

GCARE

GLOBAL CENTRE
FOR CLEAN AIR RESEARCH

Collaborative, cutting edge research
leading to clean air for all



GLOBAL CENTRE FOR
CLEAN AIR RESEARCH

UNIVERSITY OF SURREY

ABOUT GCARE

THE GLOBAL CENTRE FOR CLEAN AIR RESEARCH (GCARE) AT THE UNIVERSITY OF SURREY IS A WORLD RENOWNED, MULTI-DISCIPLINARY CENTRE FOCUSED ON IMPROVING INDOOR AND OUTDOOR AIR QUALITY. WELL-EQUIPPED WITH DIVERSE EXPERIMENTAL AND MODELLING FACILITIES, THE CENTRE HAS AN EXPERIENCED TEAM FOCUSED ON CARRYING OUT CUTTING-EDGE RESEARCH. WE TRANSLATE THESE COMPLEX SCIENTIFIC FINDINGS INTO SIMPLE SOLUTIONS, PRACTICAL GUIDANCE AND TOOLS FOR USE BY THE PUBLIC AND PRACTITIONERS TO REDUCE THE ADVERSE IMPACTS OF AIR POLLUTION ON HEALTH AND THE ENVIRONMENT.

GCARE IN NUMBERS

20+

GCARE core researchers

£8M+

Research funding

30+

Research sponsors

35+

Global partners

40+

Projects

40+

International visitors

4,000+

Media articles

300+

Journal publications





WELCOME

▶ The air that we breathe has a fundamental effect on our health and the environment around us. Air pollution – from transport, industry and other sources – leads to the premature deaths of 40,000 people a year in the UK alone, costing the NHS around £160 million. Worldwide, seven million people die as a result of indoor and outdoor air pollution annually.

GCARE draws on extensive academic expertise in the field of air pollution and indoor air quality to deliver solutions to this major global challenge. We work with local, national and international partners from academia, industry and government, as well as the public often through the ‘citizen-science’ approach.

Among our many achievements, we have published recommendations on improving the air that children breathe in and around schools (which is now being published in 11 different countries) and guidance on designing and implementing green infrastructure (e.g. trees, hedges, green walls and green roofs) to mitigate local outdoor air pollution.

We are proud to be playing an important role in improving air quality for communities around the world. We look forward to working with an even wider network of partners in the future as we move closer to realising our collaborative global vision of ‘clean air for all’.

Professor Prashant Kumar
Director of GCARE

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We provide a virtual and physical collaborative platform for conducting leading-edge research, supporting University-wide national and international projects under the themes of ‘Urban Living’, ‘Sustainability’ and ‘Lifelong Health’ as well as the United Nations’ Sustainable Development Goals.

” Professor Prashant Kumar

OUR FOCUS

Key aims

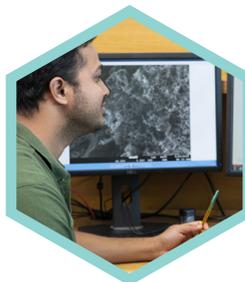
- To understand the impact of air pollutants on quality of life and the built environment
- To develop internationally-validated, engineering-driven solutions
- To underpin regulatory policy and strategies
- To set the agenda for future research.

Our values

- Quality and rigour
- Teamwork and innovation
- Trust and confidence
- Confidentiality and impartiality
- Inclusiveness.

Our approach

- Carry out fundamental research and apply it to specific global challenges
- Capitalise on emerging technologies
- Develop and use advanced modelling tools
- Undertake advanced monitoring
- Acquire high quality robust data
- Disseminate widely and effectively.



Research themes

Particulate matter: aerosols, ultrafine particles, nanoparticles and engineered nanoparticles.

Indoor and outdoor air pollution: sources, processes, exhaust and non-exhaust emissions, dispersion modelling, exposure and health impact assessment, indoor air quality, ventilation, infiltration.

Cities and megacities: low-cost environment sensing, urban nexus (energy-pollution; water-energy-pollution), emission modelling.

Built environment: green infrastructure, green/grey infrastructure interactions, air pollution impacts on built infrastructure, nature-based solutions.

Natural environment: biogenic, peatlands, wildfire and other naturally occurring phenomena which have a significant impact on rural/urban environments.

Co-pollutants: noise and global climate-related pollutants (e.g. CO₂, CH₄).

Interfaces of air pollution: with water, energy, land use, nanotechnology, transportation and the built infrastructure.

Smart cities: environmental sensing, urban mobility, transport accessibility.

Climate change: Greenhouse gas emissions, weather and climate related natural hazards (floods, droughts and heatwaves), climate-proof nature-based solutions.

Viruses: Covid-19, airborne transmission and infection, social distances, ventilation requirements, filtration, face masks.





OUR PROJECTS

WE COLLABORATE WITH PARTNERS FROM AROUND THE WORLD ON A VARIED RANGE OF RESEARCH PROJECTS, WITH FUNDING FROM VARIOUS ORGANISATIONS INCLUDING THE EUROPEAN COMMISSION, INNOVATE UK, THE ENGINEERING AND PHYSICAL SCIENCES RESEARCH COUNCIL (EPSRC), NATURAL ENVIRONMENT RESEARCH COUNCIL (NERC), ECONOMIC AND SOCIAL RESEARCH COUNCIL (ESRC), RESEARCH ENGLAND, GLOBAL CHALLENGE RESEARCH FUND (GCRF), SÃO PAULO RESEARCH FOUNDATION (FAPESP), QATAR NATIONAL RESEARCH FOUNDATION (QNRF), BRITISH COUNCIL, UNIVERSITY GLOBAL PARTNERSHIP NETWORK (UGPN) AND VARIOUS INDUSTRY AND CHARITY ORGANISATIONS.



► **GCARE** has been involved in over 40 different projects. These long-term collaborations include:

- EPSRC-funded INHALE (Health assessment across biological length scales for personal pollution exposure and its mitigation) project
- UK-India NERC-funded project ASAP-Delhi (an integrated study of air pollutant sources in the Delhi National Capital Region)

- H2020-funded OPERANDUM (OPEn-air laboRAtories for Nature baseD soLutions to Manage hydro-meteo risks)
- UKRI-EPSRC funded COVID projects such as COVAIR (Is SARS-CoV-2 airborne and does it interact with particle pollutants?) and CO-TRACE (COvid-19 Transmission Risk Assessment Case studies - education Establishments).

OUR PROJECTS

Here are just a few of the projects we are currently involved in (see our website for full details).

▶ Clean air engineering for cities

Air pollution disproportionately affects poor and vulnerable communities, and exacerbates inequalities in official development assistance (ODA) countries. The CARE-Cities (Clean Air Engineering for Cities) project, funded by Research England, brings together a multidisciplinary team to improve understanding of emissions, low-cost pollution monitoring technology and exposure reduction strategies in selected ODA cities. One study undertaken as part of this project has established that keeping car windows open exposes drivers to 80 per cent more air pollution. Another has shown that local activities such as construction and vehicle traffic contribute significantly to high levels of pollution in and around Delhi.

▶ Nature-based solutions for climate change

The OPERANDUM project has involved GCARE researchers working with collaborators across Europe to manage the rising impact of severe weather and climate-related hazards using nature-based solutions. The team has analysed over 300 case studies of floods, droughts, earthquakes and storms, and identified the most effective nature-based solutions for combatting different types of hazard. These include 'green' approaches such as urban parks, trees and grasses; 'blue' constructions such as small ponds; and 'hybrid' solutions which combine the two.

▶ Testing of low-cost air pollution sensors

The emergence of low-cost sensors (LSCs) has rapidly changed the landscape of air pollution monitoring, but currently no accreditation or regulatory standards exist for LSCs. With this in mind, GCARE designed and built the Envilution® chamber, an affordable, compact and lightweight unit which can be used to evaluate the performance of different LSCs. Easy to operate and maintain, the Envilution® chamber provides a controlled environment for temperature and relative humidity, along with different concentrations of particles.

▶ Covid-19 research

GCARE has supported the fight against Covid-19 in a number of different ways. We are part of the international effort making a case for the recognition of airborne transmission of the virus and have identified that improved indoor ventilation is an important step to reduce the risk of infection. We have also investigated mitigation strategies of Covid-19 transmission in enclosed environments within the Royal Society's RAMP (Rapid Assistance in Modelling the Pandemic) initiative and conducted a study into the positive environmental effects of lockdown in Indian cities.

In addition, GCARE has developed a state-of-the-art filter testing rig which can evaluate the filtration and efficiency performance of different types of commercial and handmade facemasks.





CASE STUDY

PUTTING GREEN INFRASTRUCTURE INTO ACTION

TREES AND SHRUBS CAN PROVIDE FAR MORE THAN A VISUAL DECORATION IN URBAN AREAS. GCARE'S WORK ON GREEN INFRASTRUCTURE HAS LED TO THE PUBLICATION OF BEST PRACTICE GUIDANCE FOR PLANTING TREES, HEDGES AND OTHER GREEN BARRIERS TO MITIGATE LOCAL AIR POLLUTION.

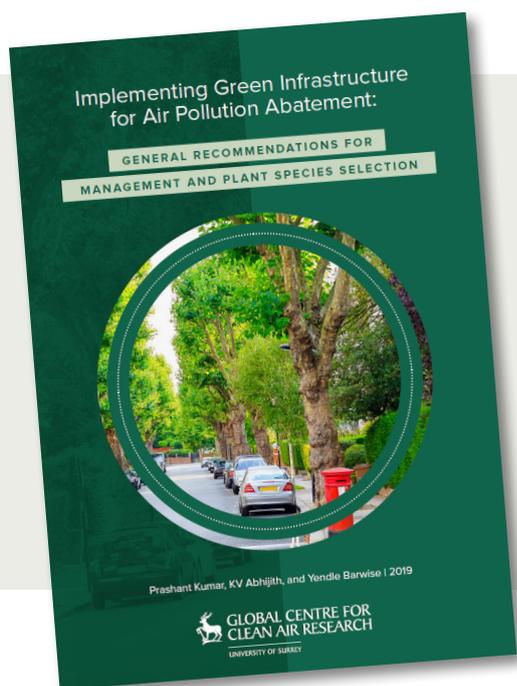
According to the European Environment Agency, air pollution causes 400,000 premature deaths annually, with pollution generated by traffic a major contributor of particulate matter. However, research by **GCARE** shows that the careful planning and planting of green infrastructure (e.g. trees, hedges, green walls and green roofs) can help to mitigate this risk. Green infrastructure offers benefits to public health both by diverting and diluting pollution away from people, and via direct capture of pollutants on leaf surfaces through deposition.

GCARE spearheaded green infrastructure research as a leading partner in iSCAPE (Improving Smart Control

of Air Pollution in Europe), a three-year project funded by the European Community's H2020 Programme.

Within this project, a Guildford Living Lab was set up to enable experimental research with community partners to tackle the issue of air pollution. This included a five-month continuous experiment at a children's park which found that simply planting a hedge can halve the amount of traffic pollution that reaches children as they play. Another study, across six roadside locations in Guildford, Surrey, revealed that planting hedges only (rather than trees, or a combination of trees, hedges and shrubs) is most effective at reducing pollution exposure.

- ▶ The results of a number of studies have contributed to an accessible and freely available guidance document, *Implementing Green Infrastructure for Air Pollution Abatement*, published by GCARE in August 2019. These guidelines are designed to help urban planners, landscape architects and gardeners to make informed decisions about the species of vegetation to use, and the factors to consider when designing a ‘green barrier’.



The guidelines identify which plant species are the most effective barriers against air pollution, taking into account factors such as leaf size, foliage density and pollen. They give recommendations for how and where to implement planting for maximum effect in two typical urban environments: built-up street canyons (streets with buildings on both sides) and open roads.

Prior to the publication of the green infrastructure guidance, GCARE contributed to London-specific guidelines designed to help borough council planners and other bodies to optimise London’s green spaces, woodlands and wetlands for better public and environmental health. The Mayor of London’s Guide, *Using Green Infrastructure to Protect People from Air Pollution*, was published by Greater London Authority in April 2019.

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We have been exploring the role of green infrastructure since 2014 and are continually learning more about its potential to protect people from the devastating effects of air pollution. Taking into account factors such as vegetation lifecycle, wind direction and other variables, we have been able to build up a framework of knowledge which is now helping municipal planners to create healthier and safer urban environments for citizens.

” Professor Prashant Kumar



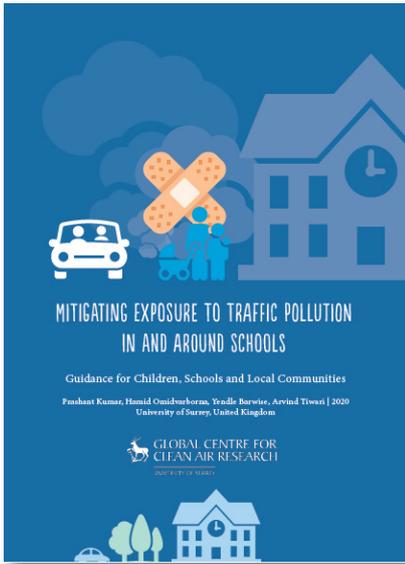
CASE STUDY

NEW GUIDANCE HELPS SCHOOLS AROUND THE WORLD TO TACKLE AIR POLLUTION

IN JUNE 2020 GCARE PUBLISHED GUIDANCE ON THE TANGIBLE MEASURES THAT CAN BE TAKEN TO IMPROVE THE AIR CHILDREN BREATHE, IN AND AROUND SCHOOLS.

Air pollution exposure in children has been linked to poor concentration and a number of short and long-term health conditions including bronchitis, asthma and stunted lung development. However, for accessibility many schools are located near to main roads, while the use of cars to take children to and from school intensifies local pollution levels.

In a collaborative Guildford Living Lab/citizen-science project with parents, schools, local government and environmental groups among other partners, **GCARE** has responded to this global challenge by publishing a new guidance booklet, *Mitigating Exposure to Traffic Pollution in and around Schools*.



- ▶ General recommendations to improve air quality are provided including planting green barriers such as hedges and building new schools away from main roads. The booklet also contains 10 targeted recommendations which can help to reduce children’s daily exposure to air pollution. These include rescheduling morning outdoor classes to the afternoon, encouraging children to keep their distance from idling cars, and encouraging parents to change their commuting habits.

The booklet is being published in Hindi, Punjabi, Urdu, Bengali, Tamil, Portuguese, Chinese, Spanish, Swahili, Kurdish and Arabic.

“ Traffic pollution has been listed as one of the top pollution sources in urban cities, leading to severe health impacts, especially on children. This booklet will enable schools, children and communities to make correct decisions, and further help reduce the exposure risk of children to air pollution.

” Professor Shijie Cao, Southeast University in Nanjing, China

“ This booklet is so helpful. It is an excellent example of an effective approach to communicating complex science by using practical and accessible messages.

” Professor Stephen Holgate, UK Research and Innovation and Met Office Clean Air Champion, and Special Advisor to the Royal College of Physicians on Air Quality





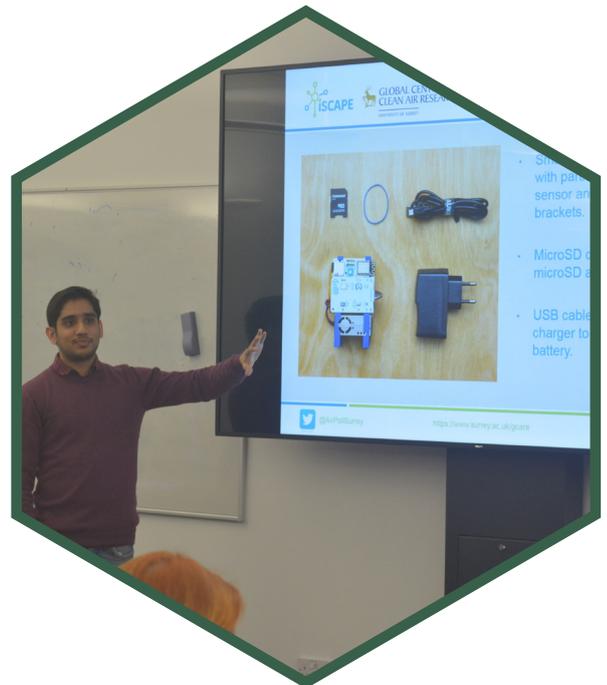
GUILDFORD LIVING LAB



- ▶ GUILDFORD LIVING LAB (GLL) IS A PLATFORM FOR LOCAL COMMUNITIES, RESEARCHERS, INDUSTRIAL COMPANIES AND OTHER STAKEHOLDERS TO TACKLE THE ISSUES OF AIR POLLUTION AND CLIMATE CHANGE, AND CO-CREATE AND CO-DESIGN SUSTAINABLE SOLUTIONS.

GLL was formed in 2016 as part of the H2020 iSCAPE (Improving the Smart Control of Air Pollution in Europe) project and is now supported via various community activities and projects that can be seen on the dedicated page of the GCARE website.

By taking a citizen-science approach and working with the public, councils and various stakeholder organisations in the local area, we have achieved successful project outcomes to a range of air pollution and climate change challenges. These projects include our work on green infrastructure for exposure mitigation along busy roadsides (see pages 7-8) and air quality in and around schools (see pages 9-10).



AIR QUALITY LAB

GCARE'S AIR QUALITY LAB (AQL) IS A WORLD-CLASS AIR QUALITY MONITORING FACILITY WHICH SUPPORTS OUR LABORATORY TESTING AND EXPERIMENTAL FIELD CAMPAIGNS.

The AQL houses advanced equipment including: monitors to measure fine particulate matter size distribution/number and concentrations, nano/ultrafine particles and gases; aerosol generator; weather station; high precision microbalance; relative humidity generator; furnace; leaf porometer; and data loggers.

GCARE researchers have the fundamental scientific knowledge to design, build and test custom-made experimental rigs such as our Environmental-Pollution (Envilution®) Chamber and our Filter Testing Rig for facemasks (see page 6 for more information on these facilities).

The AQL also offers specialised mobile air quality facilities for transportation and urban micro-environments, where traditional approaches may not be feasible.



COLLABORATE WITH US

GCARE BRINGS TOGETHER INTERNAL TEAMS WITH EXTERNAL PARTNERS TO UNDERTAKE CONNECTED RESEARCH, EXPLORE NEW AREAS AND DEVELOP PRACTICAL TOOLS AND GUIDELINES. WE ARE A HUB FOR LOCAL, NATIONAL AND INTERNATIONAL COLLABORATION, AND WORK WITH BUSINESSES, ACADEMIC AND RESEARCH INSTITUTIONS, AND GOVERNMENTS ALL OVER THE WORLD.

Our research is funded from a range of different sources:

- ▶ UK Research Councils and other government initiatives
- ▶ Industry partners working on collaborative projects
- ▶ Philanthropic donations from trusts and foundations, and individuals

If you would like to support or collaborate with **GCARE**, or to commission us to provide solutions to your air quality problem, please contact us at GCARE@surrey.ac.uk



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