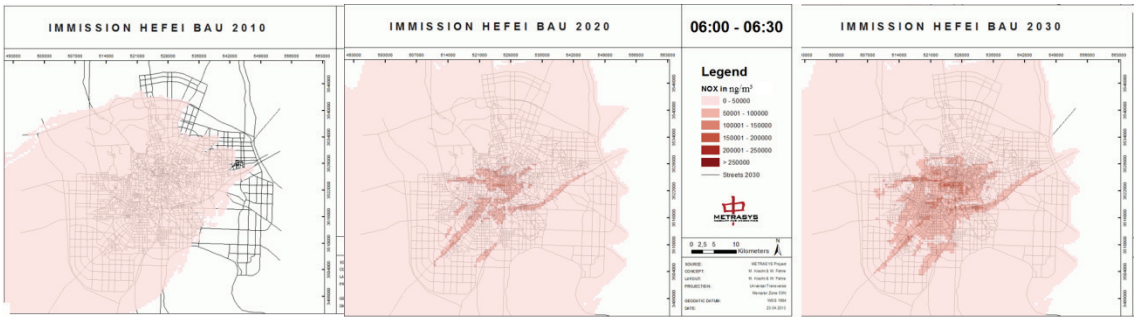


Figure 11: Emission changes of BAU in relation alternative scenarios for 2030 (example NOX); source: METRASYS

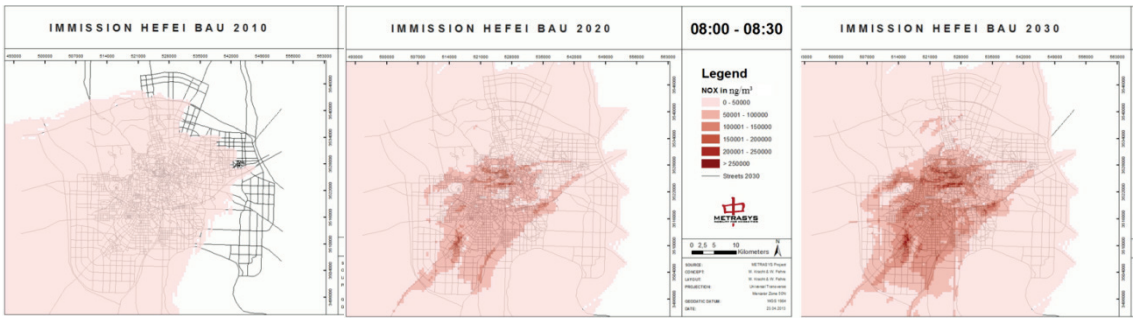
There was a second big change of the work package 3.1(1.3.1) during the project period. Because of the negative health effects and new regulations not only in China but also in European countries of the maximum permissible values PM2.5 particulates, new simulation models taking also PM2.5 into account were needed. FIRST/FOKUS implemented this new feature in both models TEM and AIM in order to simulate in addition the distribution of PM2.5 particulates.

The validation of the environmental models was based on the 2010 Business as Usual (BAU) Scenario of the Hefei region. The simulation results were compared with the results of a measurement campaign performed by the Anhui Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences (CAS). The measurements include the concentrations of SO_2, NO_2 and airborne dust on three different weekdays (25.-27.10.2010). The results of TEM show a good compliance between the simulation results and the measurements after some adjustments of the traffic emission model.

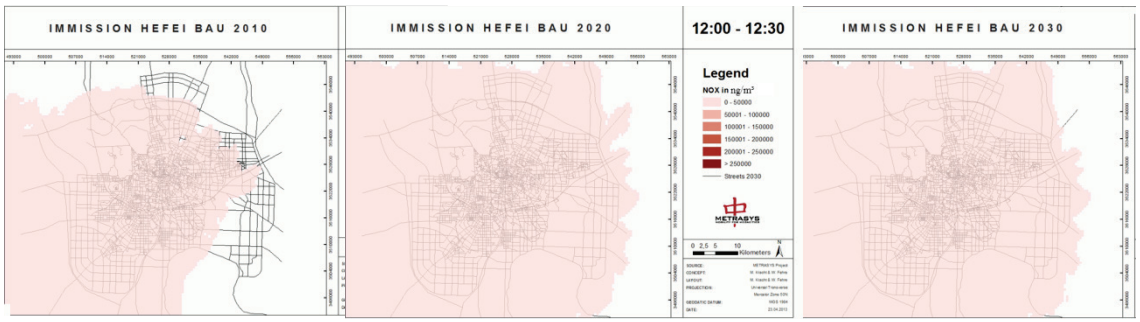
Based on these boundary conditions, the impact on the environment for the different scenarios could be analyzed. Figure 12 shows the NO_X for the BAU scenario for 2010, 2020 and 2030.



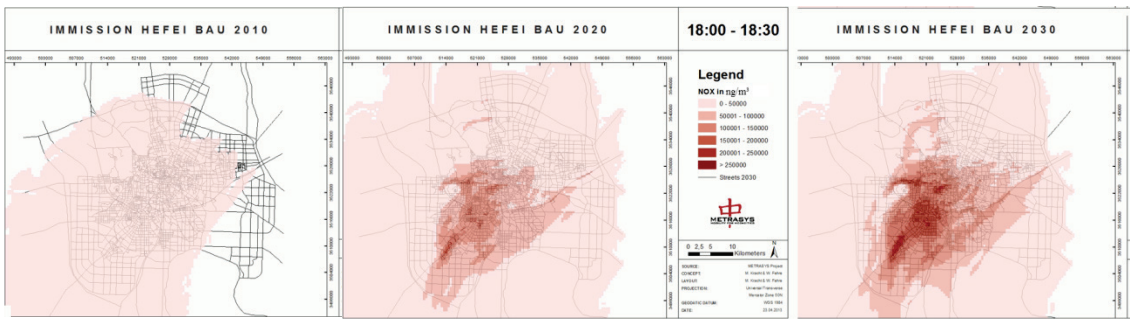
6:00-6:30



08:00-08:30



12:00-12:30



18:00-18:30

Figure 12: Immissions for the BAU scenario for the year 2010, 2020, 2030 (example NOX); source: METRASYS

1.3.2. Perspectives for Transport Management in Hefei (Work Package 3.2)

Core objectives of this work package are:

- Identify and analyze current traffic flows
- Make projections about future traffic flows for the city of Hefei
- Analyze current and future city development and transport developments
- Provide policy advice to the city government to shape a more sustainable future of the transport system in Hefei
- The task 3.2.2 (Implication of the BAU scenario for the local environment within a GIS-Model) is implicit included in WP3.1(1.3.1)

Business-as-usual (BAU) scenario of Hefei's transportation system:
The description of the qualitative aspects of the scenario was finalized. This storyline focuses on projections for key drivers of future developments in Hefei until 2030. It explores long-term visions and objectives for a business-as-usual (BAU) case and one or more alternative scenarios and the quantification of those scenarios. The qualitative scenario provides the strategic environment for the quantitative analysis of future developments in the transport sector in Hefei.

The mid-term evaluation report suggested the development of a traffic model to visualize current and future traffic flows in the city of Hefei. As part of this task the Wuppertal institute examined data on:

- Surveys and official documents, to identify future transport demand (incl. changes in modal split), traffic flows, time, assignment and volume.
- Suitable policy measures to curb transport sector greenhouse gas emissions in Hefei
- Recommendations for comparable cities

Following the assessment of current traffic flows projections have been developed in cooperation with Southeast University, and the Nanjing University of Science & Technology for traffic forecast for the city of Hefei by 2030.

The scenarios on the vehicle fleet development developed in 2011 have been fed into a traffic model of the city of Hefei (see below) to obtain projection for the effects the different scenarios are likely to have on the traffic flows in Hefei.

The Wuppertal Institute developed a peer-reviewed paper on framework scenarios: Fulton, L., Lah, O., Cuenot, F. (2013) "Transport Pathways towards a 2 Degree Scenario" Sustainability, Special Issue Sustainable Cities. The paper was developed in cooperation with the University of California, Davis and the International Energy Agency. The paper was submitted in January 2013. The paper has been accepted and is available http://www.mdpi.com/2071-1050/5/5/1863 (open access).

Testing the suitability of traffic management for CDM application:
Work on this task has commenced according to the planned timeline. The analysis focused so far on traffic management in the context of sustainable urban transport, the description of traffic management in general and the development of options for traffic management in a sustainable transport system. While traffic management contribute to better traffic flows and can reduce congestion and thus improves the utilization of the existing road network, it may not

necessarily improve energy-efficiency in transport. This is due to the fact that improved reliability of individual motorized transport can improve the attractiveness of this mode of transport and may even induce transport demand. The effectiveness of traffic management measures in terms of energy efficiency depends on how travelers respond to improved traffic flows in the road network. In a policy environment such as China, where travel demand is surging and fuel prices are subsidized the rebound effect is likely to be substantial. Reduced travel time and fuel costs are often mirrored by increased travel demand, which undermines the efficiency gains and may even outweigh them.

To ensure that traffic management contributes to sustainable urban transport, it is essential that the measure is framed by additional policies and measures that limit the negative side effects of traffic management and that reduce the rebound effect. Vital to the success of sustainable urban transport concepts is a mix of measures that improve the efficiency of the vehicle fleet, reduce travel distances via integrated land-use planning and provide modal alternatives to the private vehicle

A package of measures was developed in which traffic management was embedded in a wider policy framework to contribute positively to climate change mitigation efforts. Induced travel and travel redistribution vs. reduced travel, rebound effects were scrutinized and options were analyzed for the contribution of traffic management to the improvement of the overall efficiency of the transport system in Hefei. The current approach to congestion management in the city of Hefei focuses primarily on the expansion and completion of the road infrastructure network. In a final step of this task we developed a Hefei specific package of measures "transport management" (incl. traffic management) that could be subject to climate finance. The packages of possible measures were discussed with partners and city officials in Hefei. Based on results from these discussions, slight alterations to the packages have been made. All packages are tested with regard to the applicability of CDM, NAMAs and other climate finance measures. This will include a description of data requirements under each methodology and a simulation of the CDM and NAMA processes for the package.

1.3.3. Financing Sustainable Transportation through the CDM (Work Package 3.3)

As scheduled in the action plan, this work package started in 2012. Existing frameworks and potential options for climate finance at the international level have been examined. The challenges and success factors for obtaining financial contributions for transport projects in China have been analyzed. Examples for international climate finance options that are applicable for sustainable, low-carbon transport measures are:

- Funds provided by the Global Environmental Facility:
  The Global Environment Facility (GEF) is the designated financial operator for a number of multilateral environmental agreements, namely on climate change, biodiversity, and persistent organic pollutants. The GEF provides the agreed incremental costs that result from the implementation of the relevant agreement by developing countries. The GEF has provided funding for several projects focused on sustainable transport and several transport specific programs have been launched such as "GEF-World-Bank-China Urban Transport Partnership Program" or the "ASTUD Asian Sustainable Transport and Urban Development Program" and the "Eco-Transport in City Clusters". However, the development and implementation of projects under the GEF is requires substantial effort and a relatively long time. Often the approval process takes several years. Furthermore,

the definition of "incremental costs" is difficult and has been criticized to be subjective and is one of the main reasons for delays in the approval for GEF projects.

- Clean Development Mechanism:
  The Kyoto Protocol's Clean Development Mechanism (CDM) is an instrument under the UNFCCC that involved developing countries in emission reduction efforts. Industrialised countries can purchase Certified Emission Reductions (CERs) from CDM project activities and count these towards their Kyoto targets. So far, the CDM has largely failed to foster transport-related project activities. The majority of CDM projects have been developed in the industrial and energy sectors, mostly using single, isolated technological devices. As of March 2012, only 11 out of 3871 registered CDM projects were transport projects. The specific challenge for transport projects under the CDM is that projects have to be "additional", meaning that the projects would not have occurred without the CDM. As transport is a key function of urban life, it is rather difficult to show that a project would not have been carried out without the CDM, especially as the financial benefit for transport projects is rather low. Furthermore, as current carbon prices are very low, CDM financing can cover just a marginal part of the overall costs of the often large-scale infrastructure activities in the transport sector. The outcomes of climate summit in Doha in November 2012 ensured that the CDM can continue through 2020, but prices for CERs are likely to remain low.
- Nationally Appropriate Mitigation Actions (NAMAs):
  NAMAs are voluntary emission reduction measures by developing countries that are registered and reported by national governments under the United Nations Framework Convention on Climate Change (UNFCCC). NAMAs are a relatively new concept. Currently, different types of NAMAs are under discussion: unilateral NAMAs, that are actions that countries pursue based on their own resources and supported NAMAs , that are enabled by technology, financing and capacity building by industrialized countries. Additionally, it was suggested that certain NAMAs could generate carbon credits. However, there is so far no system in place for crediting NAMAs. Several countries have already submitted NAMAs that address the transport sector. Potentially, NAMAs offer a new opportunity to gain international support for domestic mitigation actions in transport in developing countries. However, how the delivery of financial support by industrialized countries is going to work is still very open. Thus, NAMAs might be a climate finance option for the transport sector in future.

The new developments with regard to climate finance after the climate summit in Doha in November 2012 are analyzed and will feed into an update of the information on climate finance in the transport sector in China.

To provide hands-on information for city officials, practical steps that need to be pursued to apply for international climate finance have been explored and will be updated regarding new international developments.

1.3.4. Traffic Model for Hefei (Work Package 3.4)

As stated in the interim reports it was decided to develop a traffic model of the city of Hefei and undertake further analysis and work on projections of future traffic flows in Hefei. The Department of Transportation Engineering at Nanjing University of Science & Technology and the Southeast University, Nanjing had offered their help in developing the model. The professors

Zhu from Southeast University and Ju from Nanjing University have a long history of developing traffic models and consulting the Planning Bureau in Hefei. This task builds on the mobility survey in 2006, which was developed by professor Zhu for the Planning Bureau. Part of the cooperation with the Southeast University, China and the Nanjing University of Science & Technology were:

1. The development of an Origin-Destination (OD) Matrix for the city of Hefei for the year 2011, this includes an analysis of trip generation, trip distribution and modal split for people and freight transport. This analysis covers the entire urban area of Hefei, i.e. the Luyang District, Yaohai District, Shushan District and Baohe District.
2. The development of a traffic model to identify current transport demand (public transport, walking & cycling, private car, taxi, commercial vehicles and heavy duty vehicles), traffic flows, time traffic assignment and volume.
3. The development of a traffic forecast for the city of Hefei by 2030, based on the model, surveys and official documents, to identify future transport demand (incl. changes in modal split), traffic flows, time, assignment and volume.

Preliminary results of the (transport) air pollution hotspot analysis of the have been presented at the workshop with the city council staff in Hefei in December 2012. The project partners are planning to develop a paper on the project's scenarios for submission to a peer-reviewed journal. This paper will compare and contrast the various scenarios to provide an overview of possible future developments in Hefei as an example for many similar second-tier cities in emerging countries. This will cover climate, energy, air quality and traffic flow aspects.
Some of the findings have been visualised by the DLR (Figure 13 and Figure 14).

Despite a few bottlenecks (orange and red) traffic flow is currently relatively good in Hefei, reflecting the partial overcapacity in road transport infrastructure today (Figure 13).

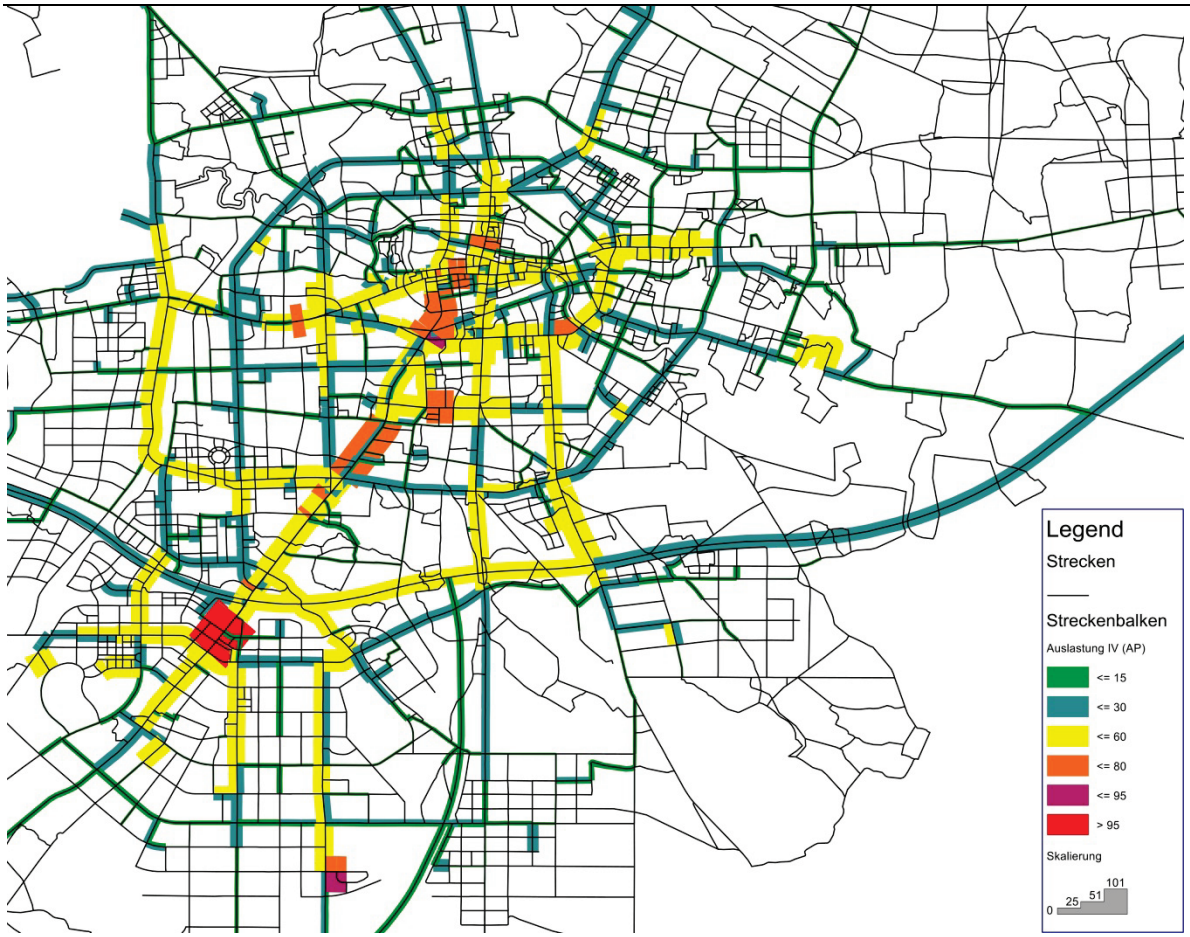


Figure 13: Peak hour traffic in Hefei (2010); source: DLR

Even with the extended network in 2020, the expected demand is likely to outstrip the road infrastructure's capacity (Figure 14).

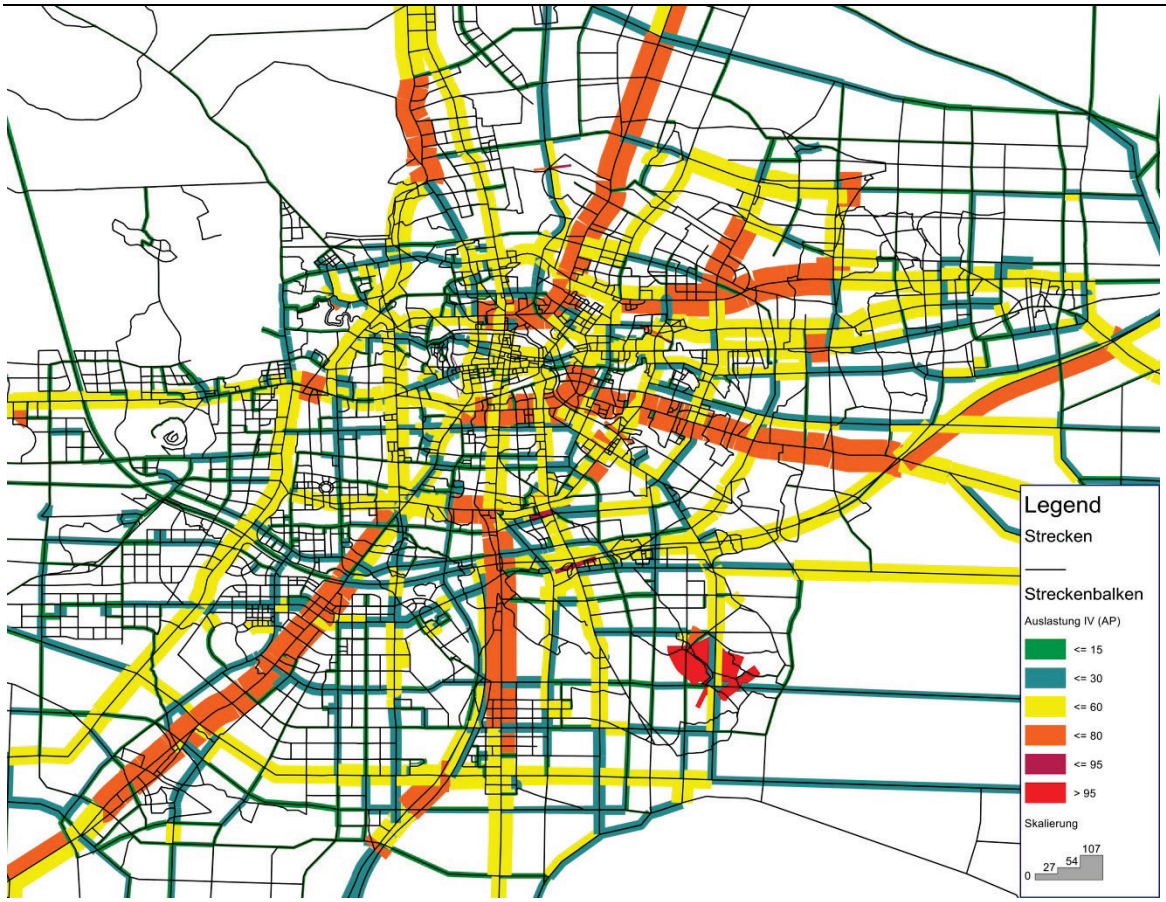


Figure 14: Peak hour traffic in Hefei (2020); source: DLR

This trend becomes even more obvious when looking at the projections for 2030, when severe congestion is likely to be wide spread in peak hours in Hefei (Figure 15).

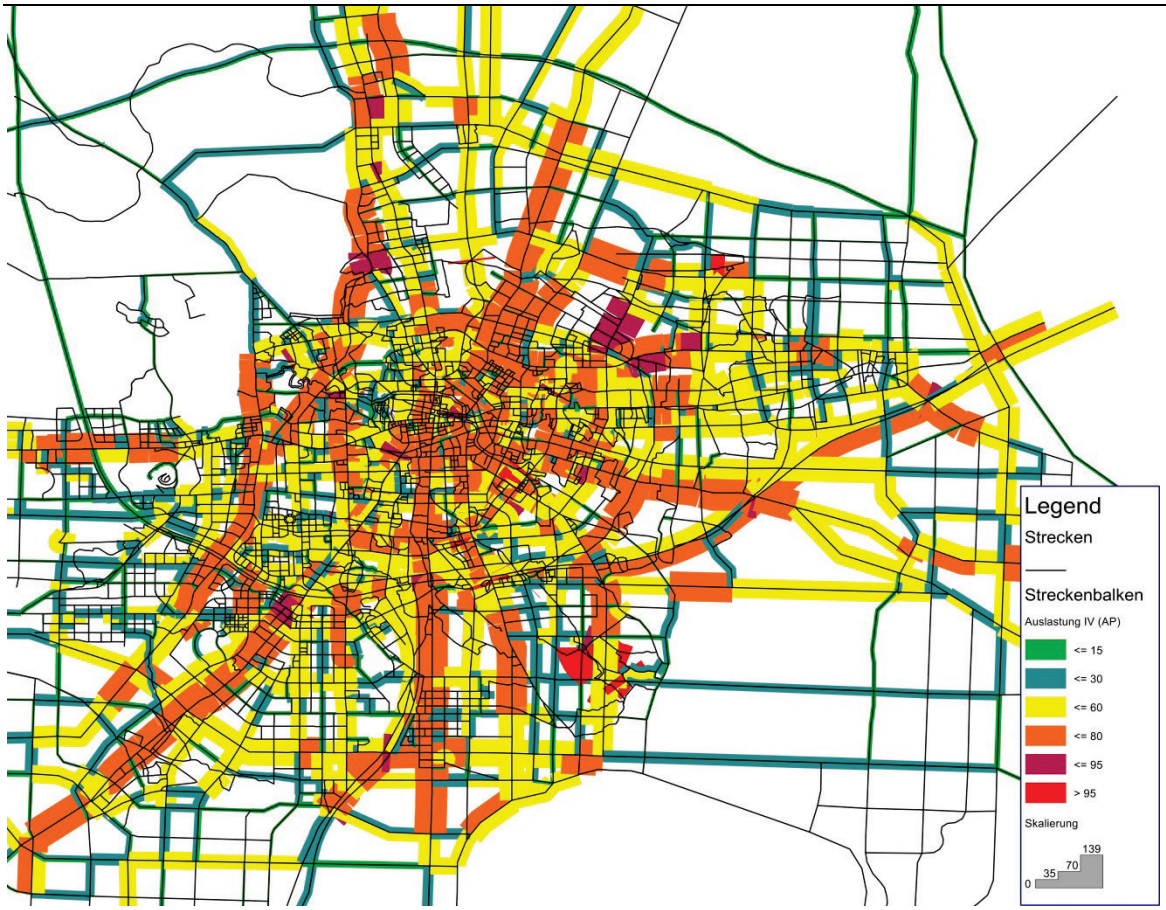


Figure 15: Peak hour traffic in Hefei (2030); source: DLR

The traffic flow scenarios (Figure 13 to Figure 15) show clearly that under a business as usual scenario congestion will become a major issue in the city center of Hefei and some arterial roads over the coming two decades.

The work on the new task Traffic Model for Hefei (1.3.4) was progressed during the reporting period and model results for the current traffic situation in Hefei and the BAU scenarios for 2020 and 2030 were presented at the Scenario Workshop in Hefei (see below). The scenarios for the vehicle fleet developments have been tested with the traffic model.

Another set of maps has been developed by FIRST/FOKUS and TEAS and shows the dispersion of harmful emissions in the city of Hefei under different scenarios.

Policy Workshop in Hefei

The results were presented and discussion on a workshop ("Transport in Hefei 2030") in December 2012 in Hefei. Experts from the Hefei Planning Bureau (BHUP), Hefei Planning and Design Institute, Environmental Protection Bureau (BHEP) and the local universities where invited to the workshop. Besides the DLR and WI, partners from the FU-TEAS and FIRST/FOKUS participated in the workshop and present the results of the traffic model and the air pollution hot spot analysis. Furthermore, potential policy pathways where discussed and the participants agreed on products and timelines.

1.4. WA4: Dissemination

Working Area IV focuses primarily on public relations, dissemination and marketing of the project and of the project results. The working area comprised in particular the tasks 4.1.1, the website, and 4.2, the expert dialogue and marketing strategies.

1.4.1. Dissemination Basics (Work Package 4.1)

Website:

The website http://www.metrasys.de is now running since May 2009. It contains information on the project, the German and Chinese project partners, the research areas (Hefei and Jiading) as well as all results achieved in the period under report. The website is provided in German, English and Chinese language. The main language is English.

The maintenance and further development of the website was constantly conducted in close cooperation with the project partners. All project partners produced and provided content for the website due to their specific expertise and tasks in the project. TEAS edit this content in order to make it suitable for the web.

Folder/Flyer:

During the project period a new presentation map and seven flyers were designed. With the modular design of the flyers it is easy to create additional flyers for new results and put them into the presentation map. On the other hand the map can be filled with personalized/individual content for the customers.

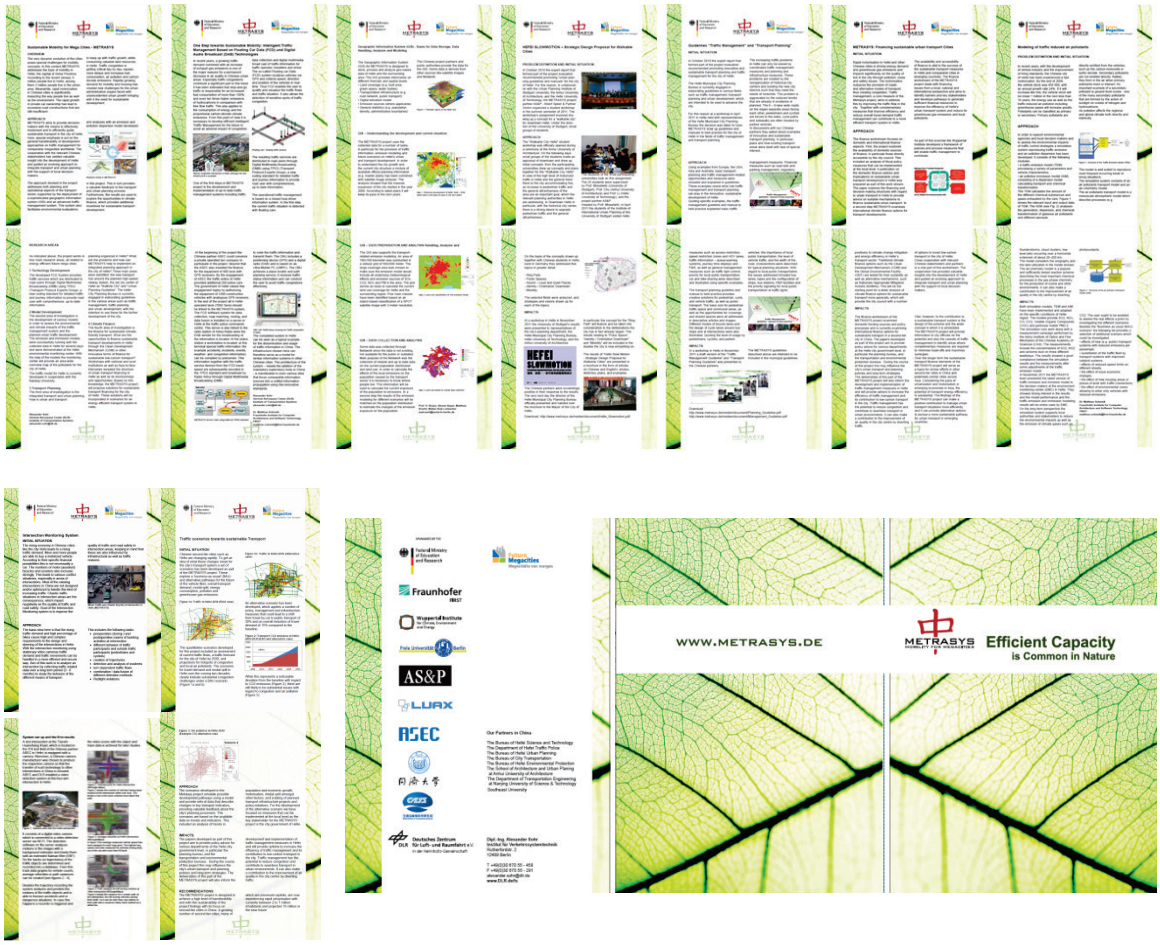


Figure 16: Nine flyers and the presentation map

All flyers can be downloaded at the project website:
http://www.metrasys.de/a_dokumente/index.html

1.4.2. Expert Dialogue and Marketing Strategies (Work Package 4.2)

An important objective of METRASYS was awareness raising and knowledge transfer in relevant interest groups and in the broad public. This has been achieved by providing and supporting platforms for a dialogue about energy efficiency and transport and urban development. The following activities have been carried out.

Expert Dialogue:
The work package deals with the dissemination of information generated by the METRASYS project. Throughout the project period this is reflected in a variety of dissemination activities. Many of the described events are also mentioned on the project homepage.
The METRASYS project team conducted a series of presentations and discussions in different Chinese cities. The following experts have been interviewed to discuss future developments in transport and urban development and present first results of the METRASYS project.

City: Shanghai
Date: 09.2010, 07.2011, 04.2012
Organisation: Jiading District Shanghai International Automobile City,

City: Beijing
Date: 04.2012
Organisation: Ministry of Science and Technology of China, Department of International Cooperation
Organisation: Beijing Office, Helmholtz Association,

City: Zhengzhou
Date: 09.2012
Organisation: Transportation Committee Zhengzhou
Organisation: BUS Company Zhengzhou

City: Guangzhou
Date: 11.2012
Organisation: Sun-Yatsen-University, School of Geography & Planning,
Organisation: Chinese Academy of Science, Guangzhou Institution of Geography,

City: Shenzhen
Date: 11.2012
Organization: Urban Transport Planning Research Centre Co., Ltd.
Organization: Shenzhen Urban Planning & Land Resource Research Centre,

City: Hong Kong,
Date: 11 .2012
Organisation: University of Hong Kong, Department of Real Estate and Construction

City: Nanjing
Date: 12. 2012

Organisation: Nanjing University of Science and Technology

City: Huainan
Date: 12. 2012
Organisation: Municipal and Huainan city Government, traffic police,

City: Hefei
Date: 07.2011, 12.2012.
Organisation: Hefei University of Technology

Training and Education Activities:
METRASYS supervised or supported the following thesis

- Liang Xu, Master Thesis: Analysis of Financing Framework for China's Sustainable Urban Transportation.
- Wenxin Xu, Diploma Degree, Title: Analyse von Logistikprozessen der chinesischen Unternehmen und Vergleich mit den deutschen Unternehmen anhand von den Fallstudien in Metropolstädten.
- Andreas Lamm, Diploma Degree, Title: Raumzeitliche Verkehrsanalyse am Beispiel der chinesischen Provinzhauptstadt Hefei - Floating Car Data als ein Instrument zur Erfassung und Darstellung des Verkehrsgeschehens in schnell wachsenden Städten.
- Xiaoli Lin, Master Degree, Title: Transit-Oriented Development (TOD) for Mega Cities. Is TOD an Effective Solution for a Mega City's Traffic Congestions? (Special Recognition of: Young Researchers Award)
- Manuel Fiechtner, Bachelor Degree, Title: Der Öffentliche Personennahverkehr in Hefei, China. Eine Analyse (Winner of: Young Researchers Award).

Marketing Strategies:
In February 2010, and Albert Speer & Partner, DLR, TEAS (since 2012 InUrban) and FU Berlin, Remote Sensing and Geoinformatics successfully applied for funding within the BMBF programme "Germany in Vietnam 2010". The objective of the programme is to trigger research networks of Vietnamese and German partners. TEAS and DLR applied with the project "Real Time Monitoring of Urban Transport - Solutions for Transport Management and Urban Planning in Hanoi".

With the funding from the BMBF, TEAS, DLR and FU Berlin organized two workshops in Hanoi and one workshop in Berlin. In July 2010, TEAS, DLR and FU Berlin visited the Vietnamese partners for the first time in Hanoi. After several meetings with public authorities, stakeholders and interested Vietnamese partners, the group of German and Vietnamese partners applied for the BMBF program "International Partnerships for Sustainable Technologies and Services for Climate Protection and the Environment" (CLIENT). The two-stage approval procedure was continued in 2011. The project was approved early 2012 and started in August 2012.
The Hanoi based project will be based on the FCD technology as well as on the experiences in Hefei. Its objective will be to tackle the traffic problems in Hanoi, which are very similar to those in Hefei: traffic jams, air and noise pollution. Thus, the Hanoi project might turn out to be the first transfer of the METRASYS project.

Also based on the METRASYS collaboration the Freie Universität Berlin and the Anhui University of Architecture have written a proposal sponsored by the BOSCH foundation. The project

application was focussing on electric mobility as means for emission reduction in urban environments. This proposal was not approved.

Focus of the Public Private Partnership (PPP) project „Low Carbon Mobility Management (LCMM)“ with the included partners DB Schenker, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and Deutsche Telekom is the examination of resource-conserving mobility in China. One of the objectives of the project is to investigate a possible reduction in fuel consumption through targeted training of professional drivers. For this purpose, drivers of taxi fleets are trained to operate in terms of fuel-efficient driving. Especially in China, taxis are one of the main means of transportation and provide a significantly larger proportion of the total vehicle fleet as for example in Germany. Through the extensive dialog of METRASYS and LCMM a new project "low carbon mobility management for taxis (LCMM4T)" in collaboration with the project partners DLR-TS and ASEC has started, which specifically examines the potential savings of taxi fleets in more detail.

The city of Huainan is currently working on the implementation of a “City-ITS-program”. During an expert dialog with stakeholders in Huainan, the achieved results from Hefei could be discussed and lead to an update of the program. A sustainable public transport and the monitoring of the environmental impacts were included into the program.

1.4.3. Workshops and Final Conference (Work Package 4.3)

Workshops and stakeholder dialogues in China

Workshops within the Sino-German Year of Science and Education 2009/10 in Hefei

In September 2009, the METRASYS team conducted two workshops within the framework of the Sino-German Year of Science and Education. The first workshop was dedicated to „Sustainable Urban- and Transport Development". The second workshop dealt with „The Application of GIS in Urban Planning“. (Organized by DLR/ ASEC/ TEAS/ Anhui University)

Student Architecture Workshop "Walkable City" in Hefei

Kick Off on April 5th-13th 2011 in Hefei, and Final Presentation on November 10th 2011. The findings of Stuttgart University were presented at a workshop in Hefei attended by representatives of the city planning bureau, Hefei University of Technology and Anhui University of Architecture.

Meeting with the representative of the”Begleitmaßnahme” in Hefei

On 3rd of December 2012, the project partners DLR, Fraunhofer, FU Berlin und Wuppertal Institute and local partners met Mr. Carsten Zehner, representative of the “Begleitmaßnahme”. The project members took the opportunity to explain Mr. Zehner the project status and outcomes so far. Mr. Zehner took part on all further meetings and site visits during the project members stay between 3rd and 6th of December 2012 in Hefei.

Internal Workshop on Transport Modelling in Hefei

On 4th of December 2012, the project partners DLR, FIRST/FOKUS, TEAS und WI met the Institute of Transportation Engineering, Nanjing University of Science & Technology. The meeting was in Hefei. Mainly, it dealt with details of the transport modelling.

Joint Workshop on Models and Scenarios in Hefei

In December 2012, Wuppertal Institute for Climate, Environment and Energy lead a workshop targeting on the transport model and scenario development (Figure 17). The German partners together with local partners and experts as well as stake holders from local government discussed interrelating issues of the transport development and scenarios.

Figure 17: Meeting on Scenario Development and Transport Modelling

Final Conference:

On the 20th of August the final Event of the project took place in Hefei. The results and ongoing research activities were presented and discussed with numerous experts from the city of Hefei and the Anhui Province. Among others, representatives of the Chinese MOST, the Government of Hefei, the Hefei Environmental Monitoring Center, the Traffic Police and different Universities and other Research companies were very interested in the projects outcome and in peer to peer session the ongoing work and new project could be discussed. Also the local press was invited and so two articles were printed at the next day in the local newspapers "Xin'an Evening News" (Figure 18) and "Hefei Evening News" (Figure 19).

新安晚报 2013年8月21日 星期三
E-mail:hekenan@foxmail.com
星级编辑:何克难 版式:王青 美编:张军 星级校对:王建武

时讯 A□13

安徽网www.ahwang.cn 官方微博@新安晚报

老城区改成步行区,你看怎么样?

德国专家为合肥智能交通献计,提出利用路口监控预警交通事故

为了避免拥堵,老城区未来可能改成步行区。昨天,在中德"百万人口城市交通系统"项目结题大会上,来自德国的交通专家给合肥交通建设提出了技术指导和一些设想。

出租车采集路况

"出租车是城市车流的一个重要组成部分,利用出租车采集路况信息从而分析整个路况的流量和流向,这就是FCD浮动车辆数据技术的应用。"德方专家表示,合肥市已有600辆出租车安装了GPS定位,这项技术投入成本不大,但却能动态采集路况信息。据悉,目前合肥交警发布的实时路况信息正是靠这一系统实现。

交通事故可预警

近年来,合肥市区不少路口都安装了监控探头,除了抓拍交通违法行为,其实监控探头还身负重任。

"通过路口监控采集的交通参数,如车流、流向以及行驶轨迹等,不仅可以进行数据采集还可以保障交通安全。"德方项目负责人介绍,未来通过对行驶在路上的车辆进行轨迹分析,可以预判车辆是否会发生碰撞或追尾,并通过车上安装的终端实现对司机提前警示。

改善拥堵靠步行

"在德国,多数人平时上班都是乘坐公共交通工具或者骑自行车,有些居住在主城区的人甚至放弃私家车,有需要就去租赁公司租车开。"相关专家为合肥市老城区的拥堵也开出了药方。未来随着城市规模的扩大,城市中心由原来的一个单中心变为网格状的多中心结构,利用现有的环城河为界,将老城区改造成步行区,积极发展步行交通,从而有效改善老城区的拥堵。

本报记者 张大为

包河区将翻新21个老旧小区

本报讯 记者从包河区了解到,本周起,包河区2013年度21个老旧小区环境综合整治工程正式开工。

这21个老旧小区分别为康南小区、芜湖路邮政小区、芜湖路174号、南苑新村、金水花园、科苑小区Ⅰ期和Ⅱ期、美湖小区、新园小区、供水集团小区、银屏南村、江淮化肥厂小区、东风小区、朱岗恢复楼、南凌小区、海达小区、王大郢新村A区、独秀园小区、胡岗小区、医药站小区、小葛郢小区、警民小区。

Figure 18: Article in the "Xin'an Evening News" – 2013-08-21, title: "What about making the old town with a pedestrian zone to a 'walkable city'?"

合肥晚报 焦点新闻 合晚热线:96511 官方微博:@合肥晚报 2013年8月21日 星期三 责任编辑 朱 萍 美术编辑 徐 晴 版式设计 余新雅 责任校对 力 真 7

洋专家把脉老城交通 禁车?

破解合肥环城公园内交通难题 德国专家"点子"超炫

□卢佳玮 刘超 本报记者 谢华兵

将核心城区改造成"步行城区"、建设综合社区减少交通需求……昨天,在中德"百万人口城市交通系统"项目结题大会上,来自德国的交通专家们为破解合肥交通难题献计献策,不少点子极具想象力。

芜湖路 环城南路 380m 890m 梅山路 南一环路 曙光路 1050m 430m

○交通拥堵已成为城市发展亟须解决的难题之一。 吴芳 摄

揭秘

出租车成路况"间谍"

2009年,"百万人口城市交通系统"项目在合肥启动,项目组由中德两国专家组成,在合肥完成各项交通信息数据采集及分析,由此制定、实施和应用一些先进的智能交通技术,为全球示范。

据介绍,项目组在合肥600台出租车上安装了GPS定位装置,利用出租车采集路口信息,从而分析整个城区交通流量和流向,达到整体控制。

"通过出租车的GPS空间定位数据,从而采集大规模交通信息,提供给相关部门及公众。"德国专家索尔介绍,这项技术成果已成功运用到合肥交管平台,提供了大量实时路况信息。

城区路况分四个等级

担着"路况间谍"身份的出租车每天流动在市区各个角落,合肥哪里拥堵、哪里缓行、哪里通畅,项目组在后方均可通过技术控制一览无余。

"老城区及周边主干道最拥堵,"作为"百万人口城市交通系统"(METRASYS)项目负责人,索尔对合肥交通了如指掌,他告诉记者,每天早晚高峰时段,步行街、四牌楼、三孝口以及火车站等区域最为拥堵。

索尔介绍,通过出租车的流动"观测",后方可凭借技术软件实时绘制出合肥城区整体交通路况示意图。"我们将路况分为畅通、缓行、拥挤、拥堵四个等级,用不同颜色标出,一目了然,供决策部门使用。"

探头不应只是监控

城区各个路口,几乎都安装有探头。在很多人看来,这些探头是交警部门为监控路口而设,主要用于违章拍摄和事故现场录像,其实不然。索尔介绍,部分探头除了抓拍交通违法行为,还肩负采集交通信息的重任。"相比于出租车,路口探头属于固定观测点,能够准确清晰监测路口各项交通流量参数。"据透露,合肥交管部门目前也是通过探头对路口交通流量实施监控。

索尔表示,随着车载物联网技术的引用,探头还将在保障交通安全上发挥作用。"通过对车流、流向以及车辆行驶轨迹的监测分析,可以预判路口交织车辆是否会发生碰撞或追尾,并通过车载终端提前发出警示。"

支招

老城区改"步行区"

人口增长、机动车保有量膨胀、城市交通拥堵,针对合肥正面临的出行难题,索尔及他的科研团队提出了几点颇有想象力的建议。

"可将老城区改成步行城区。"索尔的首条建议就语出惊人,索尔提议,利用现有的环城河为界,将老城区改造成步行区,限制机动车通行,积极鼓励步行等非机动出行,可有效改善老城区拥堵。在他看来,可以尝试在老城区最拥堵的区域禁止机动车通行,仅允许非机动车和行人通行,准河路步行街的模式可以适度扩展。

减少长距离交通需求

"破解交通拥堵,除了疏解,另外一条路就是源头控制,减少交通需求。"索尔说,随着城市规模的扩大,减少市民每天长距离出行,是控制交通需求的有效途径。

索尔建议,将城市商业圈和居民生活圈多元化,积极发展城市综合社区,满足市民"走几步"就可完成工作、购物、消费等生活出行需求,而不必"长途跋涉",减少占用公共交通资源。

提升公共交通魅力

"减少个人交通,鼓励发展公共交通,才是一座城市交通出行的正确模式。"索尔说,在德国,多数人平时上班都是乘坐公交或骑自行车,不少主城区居民甚至彻底弃用了私家车。

索尔认为,发展公共交通的关键在于要增加公共交通吸引力,让市民乘坐起来方便、快捷、舒适。其次,可通过价格杠杆,引导市民放弃私家车出行,如控制中心城区停车位数量或提高停车成本。

Figure 19: Article in „Hefei Evening News" – 2013-08-21, title: "Foreign experts feel the pulse of the Old City Traffic, car prohibitions? - German experts stunning ideas"

2. Report on expenditure of funds

A detailed overview on the expenditure of given funds refer to the report of grant which is delivered to the project administrator by the DLR, WI, FIRST/FOKUS and FU-TEAS. The Responsible persons are

DLR: Ms. C. Zöllter, Phone (+49 30-67055139).

WI: Ms. Annemarie Sauter-Merten (+49 202 2492-159).

Fraunhofer-FIRST/FOKUS: Ms. Martina Graf (+49 2241 14-2977)

3. Necessity

The rapid increase in motorisation in Hefei and other Chinese cities is driving growth in energy demand and greenhouse gas emissions. Also, growing motorisation significantly affects the quality of life in the city through pollution, noise, and road safety issues (Schipper, L., Marie-Lilliu, C. and Lewis-Davis, 2000). The METRSYS Project focuses on the Chinese city of Hefei, the

capital of Anhui Province, one of the numerous, and growing in number, 'second-tier' cities (often provincial capitals with two to seven million inhabitants). It is hoped that the findings from Hefei may be transferable to other second-tier cities. The large growth of Hefei enables a quick efficiency control of the novel systems to be implemented. It can easily be assessed in a convincing manner. The experience given by the assessment is an important reference for a transfer of the results to other cities in China and elsewhere in countries with similar challenges.

Implementing a transportation system with energy efficiency and the reduction of greenhouse gas emissions are the central objectives of the METRASYS project. The desired energy efficient transport must be integrated into the request for sustainable urban transport. In order to effectively tackle problems such as climate change, air pollution, biodiversity and human health more information about the energy saving and pollution abatement potential of specific measures is necessary. Hence, the assessment of measures and policies requires methods to quantify their respective reduction potential of environmental impacts. This will not only identify results in the work of the project, but also generate knowledge about emission reduction potentials.

4. Benefit

The METRASYS project advised the Hefei municipal government throughout the entire policy cycle and technology uptake process, which included:

- assessing the current status of urban transport, policy and finance frameworks in the city,
- developing the scenarios for future traffic congestion, greenhouse gas and harmful emissions,
- developing and implementing a traffic management system based on Floating Car Data (FCD),
- providing policy and planning advice through guidelines and policy papers, and
- providing advice on financing options for the city's planned sustainable urban mobility measures.

The cooperation with the city administration and local industry partners was based on a long-standing partnership, which allowed open and focused discussions. Vital for the success of the project was the focus on the city's specific needs regarding the solutions presented for consideration, presented in a form most useful to city officials.

It shows by a closer look to the action of the technical development that the project METRASYS instigated positive local developments in Hefei. It should be shown with an example: The joint and agreed manner of the Chinese and German partners during the first phase of METRASYS brought the local government of Hefei to select the approach of Floating Car Data for traffic data collection for its traffic management system. The impending delay caused by the indifferent attitude of the transportation bureau of Hefei led the Chinese partners to invest in themselves. On the basis of these data, the further developments of METRASYS could be

implemented. In addition, the Chinese partners have developed and implemented based on the floating car data their own ideas. Hence, the software system to monitor the taxi fleet, which makes a significant contribution to the safety of taxi drivers, is created. Moreover the system can generate important statistical analysis of the financing to operate taxi fleet. With this software it was possible to show that up to 50 % of the trips are "searching" trips without passengers. The taxi driver is watching for new gests in the city. The German partners have taken the opportunity of this statistical analysis in combination with the existence of the fleet management software to point out the need of a taxi call center.

Using a call center can avoid many of the trips without any passengers in the taxis, which leads to energy savings and to improve the traffic situation. It is no question that the call center will be there in future. However it is important, that this will be a purely Chinese development, which was just initiated by METRASYS.

Such examples show the positive and sustainable impact of the METRASYS project to the development of the city of Hefei. The success of the project give entitled reasons for hoping that Hefei can be established as a positive example for sustainable urban development of rural areas and megacities. In China alone there are more than one hundred cities in a similar situation as Hefei and their local governments have to make essential decisions for a sustainable city development in the near future. The project objectives, the applied methods and the achieved results are introduced to the related communities and the decision makers of other cities in China through the attendance of conferences and workshops as well as the stays in Hefei. The experiences have been exchanged as well. One of the examples is that the project team of METRASYS has partially participated in the planning of the ITS Establishment Program of City Huainan in the province of Anhui. Based on the gained results and experiences in Hefei, which were introduced to the decision maker in Huainan, much more attention is put on the improvement of the public system in the ITS establishment program. A new work package "Monitoring of Traffic and Environmental impacts" is added in the ITS Establishment Program as well. Together with the already planned work packages "traffic control system", "traffic safety management system" and "mobility service" this new work package can contribute to achieve the defined target of City Huainan, i.e. the establishment of sustainable transport system.

It is of course to early to say if and how the project impacted on future developments in the city. The scenarios developed for this project at least indicate that if the policy measures proposed and technology solutions implemented in the project have the potential to make a substantial positive contribution to air quality, energy consumption and greenhouse gas emissions in the city and may also contribute to improved access and road safety.

Technology can only develop its full potential to the extent that it is used. This requires that people want to use the new technology and that they know how to make use of it. These requirements are the more important the more the innovation necessitates an adaptation or change of habits. Furthermore innovations meet resistance if they do not fit into the cultural setting or if they seem to threaten the established power of certain people.

To avoid such resistance - and in consequence the failure of an otherwise brilliant technology - decision makers, users and operators were involved in the design and development of the project work from the beginning. This involvement serves a two-way learning: The project team understands the cultural setting better and learns about both the non-technical obstacles as well as the motivations. The future users and operators learn about the specifics and limitations of the new technology and how to make optimal use of it.

Last but not least, comparing the progress, the necessary adaptations and outcomes across the different works allows drawing more general conclusions. They will be fed back as "Issues to care for and points to avoid" for any future project.

5. Results of other institutions

Currently, much research is being devoted to making climate instruments under the UNFCCC (United Nations Framework Convention on Climate Change) applicable to the transport sector. Climate instruments under the UNFCCC are carbon finance mechanisms to provide a stimulus for enhanced climate change mitigation actions in developing countries now and for the period post 2012.

Ecofys is currently developing so-called "sectoral approaches"in the transport sector (www.sectoral.org). Another proposal of the research community is to implement a mitigation fund with a dedicated transport window in order to foster transport-related mitigation activities (Bongardt et al. 2009).

However, none of these activities discusses how a transport management system as being introduced by the METRASYS consortium in Hefei can support data acquisition to implement such climate instruments. Moreover, carbon finance mechanisms must also be applicable to the specific situation in Hefei City.

At this stage the work of the other megacity projects of the same funding program in the area of traffic and transport should be alluded. The workshops "MC Mobility" organized by the Technical University of Berlin have shown that the other projects do not plan similar technical developments. There is no risk for any work package to become obsolete. Currently the MC Mobility Network action is writing a book about "Transportation in Future Megacities".

The FCD Approach has now spread over the world, and it is common to derive travel-times from this easy to acquire data-source. For example is Google since ca. 2years evaluating phone movements to display traffic conditions in their maps. What the MERASYS- System makes so unique is the calculation of traffic flows, which in the next steps allows the processing of emissions and immissions of the traffic.

6. Publications

All Publications of the project METRSYS during the project time are fund by the website

http://future-megacities.org/index.php?id=126&L=1

- Frederic Rudolph(2009), METRSYS Working Paper: Evaluation of Environmental Impacts of Transport Policies and Measures,
- Kracht, Matthias/Ruiz Lorbacher, Matias/Ruhé, Martin (2010): "Floating Car Data (FCD) as Means for Traffic Flow Detection in Evolving Chinese Mega Cities."
- Ruiz Lorbacher, Matias/Kracht, Matthias/Bayer, Steven/Ruhé, Martin (2010): "Rapid Urbanization, Urban Transport and Climate Change in China's Urban Backbone". Submitted to Journal of Transportation and Society.
- Ruiz Lorbacher, Matias (2010): "Sustainable Transportation in Mega Cities: Strategies and Instruments – Case Study on Hefei, China". Paper presented at the 24th AESOP Annual Conference, Aalto University School of Science and Technology, Espoo, Finland, July 07-10, 2010.
- Kühne, R.; Bei, X.; Ruhe, M. (2010): Sustainable Mobility and Sustainable Transport for Medium-Size Cities in China. Kunming, China (International Conference on Traffic & Transportation Studies).
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- Braun, Gerhard, Matthias Kracht, Xiaoli Lin (2013): Verkehrsprobleme sind nicht Probleme der Stadt sondern in der Stadt – ein Blick auf Hefei (China)/Traffic problems are not constraints of towns but problems in towns – a look on Hefei (China), in: Schliephake, K (Editor), Bewegungen in Raum und Zeit – interdisziplinäre Beiträge zu Transport, Logistik und Raumverhalten, Würzburger Geographische Manuskripte, Heft / Vol. 80, pp. 13-24. Würzburg
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- Fulton Lewis, Lah Oliver and Cuenot François (2013), Transport Pathways for Light Duty Vehicles: Towards a 2° Scenario, Sustainability (ISSN 2071-1050; CODEN: SUSTDE), http://www.mdpi.com/2071-1050/5/5/1863
- Hüging Hanna, Lah Oliver, Sterk Wolfgang, Wehnert Timon and Jentgens Anne (2013), METRSYS Working Paper: Climate finance options for local transport projects, http://www.metrasys.de/a_dokumente/index.html
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- Braun, Gerhard, Matthias Kracht, Xiaoli Lin, Geographische Rundschau, Stadtverkehr in Chinas aufstrebenden Millionenstädten. Forthcoming
- Lah Oliver, Sohr, Alexander, Xiaoxu Bei, contribution to the book "Transport in Megacities of Tomorrow", Forthcoming
- Film: Future Megacities - Transportation Management in Hefei, China, Future Megacities Short Film Series, http://future-megacities.org/index.php?id=video&L=1