Commentary
The Ghana Urban Air Quality Project (GHAir): Bridging air pollution data gaps in Ghana

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Air pollution has been recognized as a pressing sustainability concern seeing that it is directly mentioned in two SDG targets: SDG 3.9 (substantial reduction of health impacts from hazardous substances) and SDG 11.6 (reduction of adverse impacts of cities on people) (Rafaj et al., 2018). Air pollution, both ambient and indoor, is known to contribute significantly to the global burden of disease, contributing to a majority of non-communicable disease-related deaths in low to middle-income countries in Africa and Asia (WHO, 2016). In 2018, air pollution was attributed to 28,000 deaths in Ghana (Odonkor and Mahami, 2020).

In most developing countries particularly in Sub-Saharan Africa (SSA), this precarious situation of deteriorating air quality is driven by rapid population growth and industrial expansion (Amegah and Agyei-Mensah, 2017, Satterthwaite, 2017). In fact, some of the highest fine particle levels ($PM_{2.5}$) in the world have been recorded in cities of SSA and other developing regions with $PM_{2.5}$ in some SSA cities being at 70-140 μg/m^3, most exceeding the WHO Interim Target 1 for annual average $PM_{2.5}$ concentrations of 35 μg /m^3 (Anenberg et al., 2019).

Despite the alarming rate of the deterioration of air quality in most SSA countries, addressing the situation has proven increasingly difficult owing to the paucity of data on air pollution levels in countries as a result of weak and non-existent air quality monitoring capacity (Amegah and Agyei-Mensah 2017). In Ghana, air quality monitoring is often limited to only a few locations with most being centered in the country's capital (Arku et. al., 2008). As has often been the case, national Environmental Protection Agencies (EPA) are poorly resourced with their staff lacking the requisite technical know-how for air quality monitoring. Aside from this, data generated by the EPA is often not readily accessible to the public (Usman et. al., 2019), thus making it difficult for relevant air pollution research to be undertaken and hampering the independent evaluation of air pollution control policies.

In addressing this problem, various studies have suggested that low-cost sensors could be an excellent opportunity to bridge the air pollution data gap within the SSA region (Amegah, 2018, Mead et al., 2013). Low-cost sensors hold much promise for monitoring the levels of air pollution particularly in areas where little data is available. Low-cost sensors can enable the creation of a dense network with wide spatial coverage in virtually any geographical setting owing to their relatively small size and lower power requirements (Kumar et al., 2015, Pinder et al., 2019). In fact, in regions where air monitoring is weak, low-cost air quality sensors can be leveraged to complement the limited reference-grade monitors that may be available.

It is against this background that the Ghana Urban Air Quality Project (GHAir) was established in May 2019 with the overall goal of bridging the air pollution data and epidemiologic research gap in Ghana. The objectives of the project are to: (1) develop a dense network of low-cost air quality sensors interspersed with reference monitors in urban areas of Ghana to provide real-time high spatiotemporal air quality data to influence air pollution control policies, (2) raise public awareness about the dangers of air pollution to enable the citizenry to act accordingly to protect their health, (3) advocate for behavioral changes and actions within communities and amongst individuals for improved air quality, and (4) conduct research on the health effects of air pollution exposure among vulnerable groups to provide local evidence for public health action and influencing clinical practice.

The project currently has deployed low-cost sensors, a mixture of PurpleAir sensors, Clarity nodes, RAMPs, and Modulair-PM, in five metropolitan areas of Ghana, namely Accra, Tema, Cape Coast, Takoradi, and Kumasi. Through these deployments, the project has forged strong collaborations with the metropolitan authorities, notably the Accra Metropolitan Assembly (AMA) in the area of air pollution control and awareness creation among vulnerable groups such as street vendors. The project has recently received 10 sets of TEOM 1400ab, a regulatory grade particulate matter monitor, from the UK Environmental Agency (Automatic Urban and Rural Network) for deployment to improve air quality measurements. The TEOMs will be deployed in the metropolitan areas for validation of the data from the low-cost sensors. The project also collaborates with sister projects in other African countries as part of the AfriqAir network to help build a strong air quality network across the continent for fostering the sharing of knowledge and expertise in air quality monitoring and air pollution modelling.

Despite the significant strides made, the project continues to face challenges with Wi-Fi connectivity and power supply, which severely impacts data quality. There can be several days and weeks without data from the sensors owing to these challenges. This is because the project leverages on internet connectivity at the establishments where they are installed and hence at their mercy as it relates to Wi-Fi connectivity for data telemetry. Power supply can also be unstable in some of the deployment sites.
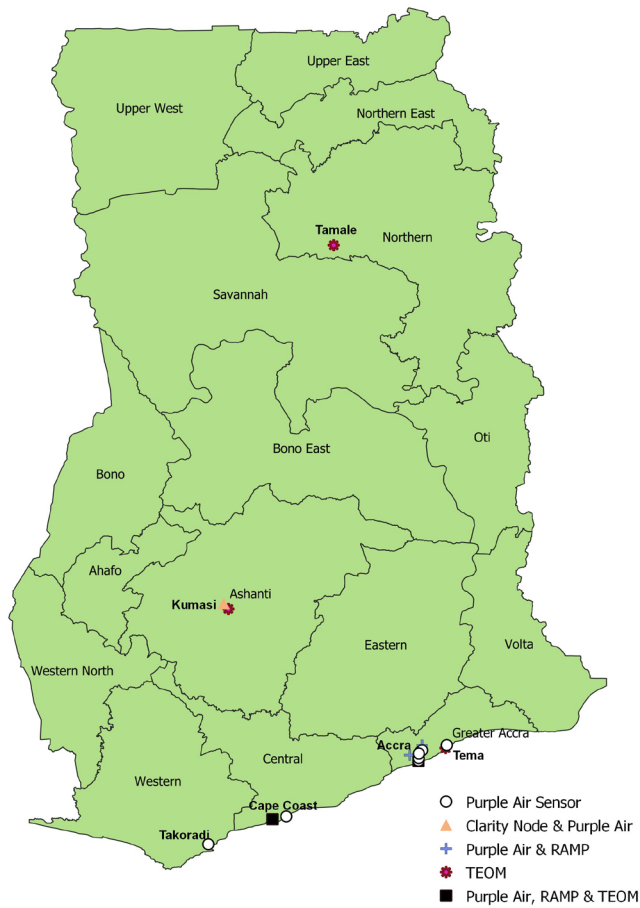
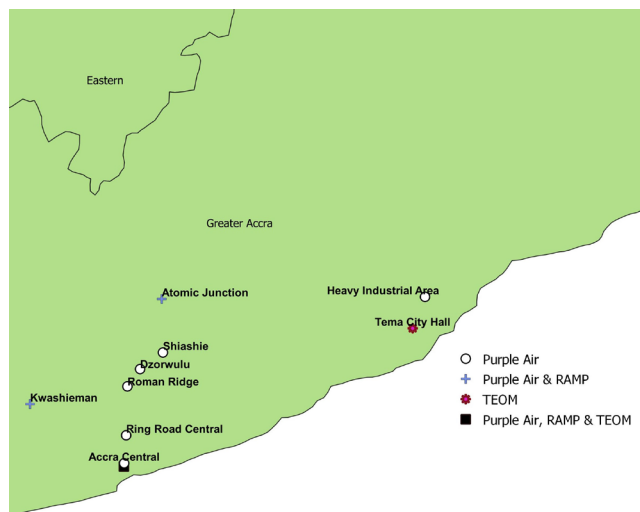**Figure 1:** *Map of Ghana showing the location of sensors*

Figure 2: *Map of the Greater Accra region showing the location of sensors*

In conclusion, the GHAir project holds huge prospects in helping bridge the air quality data gap in Ghana but requires support in terms of air quality monitoring equipment and funding for maintenance of the installations. The power and connectivity challenges can be addressed by building sensors locally that use solar power and rely on GPRS for data telemetry.

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