



# ICARUS Newsletter – 5<sup>th</sup> Issue

## Integrated Climate forcing and Air pollution Reduction in Urban Systems

Welcome to the fifth newsletter of the ICARUS project. This issue covers the period from July 2018 to December 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 endeavour 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/>

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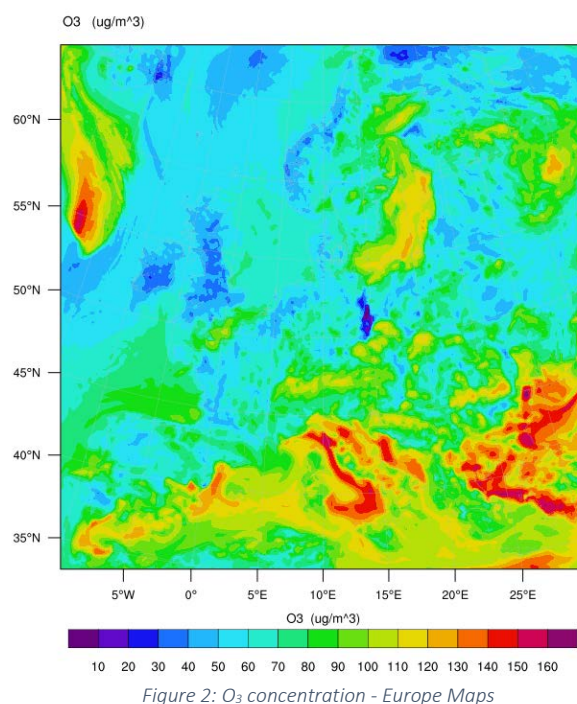
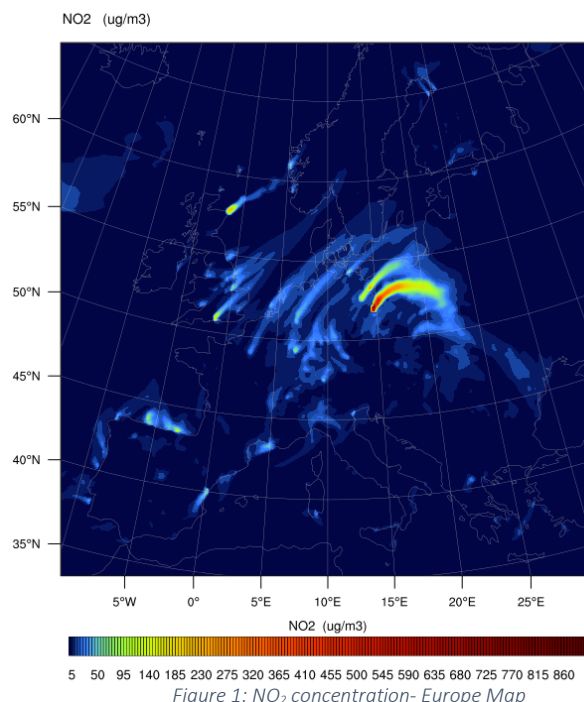
## Introduction

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 AQ and GHGs dispersion modelling simulations for the period from 2001 to 2050 in all the nine ICARUS cities, the execution of the sensors campaigns, the definition and implementation of life cycle emission and carbon footprint modelling framework, the development of narrative visions for 2050 smart green and healthy cities as well as the development of the alpha versions of the ICARUS Decision Support System (DSS) and mobile app. You may have a look below for further information.

## Atmospheric modeling

A novel approach based on weather clustering is inaugurated to study climate change effect on air quality levels. The adopted clustering technique has been applied to weather data covering a period of 50 years (from 2001 to 2050). Principal Component Analysis (PCA) and K-Means Cluster Analysis were applied to estimate the appropriate number of clusters for each ICARUS cities. The to estimate the appropriate number of weather clusters. The Weather Research and Forecasting (WRF) model coupled with Chemistry (WRF-Chem) has been applied to representative day(s) for each weather cluster to provide high space and time resolution ground concentrations of major air pollutants ( $PM_{10}$ ,  $PM_{2.5}$ ,  $NO_2$ ,  $O_3$ , BaP) and major Greenhouse Gases ( $CO_2$ ,  $CH_4$ ) in Europe (Figure 1), focusing on the nine ICARUS cities, reflecting climatic trends.

Results reinforces the view that the greenhouse effect is likely to be 'felt' even under a moderate climatic scenario such as Representative Concentration Pathways - RCP4.5. For the cities of Stuttgart, Ljubljana, Brno, Milan, Basel and Copenhagen/Roskilde the present results indicate that adverse effects in terms of heat wave events frequency seem to reach maxima in the early 40s. For the most southern cities (i.e. Athens, Thessaloniki, Madrid) the maxima shifts to the late 40s and probably beyond. We found a significant correlation between weather patterns with higher heat wave events and weather patterns with elevated  $O_3$  concentrations (e.g. Figure 2). This is an indication that the greenhouse effect seems to lead to elevated  $O_3$  concentrations likely due to the intensified atmospheric photochemical



activity. For all cities, the clusters associated with elevated heat wave events and  $O_3$  concentrations show an increase.  $NO_2$  show decreasing trends since early 20s from most of the cities with the exception of Thessaloniki, Milan and Madrid where no visible trends for this period are clearly visible.  $O_3$  concentration levels do not show visible trends in all cities except in Athens and Basel. In Athens there is decrease until 20s and an increasing trend afterwards and in Basel there is a decreasing trend after 20s.  $PM$  concentration levels show decreasing trends since early 20s for

the cities Stuttgart, Basel, Roskilde, Copenhagen and Ljubljana while in Brno, Athens, Milan, Madrid and Thessaloniki no clear trends are visible. In general terms, PM level trends seem to have an analogous behavior of NO<sub>2</sub> trends (e.g. Figure 3). Meeting the WHO health standards for NO<sub>2</sub>, O<sub>3</sub>, PM and BaP will still continue to be an issue in the future.

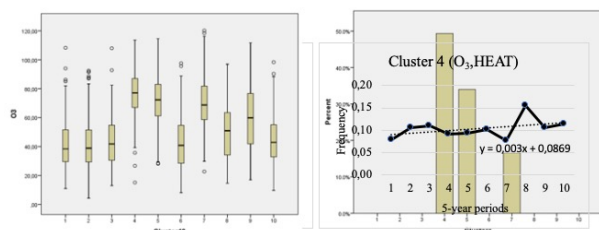


Figure 3: Athens area (a) O<sub>3</sub> Concentrations per cluster (b) Heat Waves per cluster (c) O<sub>3</sub> Daily max concentrations

Concerning the influence of the foreseen emission inventory changes on air pollutant concentrations levels: The policies incorporated into the adopted emission patterns seem to lead to NO<sub>2</sub> decreases and O<sub>3</sub> slight decreases. In the case of PM, the picture is mixed. For example, in Stuttgart, Milan, Basel and Athens the indication is of clear decrease whereas in Brno there are slight increases. In Madrid and Ljubljana slight decreases were estimated.

### Life cycle emissions and carbon footprint estimation

To allow for a consistent comparison of air pollution and greenhouse gas reduction measures there is an increasing need to look beyond direct end of pipe emissions as they are currently indicated in conventional emission inventories. Indirect emissions origin on the one hand from the cities consumption of grid supplied electricity, heat and cooling, that causes emissions at power plants outside the city area and production chain emissions due to embodied emissions from food and materials consumed in the city.

To this aim we developed a satellite system that provides indirect emission factors for all relevant life cycle stages and that can be linked to activity emission factor databases generated in previous project tasks (Figure 4). Emission factors for electricity use have been calculated up to 2050. Various scenarios represent different renewable energy shares and future emerging technologies. Additionally, emission factors have been estimated for different transportation services and means, building heating and insulation

materials based on state of the art life cycle databases (SimaPro7.0 and Ecoinvent database).

Combining emission factors of all scopes makes it possible to compare emissions of different technology options like heating systems over the whole life cycle. The contribution of each life cycle stage to the provision of a service (e.g. heating or mobility demand) differs extremely between options and is likely to be influenced by new evolving technologies. The policy selection in each ICARUS city made it clear that especially emissions from electricity generation will gain on relevance as a lot of city specific measures lead to an increased use of electricity in heating and transportation. Measures that go along with a high material consumption like the insulation of buildings or introduction of new appliances show a high importance of the production and disposal phase when compared to the total life cycle emissions. This holistic consideration of all life cycle stages allows the early identification of measure induced problem-shifting from one life cycle phase to another and from one region to another, which is especially important when assessing air pollution measures.

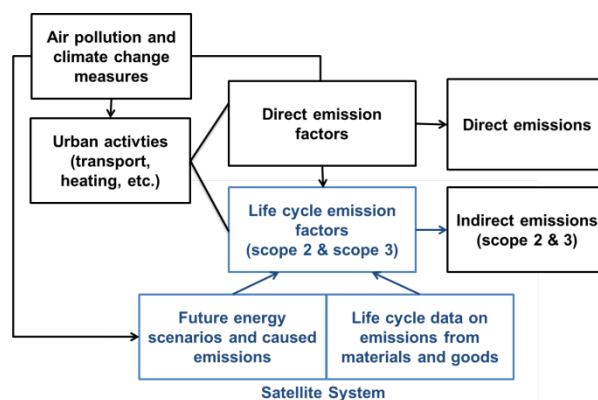


Figure 4: Framework and structure of the satellite system

### Collection of multi-sensor data for personal exposure monitoring

The ICARUS multi-sensor campaigns have been completed in some ICARUS cities to collect primary data on environmental exposure and exposure determinants directly from the field. More than 1,000 individuals overall in the 9 cities were already included in the list of volunteers paying attention to have a uniform spatial distribution within each city and within the different class ages and gender. Special attention was given to properly advertise the sensor campaigns by making use of several communication channels (website, Facebook,



Twitter, printed flyer etc.) so as to reach a wide audience to facilitate the recruitment (Figures 5 and 6).



Figure 5: two-page print flyer for the sensor campaign advertisement in Basel



Figure 6: Campaigns volunteer shares her sensors experience on twitter

Measured data included personal exposure to PM, a wide range of organic chemicals (PAHs), indoor air quality, temperature, humidity, location, distance, type of activity, heartbeat and sleeping patterns.

A data collection platform has been designed and implemented to collect data of various formats from the APIs available by the vendor of each device (Garmin, ICARUS Portable PM Sensor, uHoo). It stores all the collected data on Couchbase Server, a NoSQL document-oriented database. Figure 7 gives a complete overview of the campaign.

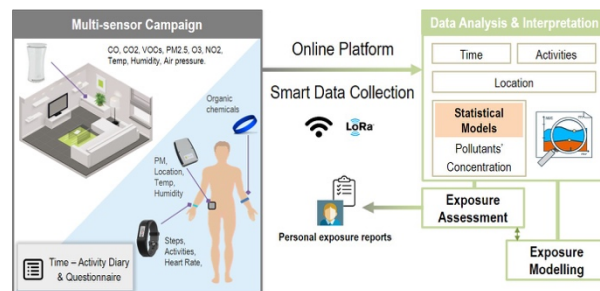


Figure 7: Overview of ICARUS sensors campaign

During this semester, Basel has completed its summer and winter campaign, covering 47 and 46 participants respectively. The winter campaigns has been completed in Thessaloniki covering 85 participants. The statistical details about the campaigns for both the cities are given in the table 1 below.

Table 1: completed ICARUS campaigns

	Basel Summer	Basel Winter	Thessaloniki Winter
Total Number of Participants	47	46	85
Female	24	23	47
Male	23	23	38
Children (<18)	-	-	27
Adults	43	41	57
Elderly (>65)	4	5	1
Total Number of Households	35	36	25
Total Campaign Duration	28 days	30 days	25 days
1 <sup>st</sup> visit duration	30 - 45 min	30 - 45 min	45 - 90 min
2 <sup>nd</sup> (final) visit duration	20 min	20 min	10 min

### Developing visions for smart green and healthy cities

ICARUS cities, as all cities around the world, are facing similar challenges (climate change, globalization, urbanization) and are adjusting by developing long-term strategies and implementing policies that will increase city resilience in all dimensions (social, financial, environmental). Urban visions are a combination of the use of digital technologies and green city planning to promote and optimize well-being whilst curbing air pollution and mitigating climate

change. ICARUS methodology on developing visions of smart, green and healthy cities employs a foresight approach by combining participatory workshops, literature review and horizon scanning.

The project organized a two-days participatory workshop for “Developing visions for Smart Green and Healthy Cities” with experts and stakeholders of ICARUS cities on 20-21 September 2018 in Madrid.



Figure 8 ICARUS community and stakeholders attending the 2nd Stakeholder Engagement Workshop in Madrid

The aim of the workshop was to identify the more relevant future trends, and to elaborate future narratives on green, smart and healthy cities from the point of view of key stakeholder and strategic sectors experts. The workshop was attended by several stakeholders of ICARUS cities that had the opportunity to share and exchange views and ideas on developing long term city visions from a green and healthy perspective. On the first day of the workshop, experts were encouraged to list future change factors and select the more relevant in the longer term, while on the second day, there was an experts' idea-sharing session followed by a discussion with stakeholders from ICARUS cities. From the narrative visions developed in the workshop, three distinct visions of future cities that would be broadly sustainable, smart and healthy were identified:

1. Smart Tech City – has more emphasis on technology as a solution to environmental and health issues and individualistic values being important.
2. Sharing Smart Communities – takes the community at the center and considers interconnection to be an important driver for improved societies.
3. Connected Cobweb City – considers a more dispersed, individualistic society, with more of a balance between technology and socially

contingent solutions to the challenges facing our cities.

The 3 ICARUS visions developed will be presented in the next round of workshops and used as the basis for framing and identifying the future strategies and policies to be analyzed.



Figure 9 ICARUS 2nd Stakeholder Engagement Workshop in Madrid

### ICARUS Decision Support Tool

The Alpha version of the ICARUS Decision Support System (DSS) that has been implemented during the first two years of the project enhanced with new functionalities. The users of the DSS can interact with the system via a Web-GIS interface, which enables them to access data for their region(s) in a user-friendly and intuitive way. Several types of information are displayed in separated layers that can be enabled or disabled (Figure 10).

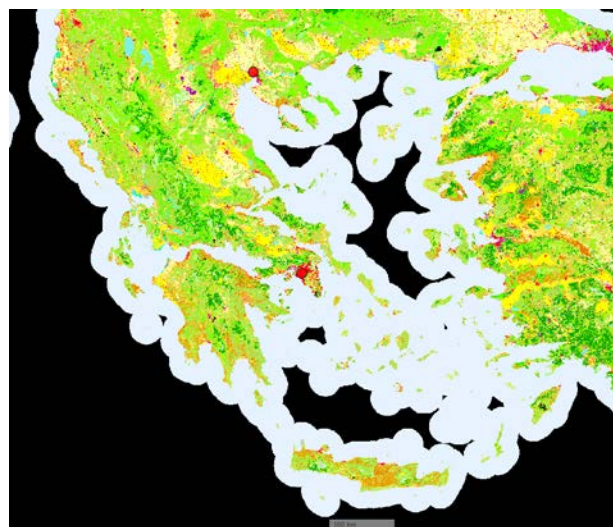


Figure 10 Land-cover for Greece

The DSS offers the users the ability to select among predefined scenarios for air-quality-related policy measures or to define their own scenarios to finally estimate their impact on the environment and human health. On top of that, users can keep track of the progress of the applied



policies and compare the estimated with the eventual impact.

The data platform created for the collection of the ICARUS sensor campaigns data has been integrated with the DSS, enabling the exploitation of collected data. A notification system is also being set up, that handles the communication from the DSS to smart devices via e-mail, SMS and smartphone applications, which will be useful for informational and user-authentication purposes.

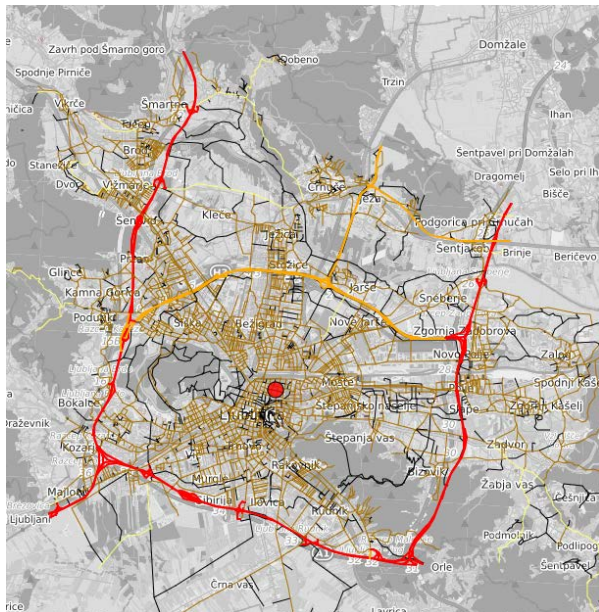


Figure 11 Liubliana road network

## ICARUS User-Centric Tool

The Design Thinking methodology has been employed for all the stages of the creation of the User-Centric Tool (UCT), from inception to development and testing. The User-Centric Tool consist of two main components: the end-user interface, which will actually be a smartphone application, and the administrative back-end, which is a web-based.

The User-Centric Tools address to main targets:

- Informing the citizens and raise awareness on urban air quality, its consequences and the impact of individual behaviour on it.
- Engaging the citizens towards adapting a more environment-friendly lifestyle

The information offered by the UCT is in text and multimedia format and is both generic and location-based. The purpose is to sensitize the citizens about the air-quality impact to all aspects of human life, from health to economic and societal. To this end the ICARUS UCT offers

personalized information and advices based on user's location and habits.

A further key aspect of the application concerns user engagement. The ICARUS UCT enables local stakeholders, such as policy makers, authorities and corporations, to set up campaigns to promote environment-friendly behaviour. Citizens residing in the area are invited to join the campaigns and try to attend the goals set by, while keeping track of their progress through the smartphone application. Awards can be offered to all people attending a goal or to the ones that get the highest “score”. The citizens can also set their own goals and follow their commitment to them (Figure 12).

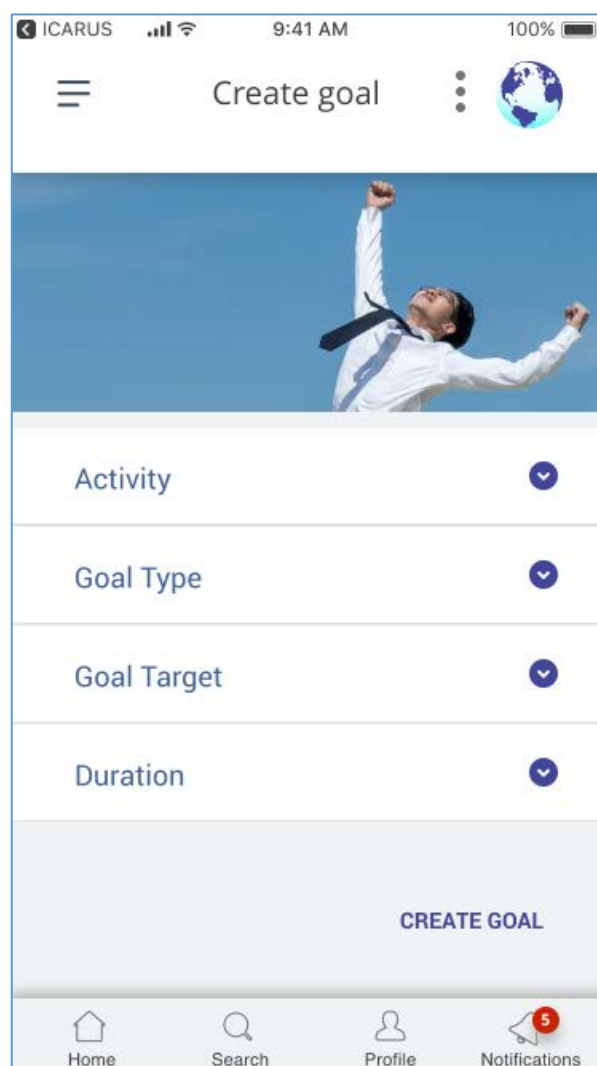


Figure 12 Setting and keeping track of own goals

## Dissemination, Communication Activities

ICARUS partners presented the main results obtained in international/national scientific meetings and conferences. During the project dissemination events, several types of communication and promotional material (scientific newsletters, flyers, booklets, etc.) have

been distributed to the participants. In this semester, the ICARUS team participated and disseminated ICARUS concept/results in the main following events:

- ICARUS participated to the 36<sup>th</sup> Congress of Spanish Society of Epidemiology and the 13<sup>th</sup> Congress of Portuguese Society of Epidemiology held in September 2018 in Lisbon with an oral presentation entitled: ICARUS project: Integrated Climate Forcing and Air Pollution Reduction in Urban System.

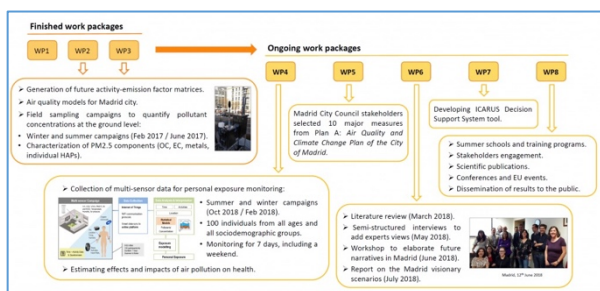


Figure 13 ICARUS Poster presented at the 36<sup>th</sup> Congress of Spanish Society of Epidemiology held in September 2018 in Lisbon

- ICARUS attended the Euro-cities Environmental Forum, respectively organized at Tampere (Finland) in October 2018. The forum aims to improve understanding of the links between air pollution, climate change, and public health, exploring different scenarios for the designing of integrated policies delivering co-benefits. By focusing on examples from the energy, constructions and transport sectors, participants will discuss the opportunities to achieve the Paris Agreement while creating immediate local benefits for people and health. The ICARUS project was presented in various round tables focused on win-win solutions for air pollution exposure management in cities.

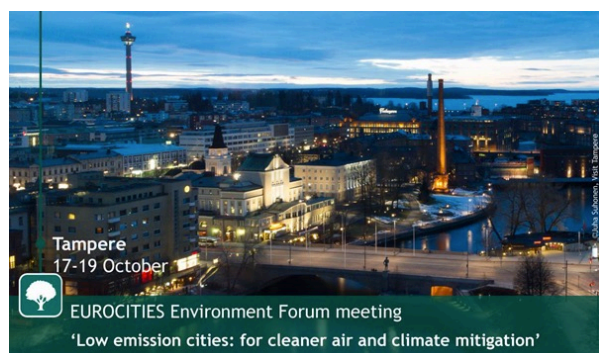


Figure 14 ICARUS chaired the roundtable "Win-win solutions for air pollution exposure management in cities" at the EUROCITIES Environmental Forum in Tampere (Finland)

- ICARUS participated at International Conference Sport and Public Space organized in September 2018 in Ljubljana (Slovenia) with an oral presentation entitled "Towards an active citizenship in a modern urban environment"
- ICARUS attended the 5<sup>th</sup> Geological congress held in Velenje (Slovenia) in October 2018 to present the results of source apportionment campaign executed in Ljubljana. In addition, measures and policies for reduction of emissions for Ljubljana were presented in the presentation entitled "Integrated climate forcing and air pollution reduction in urban systems (ICARUS): Ljubljana case study, Velenje, Slovenia".
- ICARUS participated to the 11<sup>th</sup> International Scientific Conference on Energy and Climate Change held in Athens (Greece) in October 2018 with an oral presentation entitled "Weather clustering approaches and air quality climatic trends in urban environments".



Figure 15 ICARUS presenting at 11<sup>th</sup> International Scientific Conference on Energy and Climate Change held in Athens (Greece) in October 2018, at Athens, Greece

- ICARUS was present at the LfU Symposium on Air Quality Control (Clean Air Planning - Measures and strategies against nitrogen oxides) in Augsburg in October 2018, where new findings and possible measures to improve the emission situation have been presented.

**Achievement** These events contributed to greatly enhance the ICARUS visibility and to lay the groundwork for a closer cooperation in air quality and climate change management and to institute a dialogue in the scientific community and gave us

the opportunity to establish strategic connections with other European initiatives.

Based on the ICARUS's experience, the Project Coordinator, Prof. D. Sarigiannis, AUTH, contributed to provide input to the multi-annual work programme in the frame of the Programme Committee for the specific programme implementing HORIZON 2020 – Societal Challenge 5 'Climate action, environment, resource efficiency and raw materials meetings. One key outcome of these meetings was the introduction at European level of the health component in the environment agenda. The addition of human health dimension as a major criterion for evaluating the efficacy and the benefit (in the cost-benefit analysis) of policies and measures for combatting climate change and air pollution represents a major achievement of ICARUS which indeed contributed to raise the importance of human health inclusion at the policy-science interface.

### Social media

Twitter @ICARUS2020 is used regularly to link to content on the website and build networks outside of the project. By addressing the broader community and the general public, the project will contribute to bridging the gap between science and society. 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 Project

For every updates about ICARUS project you can follow 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 Jan 2019 to June 2019.

### 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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