1. **Abstract** (http://www.sciencedirect.com/science/article/pii/S0048969700004290)

Accurate, high-resolution maps of traffic-related air pollution are needed both as a basis for assessing exposures as part of epidemiological studies, and to inform urban air-quality policy and traffic management. This paper assesses the use of a GIS-based, regression mapping technique to model spatial patterns of traffic-related air pollution. The model — developed using data from 80 passive sampler sites in Huddersfield, as part of the SAVIAH (Small Area Variations in Air Quality and Health) project — uses data on traffic flows and land cover in the 300-m buffer zone around each site, and altitude of the site, as predictors of NO2 concentrations. It was tested here by application in four urban areas in the UK: Huddersfield (for the year following that used for initial model development), Sheffield, Northampton, and part of London. In each case, a GIS was built in ArcInfo, integrating relevant data on road traffic, urban land use and topography. Monitoring of NO2 was undertaken using replicate passive samplers (in London, data were obtained from surveys carried out as part of the London network). In Huddersfield, Sheffield and Northampton, the model was first calibrated by comparing modelled results with monitored NO2 concentrations at 10 randomly selected sites; the calibrated model was then validated against data from a further 10–28 sites. In London, where data for only 11 sites were available, validation was not undertaken. Results showed that the model performed well in all cases. After local calibration, the model gave estimates of mean annual NO2 concentrations within a factor of 1.5 of the actual mean (approx. 70–90%) of the time and within a factor of 2 between 70 and 100% of the time. r2 values between modelled and observed concentrations are in the range of 0.58–0.76. These results are comparable to those achieved by more sophisticated dispersion models. The model also has several advantages over dispersion modelling. It is able, for example, to provide high-resolution maps across a whole urban area without the need to interpolate between receptor points. It also offers substantially reduced costs and processing times compared to formal dispersion modelling. It is concluded that the model might thus be used as a means of mapping long-term air pollution concentrations either in support of local authority air-quality management strategies, or in epidemiological studies.

**Cite-**

Briggs, David J., et al. "A regression-based method for mapping traffic-related air pollution: application and testing in four contrasting urban environments." Science of the Total Environment 253.1 (2000): 151-167.

2 **Abstract**: ( http://ieeexplore.ieee.org/abstract/document/4505485/)

Environmental monitoring constitutes an important field of application for wireless sensor networks. Given the severity of potential climate changes, environmental impact on cities, and pollution, it is a domain where sensor networks can have great impact and as such, is getting more and more attention. Current data collection techniques are indeed rather limited and make use of very expensive sensing stations, leading to a lack of appropriate observations. In this paper, we present SensorScope, a collaborative project between environmental and network researchers, that aims at providing an efficient and inexpensive out-of-the-box environmental monitoring system, based on a wireless sensor network. We especially focus on data gathering and present the hardware and network architecture of SensorScope. We also describe a real-world deployment, which took place on a rock glacier in Switzerland, as well as the results we obtained.

**Cite-**

Barrenetxea, Guillermo, et al. "Sensorscope: Out-of-the-box environmental monitoring." Information Processing in Sensor Networks, 2008. IPSN'08. International Conference on. IEEE, 2008

3) **Abstract** (http://www.sciencedirect.com/science/article/pii/S1352231005000713)

This study addresses two objectives: (1) to develop a formal method of optimally locating a dense network of air pollution monitoring stations; and (2) to derive an exposure assessment model based on these monitoring data and related land use, population, and biophysical information. Previous studies have located monitors in an ad hoc fashion, favouring the placement of monitors in traffic “hot spots” or in areas deemed subjectively to be of interest. We apply our methodology in locating 100 nitrogen dioxide monitors in Toronto, Canada. Locations identified by the method represent land use, transportation infrastructure and the distribution of at-risk populations. Our exposure assessments derived from the monitoring program produce reasonable estimates at the intra-urban scale. The method for optimally locating monitors may have widespread applicability for the design of pollution monitoring networks, particularly for measuring traffic pollutants with fine-scale spatial variability.

**Cite –**

**4) Abstract** (http://www.sciencedirect.com/science/article/pii/S0375674299000084)

Kanaroglou, Pavlos S., et al. "Establishing an air pollution monitoring network for intra-urban population exposure assessment: A location-allocation approach." Atmospheric Environment 39.13 (2005): 2399-2409.

The northern part of the Czech Republic ranks among the most industrially polluted areas of Europe due mainly to combustion of brown coal with high contents of pyrite and heavy metals. Fly ash produced through high-temperature combustion of fossil fuel is also rich in ferromagnetic minerals. These are also included in emissions, penetrate the soil, and can be identified using rock-magnetic methods. Magnetic susceptibility is directly linked to a concentration of ferromagnetic minerals and is dominated by high values of magnetite. This study reports on a method of monitoring the spatial distribution of pollution due to airborne solid particles based on measurements of magnetic susceptibility of the soil surface near a brown-coal-burning power plant. Areas with high emission levels and their maximum range are determined. A comparison of the spatial distribution of magnetic susceptibility with heavy-metal concentrations in soil samples suggests that magnetic mapping can be beneficially used as a rapid and inexpensive method to determine contamination due to industrial activity.

**Cite –**

**Kapička, A., et al. "Proxy mapping of fly-ash pollution of soils around a coal-burning power plant: a case study in the Czech Republic." Journal of Geochemical Exploration 66.1 (1999): 291-297.**

**5) Abstract** (https://arxiv.org/abs/1005.1737)

Sensor networks are currently an active research area mainly due to the potential of their applications. In this paper we investigate the use of Wireless Sensor Networks (WSN) for air pollution monitoring in Mauritius. With the fast growing industrial activities on the island, the problem of air pollution is becoming a major concern for the health of the population. We proposed an innovative system named Wireless Sensor Network Air Pollution Monitoring System (WAPMS) to monitor air pollution in Mauritius through the use of wireless sensors deployed in huge numbers around the island. The proposed system makes use of an Air Quality Index (AQI) which is presently not available in Mauritius. In order to improve the efficiency of WAPMS, we have designed and implemented a new data aggregation algorithm named Recursive Converging Quartiles (RCQ). The algorithm is used to merge data to eliminate duplicates, filter out invalid readings and summarise them into a simpler form which significantly reduce the amount of data to be transmitted to the sink and thus saving energy. For better power management we used a hierarchical routing protocol in WAPMS and caused the motes to sleep during idle time**.**

**Cite**-

Khedo, Kavi K., Rajiv Perseedoss, and Avinash Mungur. "A wireless sensor network air pollution monitoring system." arXiv preprint arXiv:1005.1737 (2010).

**6) Abstract** (http://ieeexplore.ieee.org/abstract/document/5766902/)

This paper presents P-Sense (Pollution-Sense), a PS system for air pollution monitoring and control. The ultimate goal of this system is to allow government officials, international organizations, communities, and individuals access to the pollution data to address their particular problems and needs. P-Sense should provide large amounts of pollution data in time and space with different granularities. Government officials will have data to monitor and control the Air Quality Index (AQI) [1] of a city, state, or country; doctors will be able to correlate respiratory problems of their patients to the AQI they are exposed to during their daily activities, in the places they work and live; county officials, community developers, and realtors will have data to determine the best place where to build a new school or community and advertise properties according to the AQI where they are located.

**Cite-**

Mendez, Diego, et al. "P-sense: A participatory sensing system for air pollution monitoring and control." Pervasive Computing and Communications Workshops (PERCOM Workshops), 2011 IEEE International Conference on. IEEE, 2011.

7) **Abstract –**(http://www.sciencedirect.com/science/article/pii/S0925400505001899)

This paper describes the development of a gas sensor system to be used as a sensing node to form a dense real-time environmental monitoring network. Moreover, a new auto-calibration method is proposed to achieve the maintenance-free operation of the sensor network. The network connectivity can be used not only for data collection but also for the calibration and diagnosis of the sensors since the measured pollutant concentrations can be easily compared through the network with nearby sensors and governmental monitoring stations. Different pollutant concentrations are usually monitored at different sites. However, a case study on local NO2 distribution has shown that there exists a special condition under which pollutant concentrations become low and uniform in a certain local area. The baseline of the gas sensor response can be adjusted in this special occasion using the pollutant concentration values reported from the neighboring environmental monitoring stations. The experimental result has shown that NO2 concentration can be measured with sufficient accuracy by incorporating appropriate temperature and humidity compensation into calibration curves. Moreover, a case study on auto-calibration demonstrates its effectiveness in keeping the measurement accuracy of the sensor system in long-term operation.

**Cite-**

Tsujita, Wataru, et al. "Gas sensor network for air-pollution monitoring." Sensors and Actuators B: Chemical 110.2 (2005): 304-311.

8) **Abstract –** (http://www.sciencedirect.com/science/article/pii/S1468699605000483)

Air pollution is a serious problem in thickly populated and industrialized areas in Thailand, especially in Bangkok. The air pollution in Bangkok is abundant, especially in areas where pollution sources and the human population are concentrated. Economic growth and industrialization are proceeding at a rapid pace, accompanied by increasing emissions of air polluting sources. Furthermore, though the variety and quantities of polluting sources have increased dramatically, the development of a suitable method for monitoring the pollution causing sources has not followed at the same pace. Environmental impacts of air pollutants have impact on public health, vegetation, material deterioration etc. To prevent or minimize the damage caused by atmospheric pollution, suitable monitoring systems are urgently needed that can rapidly and reliably detect and quantify polluting sources for monitoring by regulating authorities in order to prevent further deterioration of the current pollution levels. Consequently, it is important that the current real-time air quality monitoring system, controlled by the Pollution Control Department (PCD), should be adapted or extended to aid in alleviating this problem.

Nanotechnology has been applied to several industrial and domestic fields, for example, applications for gas monitoring systems, gas leak detectors in factories, fire and toxic gas detectors, ventilation control, breath alcohol detectors, and the like. Here we report an application example of studying air quality monitoring based on nanotechnology ‘solid state gas sensors’.

So as to carry out air pollution monitoring over an extensive area, a combination of ground measurements through inexpensive sensors and wireless GIS will be used for this purpose. This portable device, comprising solid state gas sensors integrated to a Personal Digital Assistant (PDA) linked through Bluetooth communication tools and Global Positioning System (GPS), will allow rapid dissemination of information on pollution levels at multiple sites simultaneously. The AQ report generated can be then published using Internet GIS to provide a real-time information service for the PCD, for increased public awareness and enhanced public participation. The local deterministic and geostatistical interpolation methods have been used for spatial prediction, and to find out the most suitable method for studying air pollution, based on observations at each monitoring site.

**Cite-**

Pummakarnchana, Ornprapa, N. Tripathi, and Joydeep Dutta. "Air pollution monitoring and GIS modeling: a new use of nanotechnology based solid state gas sensors." Science and Technology of Advanced Materials 6.3 (2005): 251-255.

**9) Abstract-** (http://www.tandfonline.com/doi/abs/10.1080/03067318908028377)

Passive Biomonitoring with the folious lichen Hypogymnia physodes (L.) Nyl. has been tested in Switzerland. Multielement analyses enable qualitative and quantitative conclusions about the composition and amount of important active pollutants. Many elements correlate well with the general air pollution indicator IAP18. Hypogymnia physodes possess good accumulation capacity for important air pollutants. The method has been calibrated for Pb and Cu with technical deposition measurements. The “Passive Biomonitoring” and “Calibrated Lichen Indication Method” compose together an “Integral Biological Testing System for Air Pollution in Switzerland”. This system enables detailed statements on total air pollution in general and on single pollutants as well.

**Cite-**

Herzig, Rolf, et al. "Passive biomonitoring with lichens as a part of an integrated biological measuring system for monitoring air pollution in Switzerland." International Journal of Environmental Analytical Chemistry 35.1 (1989): 43-57.

**10) Abstract-**

We describe a fully computer-controlled differential optical absorption spectroscopy system for atmospheric air pollution monitoring. A receiving optical telescope can sequentially tune in to light beams from a number of distant high-pressure Xe lamp light sources to cover the area of a medium-sized city. A beam-finding servosystem and automatic gain control permit unattended long-time monitoring. Using an astronomical code, we can also search and track celestial sources. Selected wavelength regions are rapidly and repetitively swept by a monochromator to sensitively record the atmospheric absorption spectrum while avoiding the detrimental effects of atmospheric turbulence. By computer fitting to stored laboratory spectra, we can evaluate the path-averaged concentration of a number of important pollutants such as NO2, SO2, and O3. A measurement of NH3 and NO close to the UV limit is also demonstrated.

**Cite-**

Edner, Hans, et al. "Differential optical absorption spectroscopy (DOAS) system for urban atmospheric pollution monitoring." Applied optics 32.3 (1993): 327-333.

**11) Abstract-**

This paper presents an integrated exposure monitoring system, based on an expansion of existing air quality monitoring systems using dispersion modelling. The system allows: (1) identifying geographical areas whose inhabitants are most exposed to ambient pollution; (2) identifying how many people in an area are exposed to concentrations of pollution exceeding air quality guidelines; (3) describing the exposure of population subgroups (e.g. children); (4) planning pollution abatement measures and quantifying their effects; (5) establishing risk assessment and management programs, and (6) investigating the short- and long-term effects of both pollutants and pollution sources on public health. The effect of pollution is rarely very large and in order to discover it, exposure estimation must provide data that reflects both spatial and temporal variations. Estimates of pollution exposure are obtained using an integrated approach that combines results of measurements from monitoring programs with dispersion calculations. These values can serve as estimates for individual short-term or long-term exposure. The grouped data allows the expression of ambient pollution concentrations as the spatial distribution of estimates such as the mean or 98th percentile of such compounds as SO2, O3, NO2, PM10 and PM2.5. This integrated approach has been combined into a single software package, AirQUIS.

**Cite-**

Clench-Aas, Jocelyne, et al. "Air pollution exposure monitoring and estimating. Part I. Integrated air quality monitoring system." Journal of Environmental Monitoring 1.4 (1999): 313-319.

**12) Abstract-**(http://www.sciencedirect.com/science/article/pii/096016869390245T)

The thermal/optical reflectance method of carbon analysis developed by Huntzicker et al. (in Particulate Carbon, Atmospheric Life Cycle, edited by Wolff G. T. and Klimisch R. L., pp. 79–88, Plenum Press, New York, 1982) has been adapted by several laboratories for the quantification of organic and elemental carbon on quartz-fiber filter deposits. While the principle used by these laboratories is identical to that of Huntzicker et al., the details differ with respect to calibration standards, analysis time, temperature ramping and volatilization/combustion temperatures. This paper reports a variation on this method which has been applied to over 27,000 samples taken in more than a dozen urban and regional air quality studies in the U.S.A. In this variation, a 0.5 cm2 punch from a dozen urban and regional air quality studies in 120, 250, 450 and 550°C in a pure helium atmosphere, then to combustion at temperatures of 550, 700 and 800°C in a 2% oxygen and 98% helium atmosphere. The carbon which evolves at each temperature is converted to methane and quantified with a flame ionization detector. The seven separate carbon fractions facilitate evaluation of the method and increase the information content concerning the samples.

The reflectance from the deposit side of the filter punch is monitored throughout the analysis. This reflectance usually decreases during volatilization in the helium atmosphere owing to the pyrolysis of organic material. When oxygen is added, the reflectance increases as the light-absorbing carbon is combusted and removed. Organic carbon is defined as that which evolves prior to re-attainment of the original reflectance, and elemental carbon is defined as that which evolves after the original reflectance has been attained. By this definition, “organic carbon” is actually organic carbon that does not absorb light at the wavelength used (632.8 nm) and “elemental carbon” is light-absorbing organic and elemental carbon. Assumptions underlying the procedure are discussed, as well as comparisons with other methods and recommendations for further work.

**Cite-**

Chow, Judith C., et al. "The DRI thermal/optical reflectance carbon analysis system: description, evaluation and applications in US air quality studies." Atmospheric Environment. Part A. General Topics 27.8 (1993): 1185-1201.

**13) Abstract-** (http://www.sciencedirect.com/science/article/pii/S0926580503001250)

This paper describes the development of a Web-based construction Project Performance Monitoring System (PPMS) that aims to assist project managers in exercising construction project control. With the aid of a panel of project management specialists, the following project performance measure categories are identified for inclusion in the PPMS: People, Cost, Time, Quality, Safety and Health, Environment, Client Satisfaction, and Communication. For each of the performance measure categories, performance indicators and their measurements are also established. The monitoring process is automated through the use of the World Wide Web and database technology. Data collection and dissemination are similarly automated. The use of the PPMS can help senior project management, project directors, project managers, etc., in monitoring and assessing project performance.

**Cite-** Cheung, Sai On, Henry CH Suen, and Kevin KW Cheung. "PPMS: a web-based construction project performance monitoring system." Automation in construction 13.3 (2004): 361-376.

**14) Abstract-** (http://www.sciencedirect.com/science/article/pii/S1352231003001286)

The Center for Space Research (CSR), in conjunction with the Monitoring Operations Division (MOD) of the Texas Commission on Environmental Quality (TCEQ), is evaluating the use of remotely sensed satellite data to assist in monitoring and predicting air quality in Texas. The challenges of meeting air quality standards established by the US Environmental Protection Agency (US EPA) are impacted by the transport of pollution into Texas that originates from outside our borders and are cumulative with those generated by local sources. In an attempt to quantify the concentrations of all pollution sources, MOD has installed ground-based monitoring stations in rural regions along the Texas geographic boundaries including the Gulf coast, as well as urban regions that are the predominant sources of domestic pollution. However, analysis of time-lapse GOES satellite imagery at MOD, clearly demonstrates the shortcomings of using only ground-based observations for monitoring air quality across Texas. These shortcomings include the vastness of State borders, that can only be monitored with a large number of ground-based sensors, and gradients in pollution concentration that depend upon the location of the point source, the meteorology governing its transport to Texas, and its diffusion across the region. With the launch of NASA's MODerate resolution Imaging Spectroradiometer (MODIS), the transport of aerosol-borne pollutants can now be monitored over land and ocean surfaces. Thus, CSR and MOD personnel have applied MODIS data to several classes of pollution that routinely impact Texas air quality. Results demonstrate MODIS data and products can detect and track the migration of pollutants. This paper presents one case study in which continental haze from the northeast moved into the region and subsequently required health advisories to be issued for 150 counties in Texas. It is concluded that MODIS provides the basis for developing advanced data products that will, when used in conjunction with ground-based observations, create a cost-effective and accurate pollution monitoring system for the entire state of Texas.

**Cite-**

Hutchison, Keith D. "Applications of MODIS satellite data and products for monitoring air quality in the state of Texas." Atmospheric Environment 37.17 (2003): 2403-2412.

**15) Abstract-** (http://journals.ametsoc.org/doi/abs/10.1175/2008BAMS2355.1)

The Global and Regional Earth System Monitoring Using Satellite and In Situ Data (GEMS) project is combining the manifold expertise in atmospheric composition research and numerical weather prediction of 32 European institutes to build a comprehensive monitoring and forecasting system for greenhouse gases, reactive gases, aerosol, and regional air quality. The project is funded by the European Commission as part of the Global Monitoring of Environment and Security (GMES) framework. GEMS has extended the data assimilation system of the European Centre for Medium-Range Weather Forecasts (ECMWF) to include various tracers for which satellite observations exist. A chemical transport model has been coupled to this system to account for the atmospheric chemistry. The GEMS system provides lateral boundary conditions for a set of 10 regional air quality forecast models and global atmospheric fields for use in surface flux inversions for the greenhouse gases. Observations from both in situ and satellite sources are used as input, and the output products will serve users such as policy makers, environmental agencies, the science community, and providers of end-user services for air quality and health. This article provides an overview of GEMS and uses some recent results to illustrate the current status of the project. It is expected that GEMS will grow into a full operational service for the atmospheric component of GMES in the next decade. Part of this transition will be the merge with the Protocol Monitoring for the GMES Service Element: Atmosphere (PROMOTE) GMES project into the Monitoring of Atmospheric Composition and Climate (MACC) project.

**Cite-**

Hollingsworth, A., et al. "Toward a monitoring and forecasting system for atmospheric composition: The GEMS project." Bulletin of the American Meteorological Society 89.8 (2008): 1147-1164.