ICARUS Newsletter – 4th issue

Integrated Climate forcing and Air pollution Reduction in Urban Systems

Welcome to the fourth newsletter of the ICARUS project. This issue covers the period from January to June 2018 and gives you an overview of the progress we made in our project.

The ICARUS Newsletter shares information about results and events of the EU research project ICARUS aiming at keeping all relevant stakeholders, interested in air quality and climate change in urban areas.

Your engagement is very important to us. Therefore, we would like to encourage all interested parties and stakeholders to support us in our endeavor and to constructively collaborate in achieving the study results for the benefit of the society as a whole. We hope that you find this information useful and we were looking forward to hearing your effective and constructive feedback.

We are looking forward to making your voice matter in revamping our cities and combatting climate change!!

If you would like to see previous issues of the newsletter, you can find them all at the ICARUS website https://icarus2020.eu/category/news/

Content

- Introduction
- Emissions inventories at city level for the years 2015, 2020 and 2030
- Methodology for estimating health effects in the ICARUS participating cities
- Towards integrated win-win solutions on the urban scale
- Relationship between Policies and Measures
- User requirements for ICARUS user-centric tools
- Dissemination, communication, and involvement of stakeholders
- Brno annual meeting
- ICARUS reports
- Next Issue
- Contact Us

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Introduction

In these last six months there have been many advancements in the scientific production of the ICARUS project. Key results include the completion of the emissions inventories at city level for the nine ICARUS cities, the development of the methodology for linking exposure to health effects, the selection of air pollution reduction policies and measures in each ICARUS city, the definition of the methodological framework for estimating relationship between policies and measures and the final identification of the user requirements for ICARUS user-centric tools.

Emissions inventories at city level for the years 2015, 2020 and 2030

We completed the generation of baseline emission inventories for the participating cities: Athens, Basel, Brno, Copenhagen/Roskilde, Ljubljana, Madrid, Milan, Stuttgart and Thessaloniki. The emission inventories comprise all major anthropogenic air pollutants and greenhouse gases as well as heavy metals, benzo(a)pyrene and dioxins/furans.

The main points are the generation of bottom up emission data and the improvements of top down databases, which were generated by a sector-specific downscaling of national activities taken from the European database (WP 2.1). In addition, existing and available emission bottom-up data especially energy balances, transport and large combustion plants (e.g. power plants) for the respective cities were collected and included.

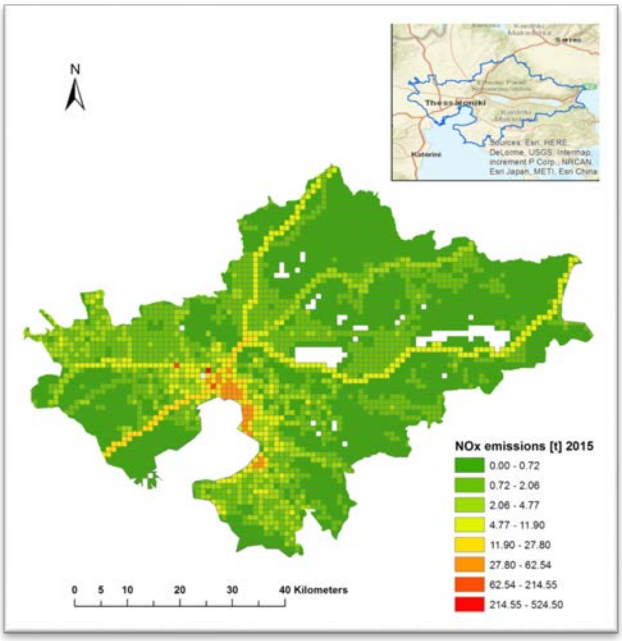

Figure 1: Spatially distributed NOx emissions in Thessaloniki for 2015

The provision of sector-specific distribution factors for all cities allows the spatial disaggregation of emissions within the city area in order to provide highly spatially resolved input datasets for atmospheric modelling (1km x 1km). The results are thus delivered to WP3 in terms of sector and grid-element specific emission values for the years 2015, 2020 and 2030.

The final activity-emission factor matrices describe the trend developments in activities and emission factors and thus can serve as a useful tool for the modelling of air pollution reduction and climate change mitigation measures identified in WP5. This becomes even more important as all ICARUS cities face diverse air pollution problems, which make it necessary to develop individual countermeasures for air pollution and carbon footprint reduction in the respective city.

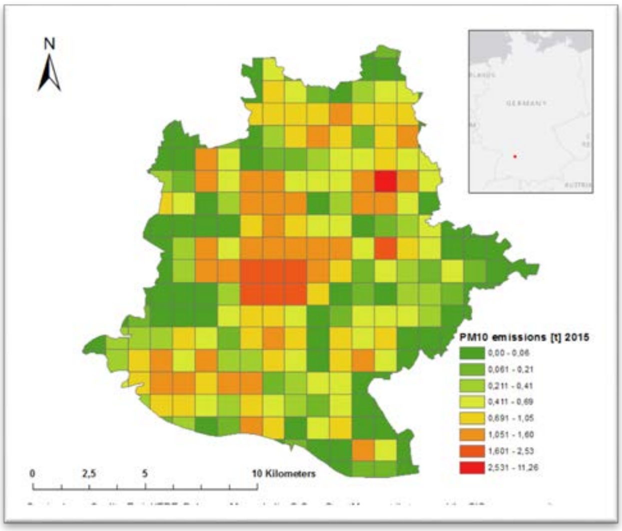

Figure 2:Spatially distributed PM_{10} Emission in Stuttgart in 2015

Methodology for estimating health effects in the ICARUS participating cities

In ICARUS, we aim at a more precise translation of the environmental exposure into health effects. To this aim we developed a methodological framework which makes use of various tools for enhancing the health impact assessment. This allow us to better translate the effect of different policies on emissions and public health. As a starting point we collated concentration-response functions established by WHO in the HRAPIE project which will be used for the health impact assessment of the major air pollutants (PM, CO, NO_2, O_3).

Innovations beyond the state of the art will be incorporated taking into account (a) the integral of indoor/outdoor and in transit exposure and (b) when available, more refined methodologies that estimate intake and internal dose. These include the use of Human Respiratory Tract (HRT) deposition of particles accounting for their PAHs content and the use of a Physiologically-Based BioKinetic (PBBK) model coupled to Biology Based Dose Response (BBDR) relations for toxic organic pollutants such as benzene and dioxins.

PBPK modelling is a relatively recent technique in chemical risk assessment) providing a biology-based approach for estimating potential health implications rather than simply using empirical relations extrapolated from epidemiological studies. PBBK models focus on the processes determining the tissue dosimetry of chemicals.

They are modelling tools which describe the mechanisms of absorption, distribution, metabolism and elimination (ADME) of chemicals in the body resulting from acute and/or chronic exposure. They are independent structural models, comprising the tissues and organs of the body with each perfused by, and connected via, the blood circulatory system. In PBBK models the organism is represented as a network of tissue compartments (e.g., liver, fat, etc.) interconnected by systemic circulation.

The transfer of chemicals between compartments is described by a set of differential equations: each compartment (tissue) in the model is described by a mass-balance differential equation (MBDE), and the set of equations is solved by numerical integration to predict tissue time-course concentrations of the chemicals and its metabolites, thus providing a more mechanistic biologically-based approach.

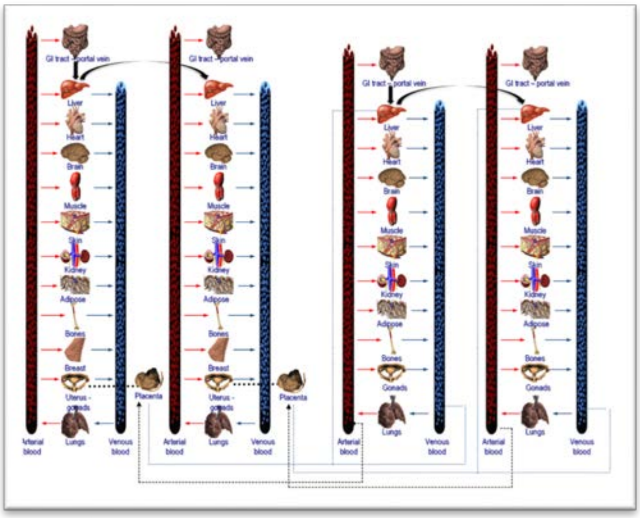

Figure 3: Generic PBBK model to estimate the internal doses of chemical in the human body tissues

For toxic organic pollutants the estimation of health impact is based on the decomposition of the dose-response relation into two distinct sub-relations: the first one links the administered dose to the total amount of metabolites produced (internal dose) while the second one connects the internal dose to the probability to develop a specific disease through an empirical-statistical model. The first relation is provided by the PBBK model while the second one by the BBDR relations.

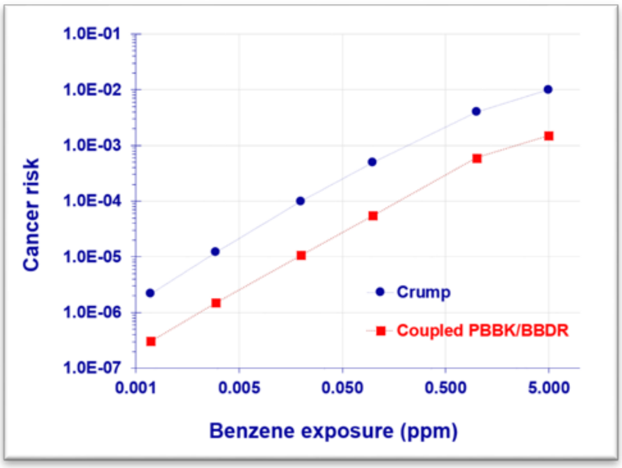

Figure 4: Biology based dose response relation for benzene (in red the model developed in ICARUS and in blue the one developed by Crump K.S. (1994))

Towards integrated win-win solutions on the urban scale

We completed the first selection of air pollution reduction policies and measures in each ICARUS city. This is the first step towards the main goal of ICARUS that is to identify feasible, cost-effective abatement options for reducing air pollution, climate change, and carbon footprint in the European cities.

In this phase over 720 potential policies and measures have been identified in relation to the incentives of the EU, national and municipal authorities, transport and energy providers. In a successive step (Step 2), a selection of approximately 10 policies/measures per city (97 altogether) was made based on the following pre-defined criteria: (1) compliance of both AQ limit values and WHO health-based guidelines, (2) reduction in long-lived GHG and short-lived climate pollutant (SLCP) emissions and (3) changes in sequestration (i.e. CO2). The policies and measures selected will be then discussed with local authorities to identify the final policies/measures for each city which will undergo further evaluation for a full quantitative impact assessment. The focus was on energy consumption/supply and transport policies, as these are the two areas that have the most direct impact on both air quality and climate change.

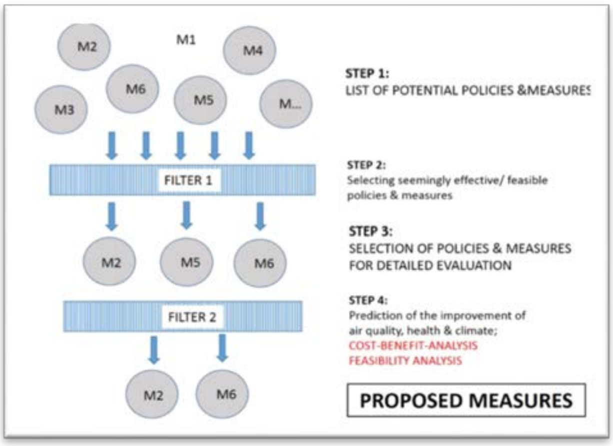

Figure 5:Flow chart of policy/measure selection and evaluation process

An overview of international policies are given below for each emission sector identified.

Transport: prioritising rapid urban transit, walking and cycling networks in cities as well as rail inter-urban freight and passenger travel; shifting to cleaner heavy-duty diesel vehicles and low-emissions vehicles and fuels, including fuels with reduced Sulphur content.

Urban planning: improving the energy efficiency of buildings and making cities more compact, and thus energy efficient.

Industry: clean technologies that reduce industrial smokestack emissions; improved management of urban and agricultural waste, including capture of methane gas emitted from waste sites as an alternative to incineration (for use as biogas).

Power generation: increased use of low-emissions fuels and renewable combustion-free power sources (like solar, wind or hydropower); co-generation of heat and power; and distributed energy generation (e.g. mini-grids and rooftop solar power generation);

Municipal and agricultural waste management: strategies for waste reduction, waste separation, recycling and reuse or waste reprocessing; as well as improved methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste. Where incineration is unavoidable, then combustion technologies with strict emission controls are critical.

Relationship between Policies and Measures

The term *policy intervention* is used for the options and measures an authority can take and the term *response* for the expected reactions that can be expressed as activity and/or emissions factor changes. The underlying assumption is that to estimate the effect of a specific measure, both the general framework (options an authority can take) and the expected response of individuals and emission source operators that lead to the emission reduction need to be described.

Policy interventions can lead to multiple types of responses with a certain probability distribution. For example, the introduction of low emission zones motivates some inhabitants to buy a new car (expressed as changes in the vehicle stock) and others to change their mode of transportation (switch from private car to public transport). In ICARUS the *responses* to standardized measures will be based as far as possible on elasticities and agent-based modeling results of ICARUS WP4.

Different methodologies will be employed to estimate the relationship between policies and measures. The Driver-Pressure-State- Impact-Response model (or DPSIR) and the Driver-Pressure-State-Exposure-Effect-Action model (or DPSEEA) will be considered for linking policies and measures to health effects.

The DPISIR model was developed for the European Environment Agency and links, in a fairly simple way, the key factors that influence environmental pressures, changes in the state of the environment and impacts.

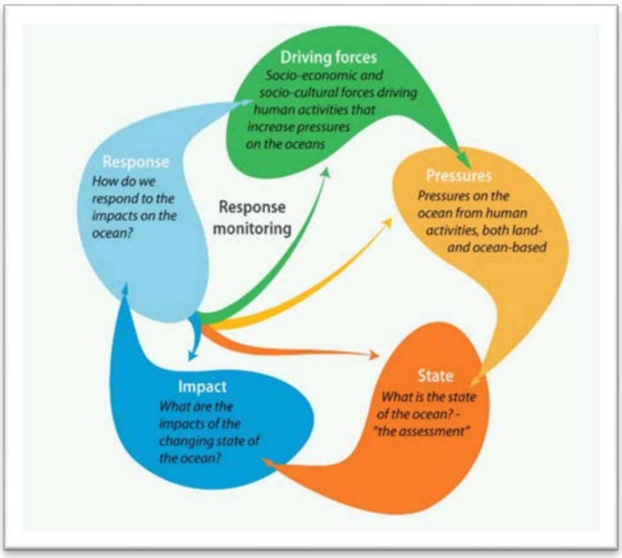

Figure 6:The levels of DPSIR framework

DPSIR has been widely used in the development of models for air pollution – for example it formed the basis of the methodological framework for the ExternE series of projects. It has advantages in that it is flexible and can be applied for a range of environmental endpoints (not just health).
The impact pathway approach stemming from the DPSIR mode is reported in Figure below.

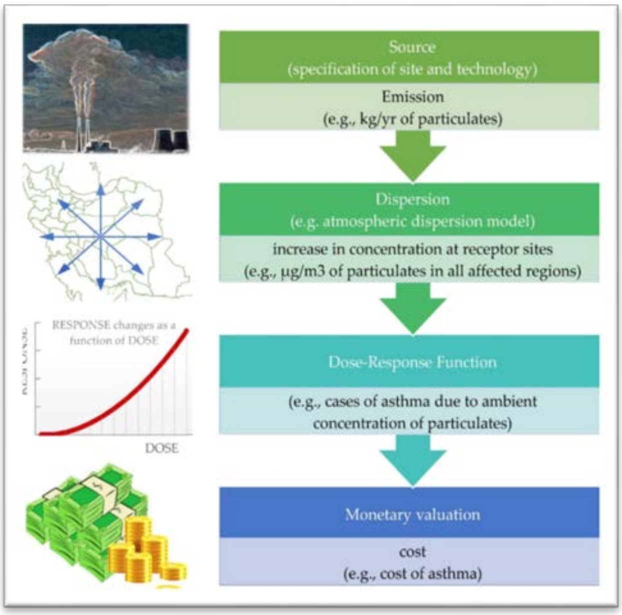

Figure 7:The Impact Pathway approach

The DPSEEA framework was developed on behalf of the World Health Organisation. It adapted the DPSIR framework primarily by recognising the links from state of the environment through exposures to health effects helping to further unpick the interrelationships between environment and health.

Figure 8:The DPSEEA model framework

The ecosystems-enriched DPSEEA looks further into the wider impacts of changes in the environment and assesses the consequences for health not only of direct impacts on health of such changes, but also impacts that are mediated by ecosystems and the services they provide.

The eDPSEEA model Considers wider threats to health through changes in ecosystems and considers wider spatial and temporal impacts

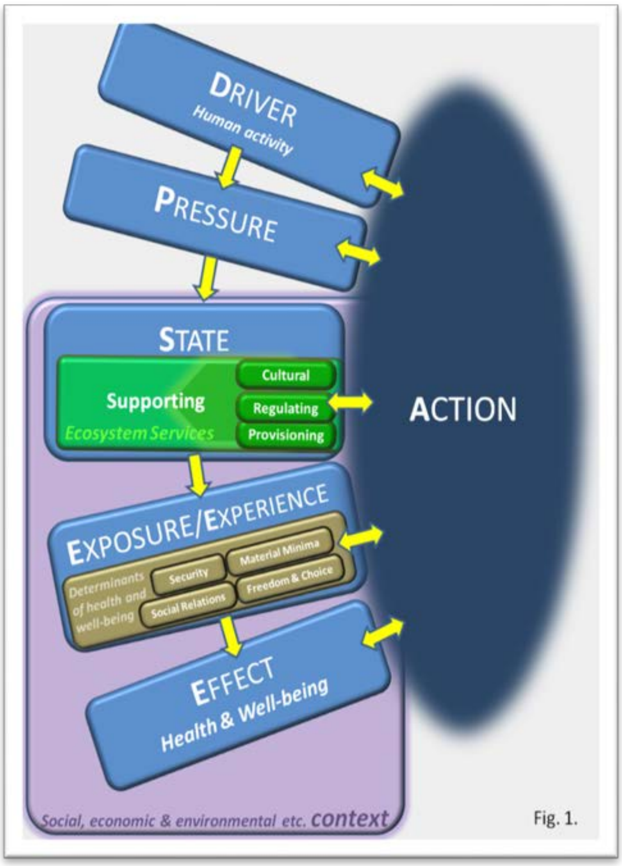

Figure 9:The eDPSEEA model

Health impact caused by exposure will be quantified mainly through Dose-Response relationships for all major anthropogenic air pollutants and greenhouse gases as well as heavy metals, benzo(a)pyrene and dioxins/furans considering the health specific endpoints both in the short and long term.

Improving well-being can have a number of impacts on individuals and society. Figure 10 gives an overview of some of the key linkages and the values that can be attached to these.

The assessment of the co-benefits to health, crime, productivity, education and environments of wellbeing improvements are likely to yield potentially significant gains over and above the direct benefits to individuals.

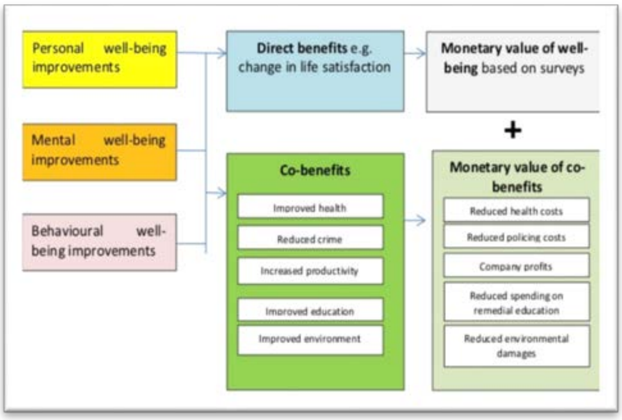

Figure 10: The impacts of wellbeing and associated values

One method used to derive monetary valuation of wellbeing is to equate a loss of wellbeing with a level three mental health problem (i.e. severe problem) and use Quality Adjusted Life Year (QALY) weights assessed by health economists. QALYs are one way economists use to estimate the varying types of health outcomes in a common metric – with a value of 1 indicating a year in full health and 0 indicating death.

Another method for valuing changes in subjective wellbeing using the "life satisfaction approach". This approach uses survey based methods to estimate changes in life satisfaction. Using analysis of the relationship between life satisfaction and income, this method can be used as a way of valuing changes in provision of a range of non-marketed goods

The approach we will use in ICARUS to evaluate uncertainty on the impact assessment of air pollution and climate change policies will be based on a tiered approach, that is, the analysis can begin with a simple qualitative uncertainty characterisation and subsequently progress to semi-quantitative and finally a complex quantitative assessment. The latter could follow when a lower tier analysis indicates a high degree of uncertainty for certain identified sources, the sources are highly influential to final result(s), and sufficient information and resources are available to conduct quantitative uncertainty assessment.

More specifically the developed uncertainty framework consists of a combination of qualitative and quantitative assessment tools clustered into three tiers. Tier 1 corresponds to the qualitative part, where all sources of uncertainty are tabulated in a matrix, by annotating direction, level and appraisal of the knowledge-base. Tiers 2 and 3 involve the quantitative evaluations of those sources with the highest degree of uncertainty and the highest influence to the final result(s), provided that sufficient information and resources are available. Methods employed at the tier 2 and 3 include screening methods for global sensitivity assessment (tier 2), the Bayesian statistics and Monte Carlo analysis (tier 3).

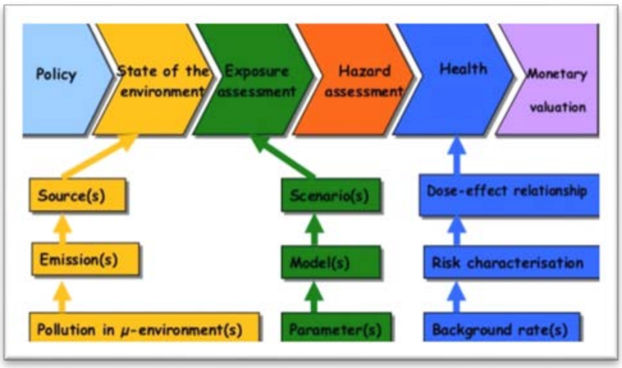

Figure 11: Identification of the 'micro' sources of uncertainty.

User requirements for ICARUS user-centric tools

ICARUS user-centric tools aim to combine the data and the know-how acquired by the ICARUS Consortium and integrate them in a structured and user-oriented way to provide personalized information to the users, to eventually raise awareness on the effects of citizen behaviors on air quality and climate change so as to actively engage them towards a shift to a more environment-friendly lifestyle.

To this aim functional and non-functional requirements have been defined based on feedback received via interviews with citizens from all the nine ICARUS participating cities. The design and the analysis of the interviews was done based on the Design Thinking methodology.

Then, based on the functional requirements, the functional specifications have been defined, in the form of user stories related to the functionalities exposed to the three user groups of the user-centric tools.

The participating cities interviewed at least six citizens each from each of the following age (and occupation) groups:

1. A 15- to 18-year old pupil
2. A student
3. One person from 25 to 35 years old
4. One person from 35 to 45 years old
5. One person from 45 to 55 years old
6. One person older than 55 years

Beside the high level of empathy that has been achieved and the experience acquired by all partners that participated in the Design Thinking based process of requirements gathering, the working groups managed to successfully combine all the feedback in three person profiles:

1. A 21-year-old student (Adam), representing the groups of the 15- to 18-year-old pupil and the student;
2. 42-year-old Elen, representing the age groups from 25 to 55 years old and
3. 65-year-old Jensen, representing the age group of over 55 years old.

Figure 12: The Design Thinking person profiles created.

Based on them, the functional and non-functional requirements were defined with confidence. The user stories created are mostly oriented in presenting the functionalities that the user-centric must have, instead of getting into low-level details of the exact way they will be implemented; thus, leaving space for an agile-based development methodology.

Dissemination Activities

A number of dissemination and networking activities happened during these 6 months. This includes the participation at international conferences, congress and scientific workshops. The most important are hereinafter summarized.

21st European Eco-Innovation Forum, Sofia Bulgaria, February 2018

On behalf of the ICARUS Coordination team Dr. Spyros Karakitsios gave oral presentation entitled "*Assessment of public health co-benefits from traffic related emission policies in Thessaloniki*" at the 21st European Forum on Eco-innovation jointly organised by the European Commission and the Ministry of Environment and Water of the Republic of Bulgaria, under the auspices of the Bulgarian Presidency of the Council of the European Union.

ICARUS was invited to take part to an interactive session showcasing companies, municipalities, and public and private sector initiatives that have succeeded in developing and deploying effective new technologies, or innovative business and governance models for reducing air pollution originating from transport.

Figure 13: Dr. Karakitsios at the Eco-innovation for air quality Forum

Green-week – Brussels, May 2018

ICARUS team was present at the EU Green Week, 21 – 25th May 2018 in Brussel. A joint stand was hosted in the main exhibition hall of the event. The stand had several visitors: policy makers, MEPs assistants, ministries' and municipalities' representatives as well as researchers that were interested in the different methodologies and citizen's engagement approaches. The session consisted of short project presentations, a panel discussion and live demonstration of low cost sensors.

Figure 14: The ICARUS stand at the EU Green Week in Brussels (May 2018).

The ICARUS team presented the use of different sensor devices, data collection methods and data interpretation and validation.

Figure 15: The EU Green Week in Brussels (May 2018).

ISEAC-40 - Environmental & Food Monitoring Conference, Santiago de Compostela, June 2018

ICARUS team participated to the ISEAC40 with an oral presentation entitled "*The Organic Carbon (OC) And Elemental Carbon (EC) In 5 European Cities. The Icarus Experience.*"

Figure 16: The ISEAC-40 Conference

2nd annual meeting of Clair-City and of iSCAPE projects (Sosnowiec, April 2018 and Bologna, May 2018)

Prof. Dimosthenis Sarigiannis and Dr. Alberto Gotti attended the 2nd annual meeting of the EU projects iSCAPE and Clair-City as representatives of the respective Project Advisory Boards. During the meetings Prof. Sarigiannis provided an overview of the ICARUS projects and first results through an oral presentation entitled "*Integrated assessment of policies and measures tackling population exposure and health impact of air pollution and climate change in urban environments - the ICARUS paradigm*".

Brno annual meeting

ICARUS hosted its second annual meeting on 18 and 19 June 2018 in Brno, Czech Republic, alongside with our External Advisory Board. The meeting was followed by the first ICARUS Summer School on 20-22 June.

Figure 17: Photo group at the ICARUS 2nd annual meeting.

Over forty organisations, individuals and groups joined us for the days to discuss the themes, identify challenges and share solutions.

Figure 18: Picture taken at the ICARUS 2nd annual meeting

Issues raised by our attendees included the increasing awareness of air pollution, discussions around air quality modelling and measurements methods, use of agent based models for estimating exposure at individual level and the methodological approaches for urban impact assessment of new or in pipeline policies and measures in Europe.

The summer school aimed to broaden awareness of air pollution and ways to control it. The two day event will provide participants with both theoretical knowledge and hands-on experience in relation to behavioral change initiatives and sensing technologies for air quality management and control. Through the co-creation workshops during the 2-day summer school, participants were actively involved and trained on the ICARUS innovative tools for urban impact assessment in support of air quality and climate change governance.

Figure 19: The first ICARUS Summer School in Brno

Social media

Twitter @ICARUS2020 is used regularly to link to content on the website and build networks outside of the project. We want to hear from you! Please do not hesitate to send us your feedback, comments or questions here

ICARUS reports

For all, detailed information about deliverables, milestones please visit
http://icarus2020.eu/work-packages/.
All materials are downloadable.

Participate in the Project

For every updates about ICARUS project you can follows us at @ICARUS2020, where you can participate in the project by giving constructive suggestions, comments, etc.

Next Issue

The next issue will feature other news and documents developed by the ICARUS Consortium covering the period of next 6 months from July 2018 to December 2018.

Contact us

We want to hear from you! Please do not hesitate to send us your feedback, comments or questions here

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