Seminar - Air Quality and IoT-based Air Sensors

Report of Contributions

https://indico.global/e/12193

Contribution ID: **1** Type: **oral presentation**

Getting useful, actionable data out of air sensors

Wednesday 8 November 2023 14:20 (20 minutes)

There is a severe lack of air pollution data around the world. Low cost sensors (LCS) for measuring air pollution offer a possible path forward to remedy the lack of data, though they require careful calibration as the manufacturer-reported data often show large biases against reference monitors. Traditionally, calibration has occurred by co-locating LCS with local reference monitors and developing correction models using statistical techniques. To address this, we first present a series of traditional "colocation"corrections models and performance evaluations in a variety of global cities, including New York City, Kinshasa (DRC), Kampala (Uganda), Accra (Ghana), and New Delhi (India). We then present a globally-applicable Gaussian Mixture Regression (GMR) probabilistic model trained on co-locations from at least 5 global cities that span across wide temperature, relative humidity, and PM2.5 ranges. The model is tested on at least 20 independent co-location datasets that the GMR has not seen. We also compare the data corrected by the universal GMR to a more traditional, local correction factor, where available. GMR has proven successful for correcting LCS data: in Kinshasa, the GMR-corrected PurpleAir data resulted in R2 = 0.88 when compared to the MetOne BAM-1020, and in Accra, the GMR lowered the Mean Absolute Error of Clarity data from 7.51 ☒g/m3 to 1.93 ☒g/m3. The wide breadth of the universal GMR allows for correction of LCS data without the need for a local co-location which enables the correction of data from 10,000+ PurpleAir sensors around the world.

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Presenter: WESTERVELT, Daniel (Columbia University)

Session Classification: SPECIAL SESSION

Contribution ID: **2** Type: **oral presentation**

Comprehensive Assessment of Air Pollution and Air Quality Index (AQI) in Residential Areas: A Case Study in Ikere-Ekiti

Tuesday 7 November 2023 10:25 (15 minutes)

Introduction: A rising worry is the deterioration of outdoor air quality, especially in urban residential areas. The main topic of this work is the measurement of significant air pollutants outdoor at Ikere-Ekiti, Nigeria, such as CO2, NO2, O3, PM1, PM2.5, and PM10, as well as their correlation with the Air Quality Index (AQI). Research Question: This study's main research question is: What can be learned through continuous monitoring with an inexpensive sensor regarding how different CO2, NO2, O3, PM1, PM2.5, and PM10 concentrations affect the computed Air Quality Index (AQI) in a residential area? Methodology: In an apartment building in Ikere-Ekiti, a month-long surveillance monitoring was carried out. Pollutant concentrations were measured using a low-cost sensor, and the AQI values were calculated using the information obtained. Results and Discussion: High levels of CO2 (582.74 ppm), NO2 (177.68 ppb), O3 (68.01 ppb), PM1 (9.28 μg/m³), PM2.5 (13.17 μg/m³), and PM10 (14 μg/m³) were found in the results. The AQI values highlighted the potential health concerns linked to the detected pollution levels by indicating air quality ranging from moderate to unhealthy. Conclusions: The findings offer insightful information about the dynamics of air pollution and its effects on a household setting. The study highlights the value of inexpensive sensors for monitoring the quality of the air in real time and highlights the necessity of focused interventions to reduce pollution and enhance the well-being of locals in cities like Ikere-Ekiti.

Keywords: Air Pollution, Air Quality Index (AQI), Case Study, Comprehensive Assessment, Ikere-Ekiti, Residential Areas.

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Session Classification: Air Pollution and Health Effects

Contribution ID: **3** Type: **oral presentation**

ASSESSMENT OF ORGANOPHOSPHATE FLAME RETARDANTS IN AIR SAMPLES FROM AN ELECTRONIC WASTE DUMPSITE IN LAGOS, NIGERIA

Tuesday 7 November 2023 10:50 (15 minutes)

In developing countries, recycling of electrical and electronic waste (e-waste) has attracted much attention as a significant source of flame-retardants. In this study, ten air samples were collected in 2022 from five different locations to include an electronic waste dumpsite and control site in Lagos, Nigeria; to investigate the occurrence of a range of 7 congeners of Organophosphate Flame Retardants (OPFRs) which include tris(2-chloroethyl) phosphate (TCEP), tris(2- chloroisopropyl) phosphate (TCIPP), tris(1,3-dichloro-2-propyl) phosphate (TDCIPP), amongst others.
The highest mean concentration of OPFRs was found in the indoor repair and storage shop (12,770 pg/m3); followed by the indoor dismantling shop (10,505 pg/m3). TCIPP had the highest mean concentration for all samples (15230 pg/m3), followed by TCEP (15,040 pg/m3) while the least was EHDPP (257 pg/m3). Although all target compounds were detected in both target and control sites, but the concentrations from outdoor samples were comparatively lower than the indoor air samples; and concentrations from the control sites were lower compared to target sites. This suggests that accumulation of electronic wastes contributes immensely to the concentration as well as exposure to OPFRs.
This study reports for the first time occurrence of OPFRs in atmospheric samples from e- waste dumpimg site in Lagos, Nigeria.

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Presenter: OLUSEYI, Temilola (University of Lagos)

Session Classification: Air Pollution and Health Effects

Contribution ID: **4** Type: **oral presentation**

Assessment of Particulate Matter Exposure Near Quarrying Vicinities in Southeastern Nigeria

Tuesday 7 November 2023 15:35 (15 minutes)

Numerous quarry operations in Southeastern Nigeria offer employment opportunities for the locals and generate income for the government. These businesses do, however, frequently cause air pollution, and the deadliest is PM2.5 which has been found to have a deleterious impact on humans and the ecosystem. The Extech Model VPC300 sensor was used to measure PM2.5, PM10, and some meteorological factors at the four quarry sites and their surroundings. The quarry locations and their surroundings were found to have high concentrations of particulate matter that exceeded the international standard. Using the methodology for assessing human health risks, estimates of the potential health risks associated with exposure to particulate matter were made. Nearly all of the quarry's surroundings had a Hazard Quotient > 1 for PM2.5 for infants, children, and adults on an acute or chronic basis. A kilometer distant from the quarry sites, PM2.5, and PM10 show the strongest association matrix with the highest value of 0.9358. Additionally, at the quarry, there is a strong relationship between the PM2.5 and temperature at 0.7860. Based on the findings, it is strongly advised that a dust control system be established.

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Presenter: Dr EKPA, Imoh (Federal University of technology Ikot Abasi)

Session Classification: Air Sensors and Air Quality Monitoring

Contribution ID: **5** Type: **oral presentation**

Assessing vehicular traffic pollution

Tuesday 7 November 2023 10:10 (15 minutes)

The work assesses how vehicular traffic pollution affects the cardiovascular and respiratory health of people living in Tema Community One. It links environmental and transportation issues to air quality and shows how contact with polluted air negatively affects health and social outcomes. Objectives focus on measuring the quality of the air, the spatial variation of pollution from selected gases, environmental factors promoting vehicular traffic pollution, perceptions of vehicular traffic pollution, and health effects on the cardiovascular and respiratory systems. In order to achieve this, medical doctors and household members in the study area were interviewed and engaged. Hospital records were collected from the various health facilities visited. Charts, tables, models, maps, and transcriptions are used in explaining and showing results. The work starts in chapters one to five with five objectives and five research questions. An exploratory and mixed research approach was used for the study. Questionnaires, an interactive guide, and gas sensors were used for the data collection.

Author: NYARKO, Isaac

Presenter: NYARKO, Isaac

Session Classification: Air Pollution and Health Effects

Track Classification: Air Pollution & Health Effects

Contribution ID: **6** Type: **oral presentation**

Design and Evaluation of a Low-cost Weather Station

Wednesday 8 November 2023 10:20 (15 minutes)

The quality of life and human activities are significantly impacted by several elements, one of which is the weather and climatic patterns. To measure the weather parameters requires weather stations which are expensive. Hence, there is a need to develop low-cost weather stations to make comprehensive meteorological data monitoring easy to attain across the world. The aim of this project was to design a low-cost weather station to monitor temperature and relative humidity. The weather station was designed to record data in real-time, store the acquired data in an SD card and also to display the data on an LCD. The study used an Arduino Uno board connected to a temperature and humidity sensor, a real-time clock (RTC), a micro-SD card module, and an LCD. The device was also capable of text file storage. The Arduino IDE was used to create a code that was transmitted to the Arduino microcontroller to operate the circuit. The performance of the weather station was tested by mounting it beside a standard weather station to measure the temperature and relative humidity. The data obtained were compared to the standard weather station data for calibrations. Following calibration, this low-cost weather station can be deployed in rural areas to measure weather parameters, augmenting the existing weather stations for more accurate climate predictions.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **7** Type: **oral presentation**

Air Pollution and Health Impacts

Tuesday 7 November 2023 16:15 (15 minutes)

Air Pollution and Health Impacts
The onset of Covid-19 lock-downs support the fact that man-made activities greatly contribute to air pollution (Hammer et al. 2021). Exposure to major air pollutants such as particulate matter, ground-level ozone, NO2, SO2, CO, etc, is estimated to cause millions of deaths annually (Neira and Prüss-Ustün 2016; WHO 2023), and the burden is more pronounced in low- and middle-income countries. A few studies have been conducted on the quality of air in Uganda (Kirenga et al. 2015; Onyango et al. 2019), mostly concentrated on urban areas and measurements done in a short period of time due to limited resources. Our project aims at comparing some of these in situ measurements with satellite-derived measurements and identify possible trends in the data. This will enable us model and make predictions as well as engage policy-makers, create public awareness, based on our research findings.

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Onyango, Silver, Beth Parks, Simon Anguma, and Qingyu Meng. 2019. "Spatio-Temporal Variation in the Concentration of Inhalable Particulate Matter (PM10) in Uganda."IJER&PH 16(10).
WHO. 2023. World Health Statistics 2023: Monitoring Health for the SDGs.

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Session Classification: Air Sensors and Air Quality Monitoring

Track Classification: Air Pollution & Health Effects

Contribution ID: **8** Type: **oral presentation**

Development of an integrated Sensor System for Real-Time Measurement of Particulate Pollutants and Environmental Parameters

Wednesday 8 November 2023 10:35 (15 minutes)

Air pollution, notably the presence of particulate matter, poses substantial hazards to both human health and the natural environment. The current particulate matter monitoring systems suffer from a practical limitation that they can measure particulate matter concentrations at only a single spatial point. This limitation constrains the ability to comprehensively understand the dynamics of particulate matter distribution. This study developed an internet of things-enabled sensor system to infer spatial particulate matter concentrations. Data collection nodes measured particulate matter concentrations across three scales (PM10, PM2.5 and PM1.0), the three weather parameters (wind speed, ambient temperature, and humidity), and spatial information (latitude and longitude), which were logged into a cloud-based server. Various machine learning models, such as Long Short-Term Memory, Artificial Neural Networks, Support Vector Regression, and RandomForest were trained using these datasets to predict spatial particulate matter distribution. The study found that Artificial Neural Networks exhibited superior accuracy based on Mean Absolute Error values, with high R^2 scores (>0.99) and low Root Mean Square Error values. However, beyond 100 meters from the reference node, prediction accuracy declined (<75%), highlighting the importance of spatial proximity. The findings of the study provides insights into a new approach for designing particulate matter sensors with capabilities extending beyond the limitations of the current single-point measurement approach. Moreover, the research shed light on the significance of including different weather parameters in the training process of machine learning models for predicting the spatial distribution of particulate matter within a specified radius.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **9** Type: **oral presentation**

Assessment of fine particles pollution inside the kitchen of a house by an optical sensor

Tuesday 7 November 2023 15:20 (15 minutes)

Introduction and objectives: Air pollution is the contamination of the indoor or outdoor environment by any chemical, physical or biological agent that alters the natural characteristics of the atmosphere. Indeed, the concentration of the main pollutants has increased due to the scale of fossil fuel-consuming and polluting activities. Among these pollutants, fine particles (PM) represent a major indicator of air quality. The objective of this work is to evaluate the evolution of pollution by fine particles inside an ordinary apartment in Algeria and more precisely in its kitchen. Methods: The level of pollution by fine particles was measured for 8 days, in January 2023, using the APOMOS system (Air Pollution Monitoring System) which includes a multi-sensor card of the ZPHS01B-Winsen type. It is equipped with the PMS7003M sensor dedicated to the detection of fine particles. Results: The study shows that in the study area, particle pollution inside the house reaches levels which sometimes exceed the limit value which is 80 µg/m3 and reach alarming rates. Conclusion: this study confirms that particle pollution inside the house is significant when gas cooking is in operation.
KEY WORDS: Fine particles; Indoor pollution; Optical sensor, Gas cooking

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Session Classification: Air Sensors and Air Quality Monitoring

Track Classification: Air Sensors & Air Quality Monitoring

Contribution ID: **10** Type: **oral presentation**

How to design and test your own low-cost air quality monitor: Part I

Wednesday 8 November 2023 09:00 (20 minutes)

In the framework of the IoT4AQ project, investigations are being carried out to develop and popularize inexpensive and climate adapted monitors. Local parameters including dust concentration levels, weather data, communications systems, and electrical grids have been analysed. IoT components including LCD screens, LEDs, RTC modules, GPRS modules, microcontrollers (Arduino, Raspberry Pi, ESP32, etc.) and various sensors (dust, gas, temperature, relative humidity, etc.) available on market have been assessed and used. The basic design tested integrates a ESP32/Wi-Fi module and a SDS011 nova PM sensor. This configuration has been tested in the laboratory to map its performance. The PM and the temperature/humidity sensors performed well.

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Session Classification: IoT TUTORIALS

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **11** Type: **oral presentation**

How to design and test your own low-cost air quality monitor: Part II

Wednesday 8 November 2023 09:30 (20 minutes)

In the framework of the IoT4AQ project, investigations are being carried out to develop inexpensive and climate adapted air quality monitor. Local parameters including dust concentration levels, weather data, mobile communications systems, and electrical grids have been analysed. Geolocation, data storage and autonomous operation options were studied. IoT components including LCD screens, LEDs, RTC modules, GPRS modules, microcontrollers (Arduino, Raspberry Pi, ESP32, etc.) and various sensors (dust, gas, temperature, relative humidity, etc.) available on market have been assessed and used. The basic design proposed here integrates an Arduino Uno 328 micro-CPU, a Sim card SIM900A and a dust sensor, the PPD42NS. It features low power consumption, low cost (˜100 €), light weight (˜200 g), integrates a battery for autonomous operation and can accommodate more settings. It has been tested and calibrated using a reference device.

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Session Classification: IoT TUTORIALS

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **12** Type: **oral presentation**

The Internet of Things, Sensors and Actuators

Tuesday 7 November 2023 12:00 (20 minutes)

Already the name **IoT** tells us, that there are two basic components:

- ***Things*** represented by sensors and actuators and
- the ***Internet***, allowing simple access to the system through graphical user interface elements like gauges and graphs for data display or buttons and sliders as control elements, accessible on the Internet.

This lecture describes the *things* part of IoT

Interfacing sensors and actuators
After a short introduction of the basic building blocks an IoT system is composed of, sensor readout and control is described. A micro-controller acting as IoT gateway must provide the necessary device interfaces as well as a network (WiFi) interface. A few of these device interfaces are shown. As an example, reading of an I2C based air quality sensor and a dust sensor with a serial interface are demonstrated. The simplest way of programming the micro-controller, is the use of either the Arduino SDK, where programs are implemented in the C++ programming language or using MicroPython, a Python-3 interpreter that can be installed on the micro-controller. The demonstration will be done with MicroPython.

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Session Classification: IoT TUTORIALS

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **13** Type: **oral presentation**

The Internet of things, uploading sensor readings to the Internet

Tuesday 7 November 2023 14:00 (20 minutes)

Once the sensor data are available they should be transferred onto the Internet. Again there are several possibilities to accomplish this. First, the micro-controller must get access to the network, which we do by connecting it through its WiFi station interface. Then we can access it through the TCP protocol. It is possible to install a WEB server with dynamic WEB pages onto the micro-controller, that can give access to the sensor data. The WEB server uses the HTTP protocol running on top of TCP for its communication. Alternatively MQTT is a light weight protocol, which is often used in micro-controller applications to communicate between the micro-controller and a bigger machine.
Last not least IoT platforms are available, providing dash boards with graphical user interface elements like gauges, graphs, buttons and sliders which can be used to collect data from the micro-controller, communicating through HTTP or MQTT or to control devices, attached to it.

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Session Classification: IoT TUTORIALS

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **14** Type: **oral presentation**

Development of an IoT based Air Quality Instrument suitable for profiling Particulate Matter (PM) distribution across Nigeria using a PMS5003 and DHT11 digital sensors.

Wednesday 8 November 2023 11:00 (15 minutes)

Informed knowledge on the distribution of dust particles and humidity variations across certain geographical location offers innumerable benefits to humanity. Such information could guide astronomers to make informed decision when locating or carrying out their optical observation; Medical professionals can monitor and predict trends in lung and cardiovascular related diseases, and other host of professions that might find such information invaluable. The work presents the indigenous development of network of Air Quality data loggers that monitors the distribution of PM based on wide range of diameter sizes in microns across a certain geographical distance within the country. The network comprised of a number of standalone sub-stations each of which is a microcontroller-based instrument that incorporates PMS5003 and DHT digital sensors for obtaining meteorological parameter, SIM module for cloud-based data storage and other peripherals for optimal performance. The network features a centralized cloud-based data repository from each of the respective locations of these sub-stations. These data can be used for onward scientific analysis and meteorological prediction.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **16** Type: **oral presentation**

Traffic-Related Air Pollution in Africa: Emissions, Sources and Health Impacts

Tuesday 7 November 2023 09:30 (15 minutes)

Transport sector, which is made up of sub-sectors, that include roadways, railways, seaways, and airways contributes to ambient air pollution and poor air quality. This work focuses solely on road traffic-related air pollution in Africa. It reviews main pollutants and sources, and their impacts on health and the environment. It explores key driving factors, such as diverse transportation modes, traffic congestion, unpaved roads, vehicle fleet conditions, urban planning challenges, fuel quality disparities, road design issues, and traffic management. Health outcomes associated with long-term exposure to road traffic pollutants are numerous, ranging from headaches, pulmonary and respiratory outcomes and cardiovascular issues to developmental and cognitive issues and increased mortality associated burden. Few recommendations and solutions are formulated, and include public sensitization, deployment of monitors, adequate regulation, and policy. A comprehensive approach is needed, and few solutions or proposals to be investigated and adapted to specific contexts are more investment to improve public transportation, development of green infrastructure and modes integration, sustainable urban planning, and stringent vehicle emission standards. Even though some of these solutions could be difficult to implement in the African countries, they are necessary if we want to reduce mortality due to road traffic-related pollution and improve the life expectancy, especially in sub-Sahara Africa.
Keywords: roadways, transport, air pollutants, Africa, health.

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Session Classification: Air Pollution and Health Effects

Track Classification: Air Pollution & Health Effects

Contribution ID: **17** Type: **oral presentation**

Satellites and Low-Cost Sensors: Advantages, Limitations, and Opportunities for Integration

Wednesday 8 November 2023 13:00 (20 minutes)

This presentation will cover the basics of the use of satellite remote sensing for air quality applications, including advantages and limitations of satellite data with respect to other data sources, and discuss some opportunities for satellite data to be used together with and as a supplement for in-situ measurements with IoT-based Air Sensors.

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Session Classification: SPECIAL SESSION

Track Classification: Air Sensors & Air Quality Monitoring

Contribution ID: **18** Type: **poster presentation**

An IoT-Based Dynamic pollution hotspots areas detection System using ESP8266 NodeMCU and Arduino

Wednesday 8 November 2023 11:15 (15 minutes)

The issue of air quality in Africa has emerged as a critical public health concern. Initial assessments conducted in major African urban centers reveal that fine particulate concentrations exceed the thresholds recommended by the World Health Organization (WHO). We developed two (2) mobile and fixed devices utilizing the Internet of Things (IoT) to detect areas with high PM2.5 particle pollution, along with other indicators. The primary innovation of this study lies in the utilization of a microcontroller (ESP8266 NodeMCU) enabling not only data collection from sensors but also transmission to a server utilizing its Wi-Fi connectivity and the HTTP protocol. The device was mounted on a vehicle for one month as part of an intensive measurement campaign across the Dakar region. The outcomes facilitated the identification of hotspots in Dakar, pinpointing the city's major anthropogenic sources of particle pollution. This mobile device will play a pivotal role in the future identification of suitable areas for the installation of fixed pollution sensors.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **19** Type: **oral presentation**

HOUSEHOLD AIR POLLUTION: AFRICAN HOMES AND DWELLINGS

Abstract:
It has been reported that indoor air can exhibit higher levels of pollution than outdoor air. This is of significant concern given that people spend the majority of their time indoors. Various factors exert influence over household air pollution, including outdoor air quality, ventilation, building materials, and indoor activities such as cooking fuel choices, cooking methods such as frying, roasting and insecticide spray use. Household air pollution (HAP) in Africa is a complex issue, with far-reaching consequences such as premature mortality in both adults and children.
This paper highlights that the majority of research on HAP in Africa has predominantly employed qualitative methodologies and there is a need for an increase in air pollution measurements and monitoring to better understand exposure levels. Cultural and behavioural factors also play a significant role in shaping indoor air quality and notably, access to modern energy sources for cooking in Africa remains substantially limited.
Addressing HAP in African dwellings requires a multifaceted approach that takes into consideration cultural practices, socioeconomic status, and educational initiatives to ensure improved health outcomes. Additionally, efforts should focus on promoting affordable and cleaner cooking fuels, especially in rural areas, as well as supporting sustainable housing initiatives. There is a need to advocate for policy implementation to enhance the overall quality of life for residents of African homes.

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Session Classification: Air Pollution and Health Effects

Track Classification: Air Pollution & Health Effects

Contribution ID: **22** Type: **oral presentation**

Improving learning through classroom experience in East Africa: Preliminary findings

Tuesday 7 November 2023 16:00 (15 minutes)

1. Context: This is an Open Development and Education (ODE) study in Tanzania, funded by the UK Foreign, Commonwealth, and Development Office (FCDO). Tanzania educational system follows a 7-4-2-3 pattern.
2. Importance of the study: The study emphasizes the significance of a conducive classroom environment, as inadequate ventilation and extreme temperatures can affect students' health and academic performance.
3. Methodology: The study comprises data collection, surveys, and sensor data to assess classroom conditions and student comfort.
4. Preliminary Findings: Initial results from comfort and walkthrough surveys reveal suboptimal thermal conditions and air quality, highlighting areas in need of improvement.
5. Retrofit Solutions: Various retrofitting solutions, such as roof color modification, sun shading techniques, and wind catcher systems, are explored to enhance classroom conditions.
6. Next Steps: The study's next phase involves implementing selected retrofits and assessing their impact on classroom environments and student comfort through surveys and data collection.
7. Outcome and Impact: The research aims to influence education, climate, and environmental policies in East African countries, ultimately improving the quality of school buildings. Overall, this study seeks to create a more comfortable and conducive learning environment for Tanzanian students, with potential implications for educational policy and environmental sustainability.

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Session Classification: Air Sensors and Air Quality Monitoring

Track Classification: Air Pollution & Health Effects

Contribution ID: **23** Type: **oral presentation**

Indoor environmental quality in elementary schools and students' wellbeing

Tuesday 7 November 2023 09:45 (15 minutes)

Besides homes, schools are primary environments for children.
The aims are fourfold: firstly, to assess the impact of indoor environmental quality IEQ on elementary school students by evaluating ventilation rates and thermal comfort, as well as the role of Heating, Ventilation, and Air Conditioning (HVAC) systems. Secondly, it aims to investigate school building practices related to cleaning, hygiene, and materials. Thirdly, to explore the associations between IEQ in schools and students' health outcomes. Lastly, it aims to analyze the link between IEQ and students' academic performance.
The studies to be presented sampled schools from various regions: all elementary schools in Finland, 70 in the US, 5 in Nigeria, and 2 in Cardiff. The Finland study collected data through questionnaires, IEQ measurements, and standardized tests. In the US, IEQ parameters were measured alongside health and academic data from school districts. Nigerian and UK studies also measured IEQ parameters in classrooms.
The general conclusions drawn from the studies suggest that inadequate ventilation is associated with indoor temperature in temperate climates but not in tropical climates. Cleaning practices need improvement, and inadequate ventilation and temperature are linked to students' health outcomes. Maintaining recommended temperature levels and adequate ventilation can enhance students' learning achievements.

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Presenter: TOYINBO, Oluyemi (University of Oulu)

Session Classification: Air Pollution and Health Effects

Track Classification: Air Pollution & Health Effects

Contribution ID: **24** Type: **oral presentation**

Air Quality Management 2.0: Leveraging Innovative Technologies and Partnerships at the Intersection of Air Quality, Health, and Policy

Wednesday 8 November 2023 14:50 (20 minutes)

A brief overview of Clarity Movement's Sensing-as-a-Service air monitoring and IoT-based sensing and exploration of how the convergence of cost-effective distributed air monitoring technologies and multi-stakeholder collaborative strategies has paved the way for significant advancements in regional air quality management —including example case studies from around the world. Learn how Air Quality Management 2.0 facilitates comprehensive cost-benefit analyses and a more actionable understanding of the health and air quality co-benefits related to energy, transportation, and climate investments and policies.

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Session Classification: SPECIAL SESSION

Track Classification: Air Sensors & Air Quality Monitoring

Contribution ID: **25** Type: **oral presentation**

IOT solutions for vehicular traffic estimation and emissions

Wednesday 8 November 2023 13:30 (20 minutes)

In recent years, there is an increasing attention on air quality derived services for the final users. A dense grid of measures is needed to implement services such as conditional routing, mobility services, sustainability, alerting and data heatmaps for Dashboards in control room. Therefore, the challenge consists of providing high density data and services starting from scattered sensors data including traffic and air quality data. In this contribution we describe the Air Quality Monitoring System scenario adopting the Snap4City Solution involving traffic flow reconstruction model and the related traffic emissions diffusion/estimation. In particular, the mentioned solution for the vehicular traffic reconstruction is based on a mathematical model for fluid dynamics on networks via partial differential equations (PDE) that allows to detect macroscopic phenomena as traffic jams and propagation of waves backwards along roads. By means of the traffic model output is also possible to understand the impact of traffic emissions on the atmospheric pollution by means of diffusion model and some advanced technics in short and mid-long terms previsions.

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Session Classification: SPECIAL SESSION

Track Classification: Air Sensors & Air Quality Monitoring

Contribution ID: **26** Type: **oral presentation**

Mountain and valley winds and their implications on processes controlling air quality

Tuesday 7 November 2023 11:05 (15 minutes)

Processes controlling pollutant dispersion over complex terrain are much more complicated than over flat areas, as they are affected by atmospheric interactions with the orography at different spatial scales. In particular, thermally-driven daily-periodic winds produce circulation patterns and stability situations which are quite difficult to reproduce by numerical weather prediction models in their operational settings. The basics of these processes will be briefly reviewed, along with open questions and challenges to our capability for better understanding and representing atmospheric processes controlling the fate of pollutants over mountainous areas, as well as possible solutions.

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Session Classification: Air Pollution and Health Effects

Track Classification: Air Pollution & Health Effects

Contribution ID: **27** Type: **oral presentation**

Air quality monitoring through solid state gas sensor systems in urban environment

Wednesday 8 November 2023 11:30 (15 minutes)

Single and mixed nano-crystalline semiconductor oxides were obtained through wet-chemistry synthesis in form of powders. They were used as functional materials to produce metal oxide (MOX) thick film gas sensors to be used in air pollutants monitoring (i.e. carbon monoxide, nitrogen oxides, ozone and the total benzene, toluene, ethylbenzene, and xylene). Portable monitoring units based on these sensors were fabricated, including electronics for acquisition, processing and wireless data transmission. Long term trials in the field were carried out placing the sensor units near to the conventional fixed-site monitoring stations. The comparison between the temporal evolution of the conductivity changes of the sensors with the pollutants concentrations and those measured by the analytical instruments shows a good agreement for each sensor.

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Session Classification: Design & Testing of IoT-based Air Quality Monitors

Track Classification: Design & Testing of IoT-based Air Quality Monitors

Contribution ID: **28** Type: **oral presentation**

Catalyzing Air Quality Improvement in Africa Through Rigorous Low-Cost Sensor Evaluation: The Afri-SET Approach

Wednesday 8 November 2023 15:20 (20 minutes)

Good air quality is critical to our health and well-being. Lack of air quality monitors, diverse pollution sources and unique weather patterns make air quality monitoring a difficult throughout Africa. Afri-SET, a new air quality sensors evaluation and training facility at the Department of Physics, University of Ghana is addressing these issues. The facility is evaluating low-cost sensors (LCS) from various manufacturers worldwide and developing calibration models, providing open access data, training, and capacity building in the use of LCS and reference monitors. Afri-SET is available to the public and has the potential to significantly improve air quality throughout West Africa and beyond by collecting high-quality data to facilitate more effective decision and policy making. This presentation will highlight the need for such a facility to address air quality issues, the potential of sensor technology, and the significance of rigorous sensor evaluation in community empowerment and policy influence.

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Session Classification: SPECIAL SESSION