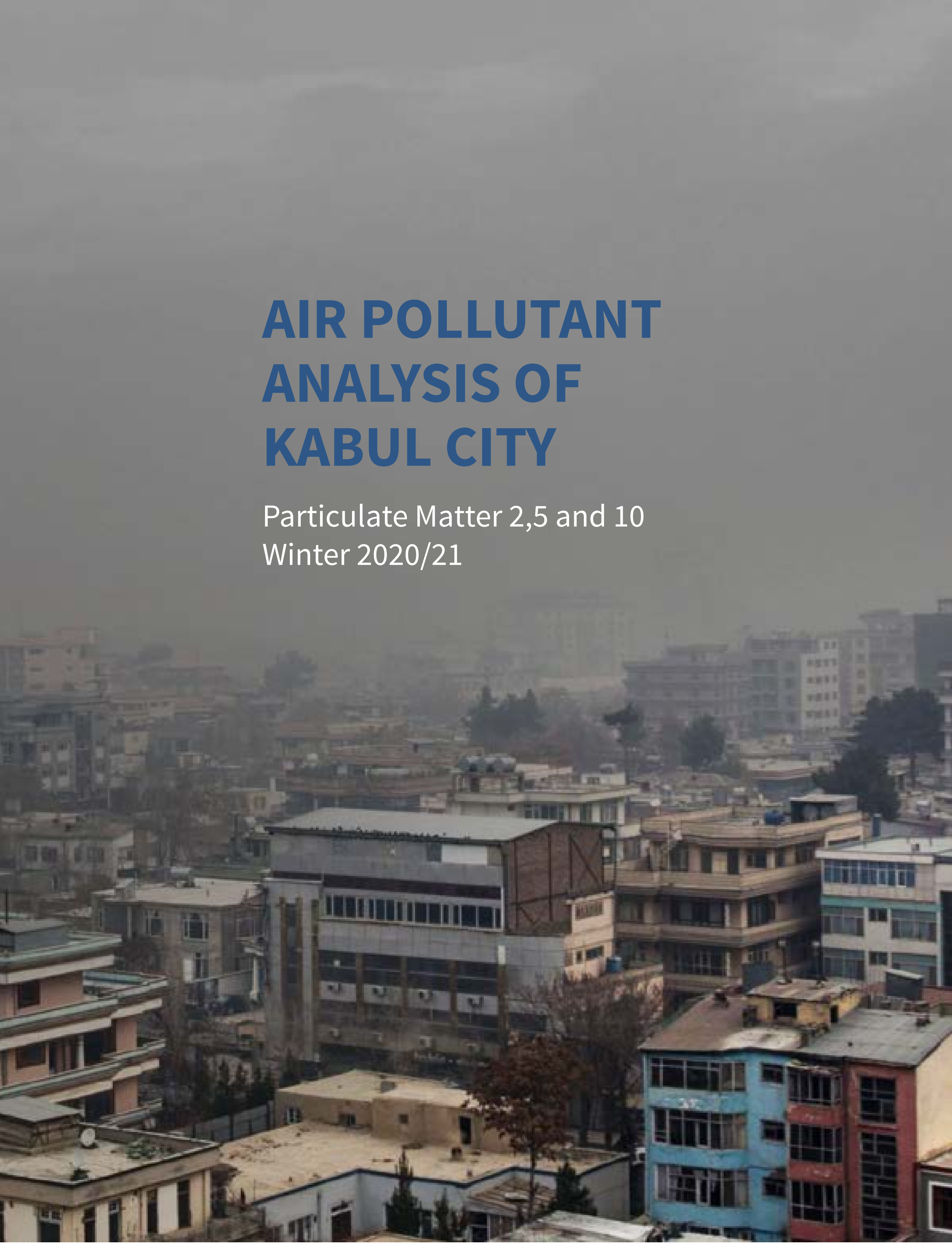
# AIR POLLUTANT ANALYSIS OF KABUL CITY

Particulate Matter 2,5 and 10
Winter 2020/21



ORGANIZATION FOR SOCIAL RESEARCH AND ANALYSIS
DATA FOR SUSTAINABLE DEVELOPMENT

DIGITAL BRIDGE

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# Particulate Matter 2,5 and 10
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# AIR POLLUTANT ANALYSIS OF KABUL CITY PARTICULATE MATTER 2,5 AND 10 WINTER 2020/21

**PROJECT MANAGEMENT**
Organization for Social Research and Analysis

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## Who we are

The Organization for Social Research and Analysis (OSRA) is a nonpartisan and independent non-governmental organization based in Kabul. At OSRA, we conduct socio-economic research, public opinion polls, big data analytics, content analysis and a variety of data-driven research.

Our mission is to facilitate fact-based transparency and research in order to support good governance and sustainable development and, above all, to promote transparency and accountability. By producing evidence-based research and high-quality data analysis, we study Afghan public attitude, demographic trends, policy impact, communication and public relations with the help of the latest technology, as well as a standardized and customized methodology to enable intelligent decision-making processes. In order to deliver meaningful messages gleaned from complex and large datasets, we focus on presenting the general public and our clients with easy to read and comprehensible information and data visualization platforms.

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# EXECUTIVE SUMMARY & MAIN FINDINGS

OSRA in cooperation with Digital Bridge gGmbH brought together international expertise of Afghan engineers and software developers in combination with local knowledge to develop a cost-effective device, the GardBox©, and software to measure air pollutants using efficient quantitative tools. Gardbox devices were installed in three different areas of Kabul city – Kaarta-ye-Seh, Macrorayan-e-Kohna, and Shahr-e-Naw – to achieve more comprehensive resolution of the readings, and also to capture the difference in concentration of air pollutants related to the environmental conditions of each area. The winter months experience a high in toxic emissions mostly due to usage of solid fuel in the form of unprocessed coal combustion. As a silent killer, air pollution is one of the largest causes of the top four non-communicable diseases and estimates suggest air pollution from households causes over 27 000 deaths per year in Afghanistan, 406 only in Kabul city. As a result of climate change, rural exodus and internal migration to Kabul, the population of the city, as well as demand for economic growth is expected to rise. Without interventions and mitigation measures, emissions of air pollutants are expected to increase in the future leading to more deaths and diseases such as lung cancer, chronic respiratory disease, and heart disease among the most vulnerable – children and elderly citizens. The data we collected highlighted the following points.

**1** Absence of a national-level emission inventory system to measure air pollution across Afghanistan on a regular basis. Due to lack of data and political-will it remains difficult to take concrete measures and identify strategies to improve air quality of Kabul city.

**2** The overall average of PM 2,5 concentration was calculated at between 123 $\mu g/m^3$ and 280 $\mu g/m^3$ from November-January 2020/21, which is considered as “Unhealthy” to “Hazardous” with serious aggravation of heart or lung diseases and premature mortality in persons with cardiopulmonary diseases and the elderly. [1]

**3** The collectected data revealed that air quality started to degrade significantly in mid November 2020 as outdoor temperatures started to fall. By the end of December PM 2.5 concentration reached alarming levels of 576 $\mu g/m^3$ 24-hour in Kart-e-Sey, 474 $\mu g/m^3$ 24-hour in Share-Naw and 287 $\mu g/m^3$ 24-hour in Mikroyan-e-kohna. In Kart-e-Seh the levels were 23 times the level of WHO target guidelines that suggest a 25 $\mu g/m^3$ 24-hour, in Shar-e-Naw the levels were 19 times higher and in Mikroyan-e-kohna 11,5 times higher than the WHO target guidelines.

**4** By the end of December 2020, PM 10 concentration reached an alarming level of 888 $\mu g/m^3$ 24-hour in Kart-e-Seh, 728 $\mu g/m^3$ 24-hour in Share-Naw and 368 $\mu g/m^3$ 24-hour in Mikroyan-e-kohna. Meaning in Kart-e-Seh the levels were 17,7 times higher than WHO target guidelines that suggest a 50 $\mu g/m^3$ 24-hour, in Shar-e-Naw 14,5 times higher and in Mikroyan-e-kohna 7,3 times higher.

**5** Concentration levels of PM 2,5 and PM 10 varied in the three locations of Shahr-e-Naw, Kart-e-Seh and Macrorayan-e-Kohna, however the pattern of rise and fall of PM 2,5 and PM 10 levels over the course of 24 hours remained more or less consistent. PM 2,5 and PM 10 levels started to rise approximately after 4 pm and continued to rise consistently reaching a peak by approximately 9 pm. Levels remained elevated until approximately 2 am the next day. Both PM 2,5 and PM 10 emission levels started to fall, reaching a low at approximately 12 noon.

**1** *Figure 6. US EPA Air Quality Index, conversion from the AQI to PM 2.5 concentration ranges.*

6 Discrepancy in air pollutant concentration levels are assessed to be directly related to the type of housing and building construction in each of these three locations where the devices were installed. Kart-e-Seh, with residents' profile of mostly middle to high income households living in courtyard houses, small to large bungalows and mansions had the highest level of PM 2,5 and PM 10 concentration. Macrorayan-e-Kohna with more diverse residents' profile of low to high income households living in the Soviet-style 4-storey multi-family apartment buildings had the lowest PM 2,5 and PM 10 concentration. Shahr-e-naw, with residents' profile of middle to high income households however living a combination of courtyard houses and small to large bungalows as well as several storey high multi-family residential apartment buildings remained in the middle in terms of PM2,5 and PM10 concentration levels.

*Figure 1 : PM 2,5 levels from November 2020- January 2021*

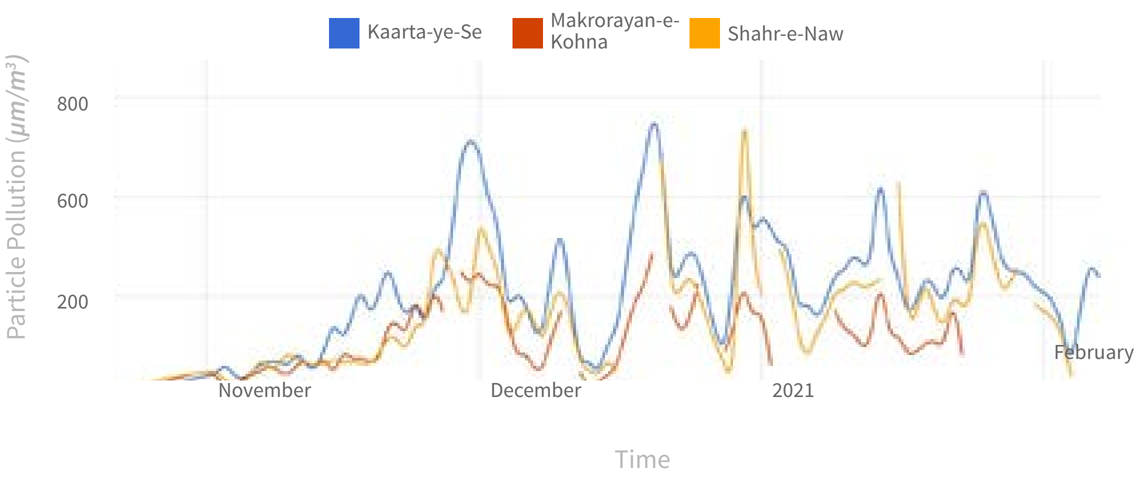
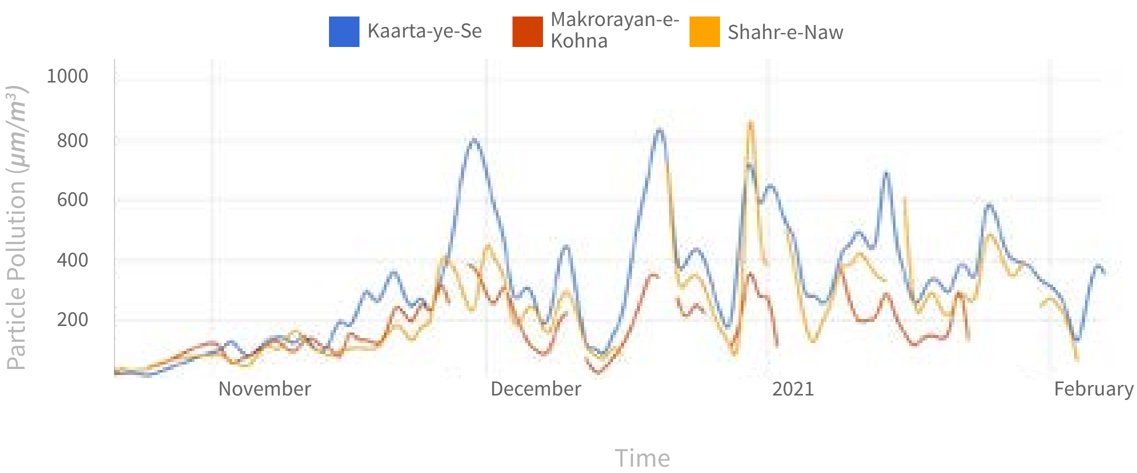



*Figure 2 : PM 10 levels from November 2020- January 2021*



# INTRODUCTION

# INTRODUCTION

The region of Kabul city and its surrounding area face great threat from increased air pollution throughout the year, but especially in the months of winter. In 2019 Kabul was ranked as the 4th most polluted city in the world[2]. Air pollution reaches dangerous levels due to increased urbanization and use of solid fuel combustion which impacts human health and the environment. Toxic air pollution poses especially hazardous risk in Kabul city in the winter as the city is situated in a valley surrounded by mountains on three sides preventing air escape. Till date no national-level emission inventories have been developed to measure the air pollution across Afghanistan on a regular basis. The only open data that is available is from the Swiss based IQair.com. Due to lack of data and a national air quality monitoring system, it remains difficult to take concrete measures and identify strategies to improve air quality of Kabul city and its surroundings. The only other detailed available data on air quality in Afghanistan has been from Swedish[3] and US military[4] sources from 2012 and 2015 respectively, indicating high levels of air pollutants for Mazar-e Sharif city and more critically for Kabul city.

OSRA in cooperation with Digital Bridge gGmbH brought together international expertise of Afghan engineers and software developers in combination with local knowledge to develop a cost-effective device, the GardBox©, and software to measure air pollutants using efficient quantitative tools. The aim was to enable policy-makers and responsible authorities to design strategies and identify mitigation measures in order to lower emissions and decrease levels of toxic air pollution for Kabul city to help improve and monitor Kabul's air quality.

In the first section the report discusses the danger and risks of air pollutants especially of particulate matter (PM) to human health in Afghanistan and in particular Kabul city. The second section reveals how data was collected, the circumstances and measurement sites of collection, why these sites were chosen, the challenges faced during data collection, solutions our experts came up with to ensure non-stop data collection, and, finally, what lessons were learned. The third section presents the analysed data on monthly, weekly and hourly (24 hrs) basis to provide an overview of emission concentration and patterns. Furthermore, the collected data is analysed by looking closer at the construction features of the three areas the GardBox© were installed, shedding light on the reasons behind the fluctuation and variation in emission concentration levels. After providing a snapshot of emission levels for winter 2020/21 and what should be expected in the future if no intervention or mitigation measures are taken, the fourth section provides a set of commendations for policy-makers to implement at national, local and project level to ensure better air quality.

2 *Kabul air pollution on a par with world's most polluted cities*
3 *Broad Exposure Screeninf of Air Pollutants in the Occupational Environment Swedish Soldiers Deployed in Afghanistan*
4 *Military Deployment Periodic Occupational and Environmental Monitoring Summary (POEMS): Kabul and Vicinity, Afganistan Calenda*

## AIR POLLUTION AND RISK TO HUMAN HEALTH

The winter months experience a height in toxic emissions mostly due to usage of solid fuel in form of unprocessed coal combustion, use of plastic, car tyres, and other waste material to heat households as well as shops, brick factories and gastronomies – including hotels, restaurants and public hammams–, apart from the exhaust fume of large number of old vehicles occupying the streets of the city, and emissions from generators used excessively due to blackouts and shortage of electricity.

As a silent killer, air pollution is one of the largest causes of the top four non-communicable diseases such as stroke, lung cancer, chronic respiratory disease, and heart disease. Estimates suggest air pollution from households cause over 27 000 deaths per year in Afghanistan.[5]

Over half of deaths among children less than 5 years old from acute lower respiratory infections are due to particulate matter (PM) inhaled from indoor air pollution from household solid-fuel burns. Air pollution poses a danger to all age groups but even more to children, women, senior citizens, and people with heart diseases or respiratory diseases. Moreover, epidemiological research suggests that exposure to household-caused air-pollution leads to low birth weight, stunting and preterm birth.[6] Increase in respiratory related diseases in Afghanistan, and especially Kabul ranks as the worst in the world with 406 deaths per year according to the State of Global Air, which found that the country has one of the highest per-capita rates of death from air pollution in the world.[7]

## PARTICULATE MATTER (PM)

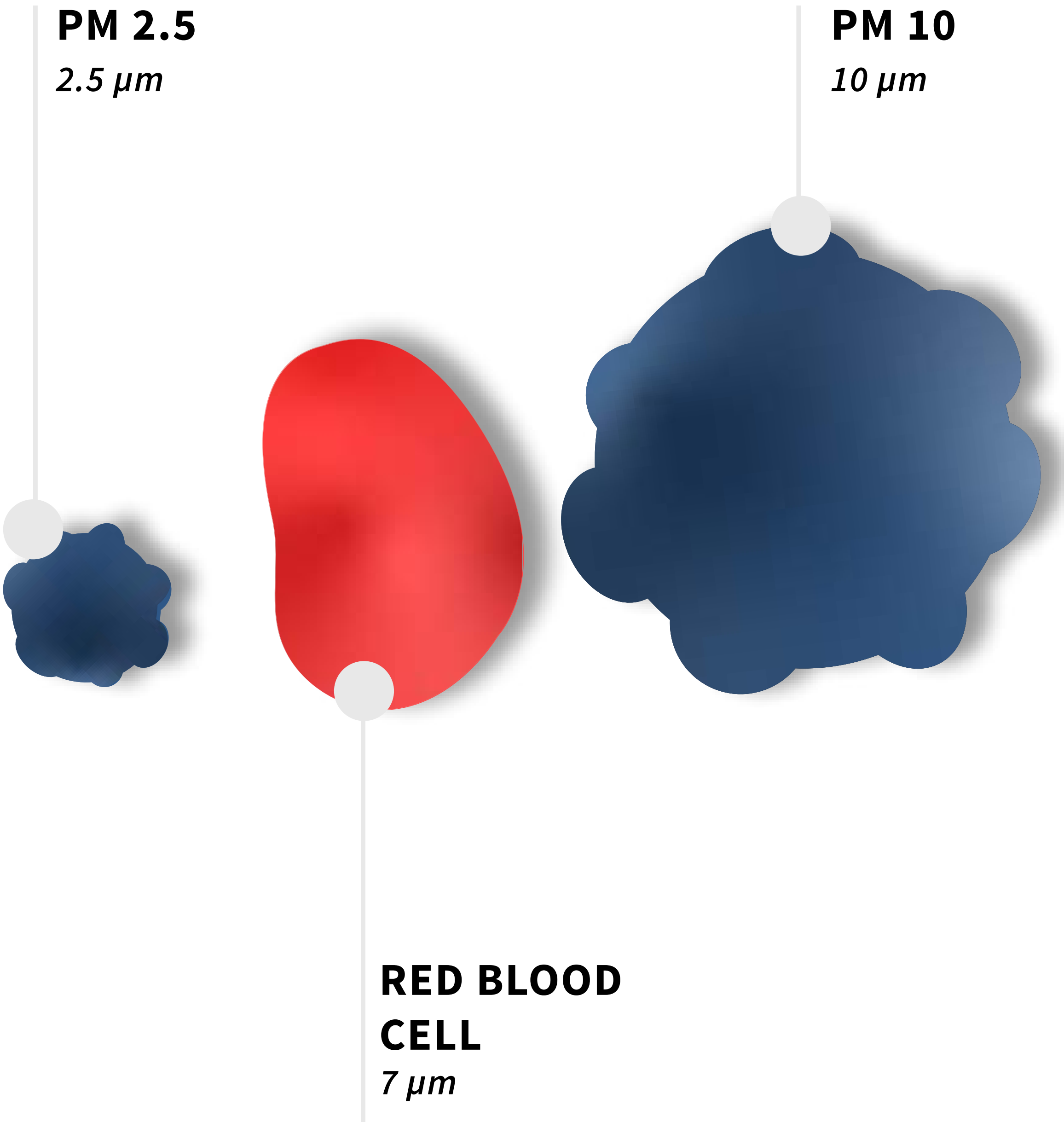
Particulate matter (PM) is a pollutant substance found in the air that includes dust, dirt, soot, smoke, bacteria, liquid droplets that vary in size, composition and origin. PM related to health concerns are divided by size into two groups: PM2,5 and PM10.

Major sources of PM10 are mining and quarrying activity, construction sites, unpaved roads and etc., while major sources of PM 2,5 are coal combustion, wood and organic mass burning, factories, vehicles exhaust and etc. PM 2,5 can reach the deepest regions of the lungs when inhaled and in general, excessive exposure to PM is linked to a variety of potential health effects. Although PM particles enter the human body either through breathing, PM2,5 can simply penetrate through the skin because of its size. The long-term health risk assessment of PM exposure is likely to lead to chronic conditions such as, reduced lung function or exacerbated chronic bronchitis, asthma, atherosclerosis, and other cardiopulmonary diseases. Those with a history of asthma or cardiopulmonary disease have a higher risk for developing these chronic conditions.

According to World Health Organization target guidelines suggest for PM2,5 is 10 $\mu g/m^3$ annual mean, and 25 $\mu g/m^3$ 24-hour mean; and for PM10 it is 20 $\mu g/m^3$ annual mean, and 50 $\mu g/m^3$ 24-hour mean.[8]

**5** Sida's Helpdesk for Environment and Climate Change
**6** Air pollution stunting children's lungs, study finds – Clear The Air News Blog
**7** The slow violence of pollution in Afghanistan | CEOBS
**8** Ambient (outdoor) air pollution

*Figure 3 : Size of PM 2,5 and PM 10 in comparison with a human blood cell*



# DEVICES & MEASUREMENT SITES

## DEVICES & DATA COLLECTION

Several GardBox© devices were designed, assembled and tested at OSRA in cooperation with Digital Bridge gGmbH to gather air quality samples over a period of three months, running around the clock. The devices were constructed keeping the atmospheric environment of Kabul city in mind. Using efficient quantitative tools the GardBox© is designed to measure PM 2,5 and PM 10 pollutants, which are mostly made up of black carbon, organic carbon, volatile organic compounds such as carbon monoxide, sulphur dioxide and ammonia. The GardBox© devices were set up in different parts of Kabul city to be able to gather a wide range of data for overall comparability between the air-quality and gain precise data on different levels of pollution in the city.

The GardBox© is a cost-effective device built in a way to reduce procurement time, cost, and scale-up as required. GardBox© devices communicate using established IoT protocols, which enables them to be integrated with other analytics, monitoring tools and platforms. The devices can be configured and calibrated on-site and remotely which reduces maintenance costs and makes remote management and updating easier.

## MEASUREMENT SITES

The GardBox© devices were installed in three different areas of Kabul city – Kaarta-ye-Se, Macrorayan-e-Kohna, and Shahr-e-Naw – so as to achieve a better city-wise resolution of the readings, and also to capture the difference in concentration of air pollutants related to the environmental conditions of each area.

For further technical specifications of the GardBox© refer to Annex I. In Kaarta-ye-Se it was located on the ground/first floor, in Macrorayan-e-Kohna 4th floor, and in Shahr-e-Naw on the 8th floor.

The difference in height of the locations could probably give somewhat different readings than if they all would've been at the same height from the ground. But as some of our tests showed there was not much significant change. Such a test was done in Kaarta-ye-Se to check if two sensors at the same location but at different elevations would report different readings. This was not the case as the readings were practically identical.

## CHALLENGES AND SOLUTIONS

One of the main challenges in the Afghan contexts is lack of reliable power source. To explore the most efficient and reliable source of power the GardBox devices at the three stations were connected to three different power sources: the local electricity grid in Makroyan-e-Kohna, to solar power in Kaarta-ye-Se and local power-grid with instant diesel generator back-up in Shahr-e-Naw. Although the Macrorayan-e-Kohna station was connected to a large battery back-up to prevent data gaps, still data was lost due to frequent and prolonged power-cuts that didn‘t provide enough power to recharge the battery. The most stable, environmental-friendly and effective power source was the Kaarta-ye-Se device which was connected to solar power.

## OUTLOOK

From the lessons learned during this pilot project the GardBox© device will be updated with a 6V solar panel. This will allow the GardBox© to operate independent of grid power supply and deliver stable data continuously without interruptions.

The GardBox© will be extended with additional gas sensors to calculate the Air Quality Index for Afghanistan. These gas sensors include CO, SO2, NH3, and NO2, and if required also other sensors.

Our aim is to scale-up this project into a nation-wide emissions inventory project by installing the updated GardBox© devices in other major cities of Afghanistan including Herat, Mazar, Jalalabad and Kandahar.

# DATA ANALYSIS

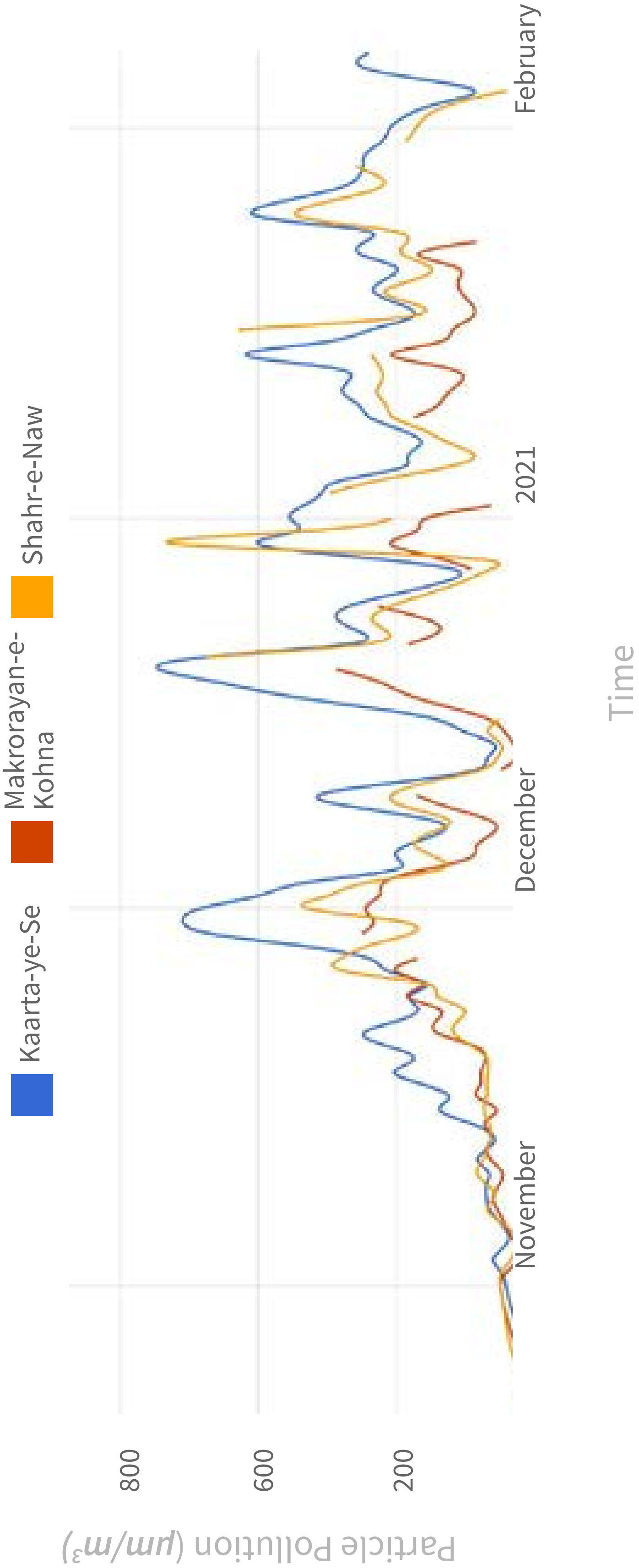
# DATA ANALYSIS

Large amounts of data was collected over a period of three months, from November 2020 to January 2021 enabling a solid analysis of PM 2,5 and PM 10 levels in the air-quality of Kabul city. The data was collected in 5 minute tact. As a result, real-time air-quality changes could be observed on hourly, daily, weekly, and monthly bases. However due to power-cuts and lack of reliable electricity source, the Gardbox would turn-off causing unavailability of data for certain hours and sometimes for many days.

When comparing the data from the three locations of Shahr-e-Naw, Kaarta-ye-Se and Macrorayan-e-Kohna it became clear that the concentration levels of PM 2,5 and PM 10 varied by different extents but the pattern in terms of rise and fall of PM 2,5 and PM 10 level at different times of the day remained more or less consistent.

Discrepancy in varying levels is directly related to the type of housing and building constructions in each of these three locations where the stations were installed. Kaarta-ye-Se had the highest level of PM2,5 and PM10 concentration while Macrorayan-e-Kohna had the lowest and Shahr-e-naw remained in between. Moreover, the levels of PM 2,5 correlated directly with falling outdoor temperatures as people started to burn different kinds of fuel to heat the inside of their houses.

*Figure 4 : PM 2,5 levels from November 2020- January 2021*



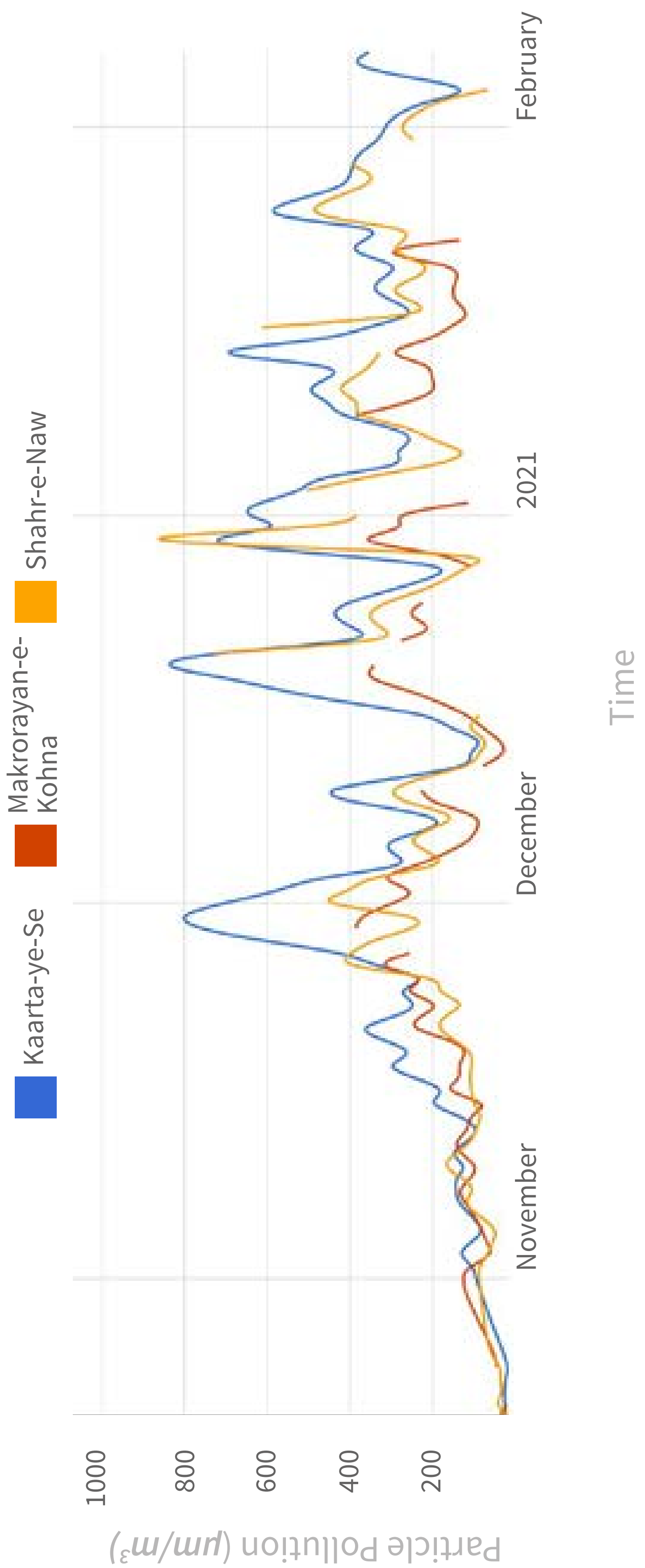



*Figure 5 : PM 10 levels from November 2020- January 2021*

# DIFFERENTIATORS

***Kaarta-ye-Se***

Kaarta-ye-Se is a residential area with predominantly middle to upper-middle class households with regular income sources. It used to be a sub-urban area of Kabul before the war, with mostly affluent and well-off residents. Even now many Afghan politicians, businessmen and parliament members live here. It also houses several national and international organizations. Kaarta-ye-Se consists mostly of single-joint-family large to small bungalows, courtyard houses to large mansions, and comparatively fewer multi-family residential buildings than Shahr-e-Naw and Macrorayan-e-Kohna. It has a highly frequented shopping district with high-end shops, restaurants, cafes as well as several swimming pool halls and hamams. The type of buildings and houses in Kaarta-ye-Sa which are usually one- to three-storey high either do not have a proper heating system and/or also lack proper insulation layer in their construction. Most bungalows however have a smoke vent system and chimney that leaves no other option than to burn solid-fuels to heat the houses. Also sufficient spaces at the disposal of residents allows to store large amounts of solid-fuel to use throughout the winter. With lack of regulation and control mechanisms residents and business-owners often burn wood or coal to heat their houses and stores as soon as temperatures start to fall. In addition most residents, shopkeepers as well as big business owners resort to fuel-run electricity generators due to recurring blackouts which add to the already high level of PM 2,5 and PM 10 in the air. With the high number of bungalows and mansions spread across a large PM 2,5 and PM 10 emissions were extremely high in Kaarta-ye-Se. PM2.5 concentration reached an alarming level of 576 $\mu g/m^3$ 24-hour which is more than 23 times the level of WHO target guidelines that suggest a 25 $\mu g/m^3$. PM10 concentration reached an alarming level of 888 $\mu g/m^3$ 24-hour which is almost 17,7 times the level of WHO target guidelines of 50 $\mu g/m^3$ 24-hour. This level is considered beyond “Hazardous” with serious aggravation of heart or lung diseases and premature mortality in persons with cardiopulmonary diseases and the elderly. Serious risk of respiratory effects is assessed for the general population and everyone is advised to avoid outdoor exertion. Particularly the elderly and children are advised to remain indoors under such conditions.

### *Shahr-e-Naw*

Shahr-e-Naw is the shopping and business district of Kabul. The residential parts of the district consist mainly of several storey high multi-family residential buildings and one to three-storey high bungalows and courtyard houses. Shop and business owners as well as residents of Shahr-e-Naw are considered to be middle to high-income citizens. Shahr-e-Naw is a highly congested part of the city due to traffic. A lot of construction work in recent years has changed the landscape of the district. However each building has its separate central-heating-system which runs on solid fuel, usually unrefined and unprocessed coal, each building produces large amounts of PM 2,5 and PM 10 emissions. Similar to Kaarta-ye-Se, fuel-run electricity generators, due to recurring blackouts, remain a common sight and sound in this district. Shahr-e-Naw also showed very high levels of PM 2,5 and PM 10 in the air. The hazardous levels of PM2.5 concentration reached an alarming level of 474 $\mu g/m^3$ 24-hour which is more than 19 times the level of WHO target guidelines that suggest a 25 $\mu g/m^3$. PM10 concentration reached an alarming level of 728 $\mu g/m^3$ 24-hour which is almost 14,5 times the level of WHO target guidelines of 50 $\mu g/m^3$ 24-hour.

### *Macrorayan-e-Kohna*

Makrorayan-e-Kohna is exclusively a residential area built during the 1960s according to the Soviet Plattenbauten or large panel-system method. The residents‘ income bracket varies from low to very-high. The buildings are usually four-storey high and house multiple families in each block. The Makroyans have a district-heating-system which is a centralized local or cogeneration plant that distributes heat through insulated pipes. It is one of its kind in Afghanistan. These are usually turned on during the winter months, however this was not the case in the winter of 2020/21. Furthermore, with a lack of apartments smoke-vent-system, too dense exterior panel walls compared to the brick walls of the bungalows in Kaarta-ye-Se, and no storage facility to store large amounts of solid-fuel like wood or coal, residents of Macrorayan-e-Kohna resorted to gas-heaters to heat their apartments this winter. This explains the comparatively lower levels of PM 2,5 and PM 10 in the air. PM2.5 concentration reached 287 $\mu g/m^3$ 24-hour which is more than 11,5 times the level of WHO target guidelines that suggest a 25 $\mu g/m^3$. PM10 concentration reached an alarming level of 368 $\mu g/m^3$ 24-hour which is almost 7,3 times the level of WHO target guidelines of 50 $\mu g/m^3$ 24-hour.

# MONTHLY COMPARISON

### *November*

The monthly reading pattern enabled us to analyse the data – which is collected in 5 minute tact – to be assessed on a daily basis. By mid November pollutant levels started to rise. During the same time the temperature fell from 17,8 °C to 5 °C - a fall of 72%. Both PM 2,5 and PM 10 patterns remained identical in November 2020.

*Figure 6 : PM 2,5 levels in November 2020*

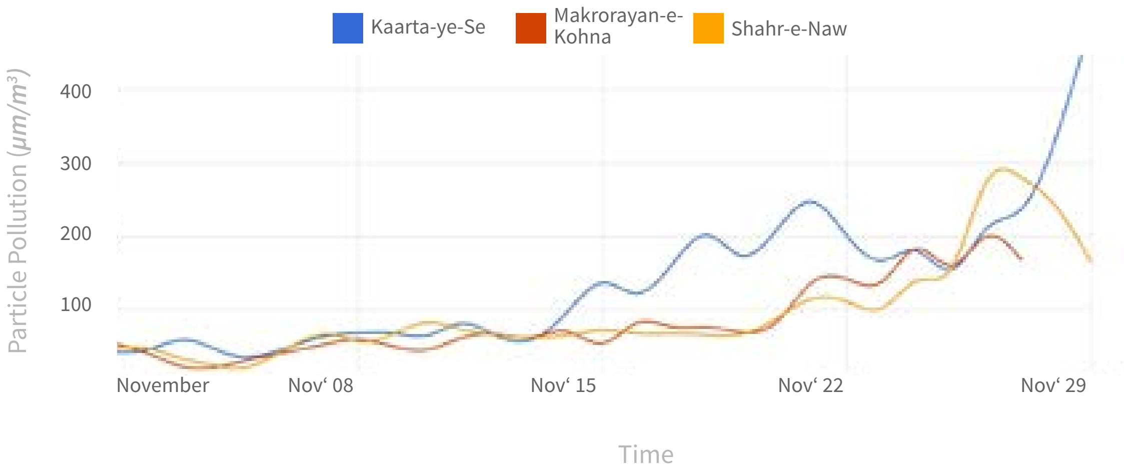
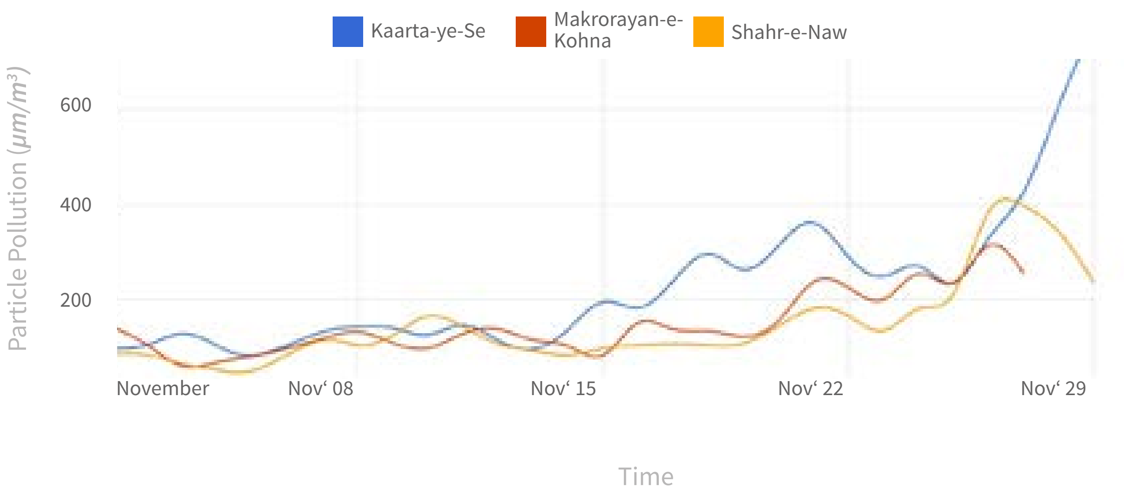



*Figure 7 : PM 10 levels in November 2020*



### *December*

Pollutant levels remained high till the first week of December when levels fluctuated and fell by mid December, but started to rise by the end of the month as emission levels reached a peak. Gaps in Macrorayan-e-Kohna and Shahr-e-Naw in readings in December resulted from power-cuts over a period of several days. Both PM 2,5 and PM 10 patterns remained identical in December 2020.

*Figure 8 : PM 2,5 levels in December 2020*

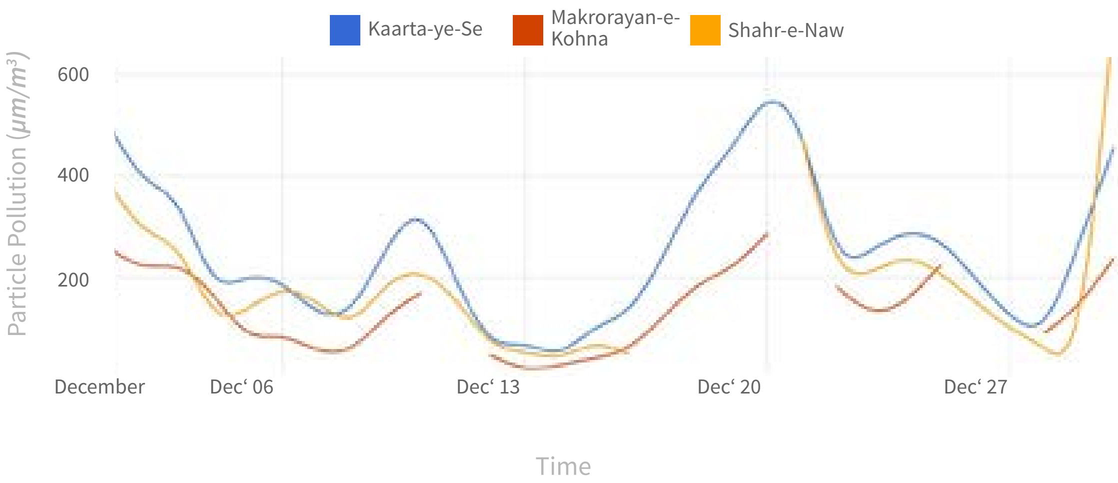



*Figure 9 : PM 10 levels in December 2020*

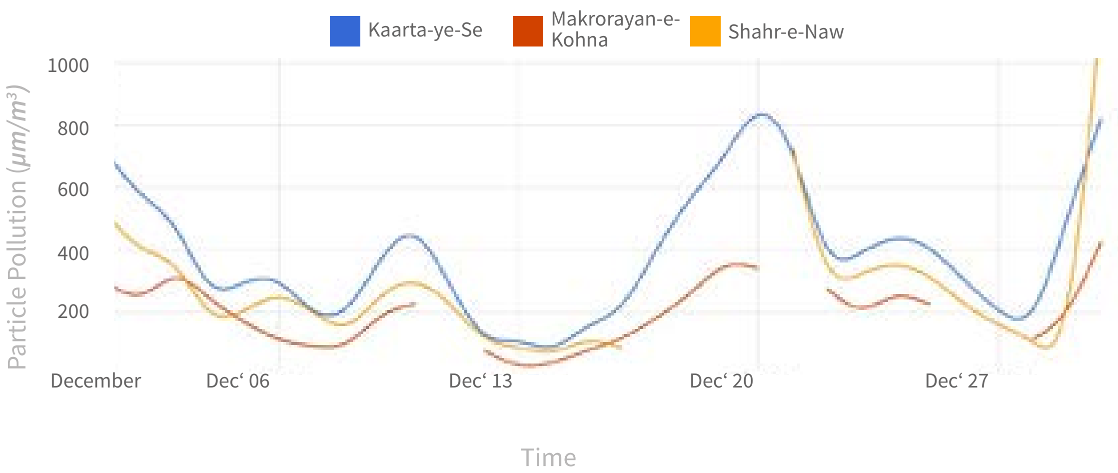


*Figure 10 : PM 2,5 levels in January 2021*

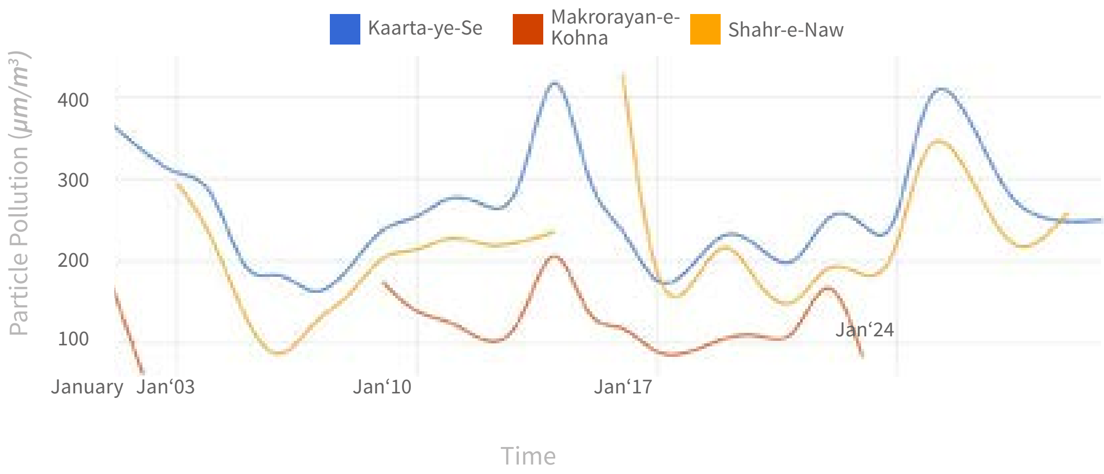
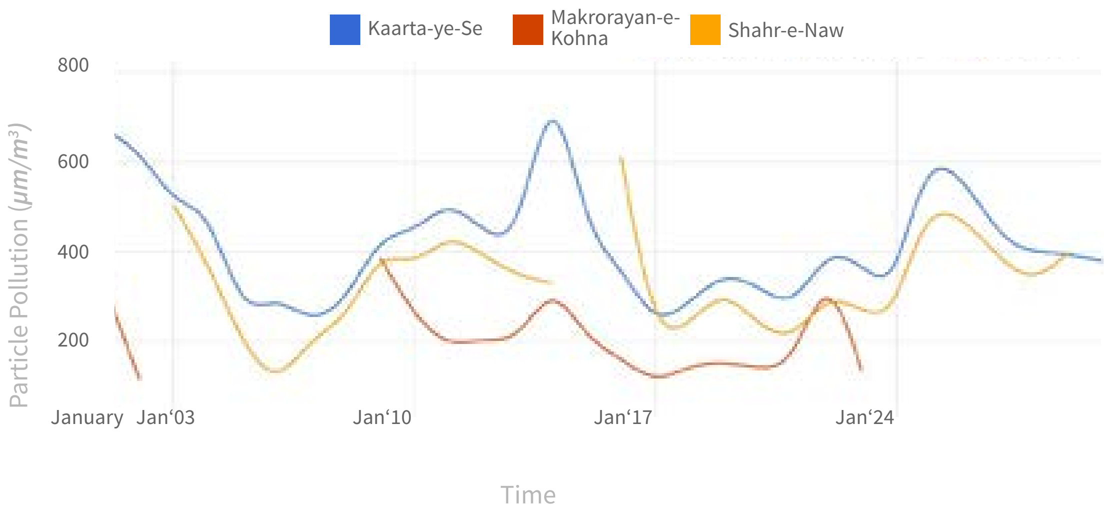



*Figure 11 : PM 10 levels in January 2021*




## *January*

Pollutant levels remained rather high till the third week of January. After a comparative fall emission levels rose again by the end of the month. Data loss and gaps in reading continued especially in Macrorayan-e-Kohna and Shahr-e-Naw as a result of power-cuts over a period of several days. Both PM 2,5 and PM 10 patterns remained identical in January 2021.

# WEEKLY COMPARISON

### *November*

The weekly pollutant emission pattern of Macrorayan-e-Kohna and Shahr-e-Naw showed similarities as in when they fell and rose. Kaarta-ye-Se emission levels however rose 1 to 2 days later indicating a time shift in addition to different levels.

*Figure 12 : PM 2,5 levels on weekly basis in November 2020*

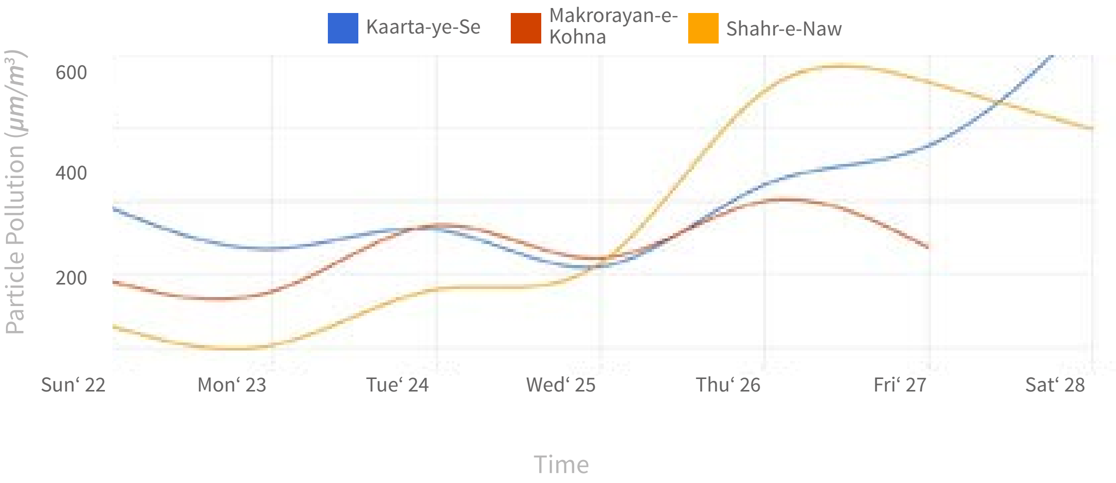



*Figure 13 : PM 10 levels on weekly basis in November 2020*

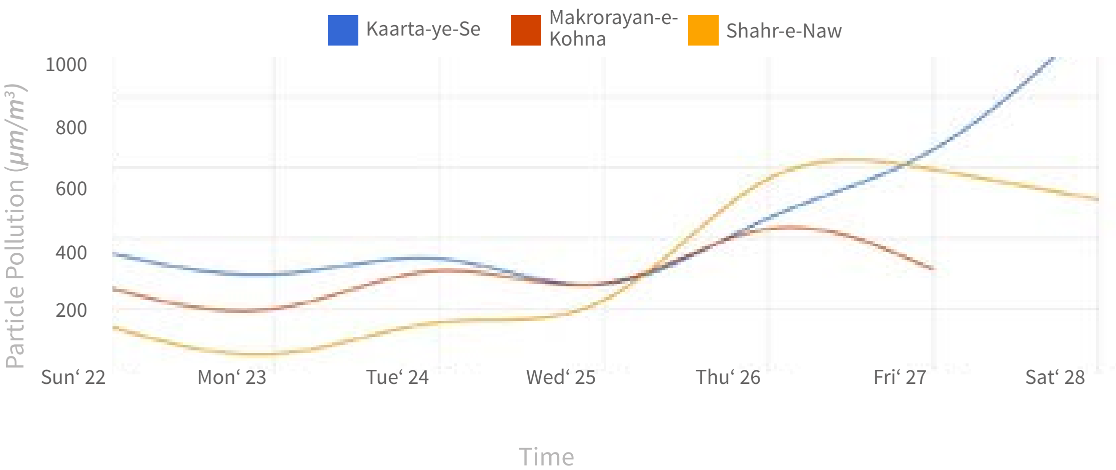


*Figure 14 : PM 2,5 levels on weekly basis in December 2020*

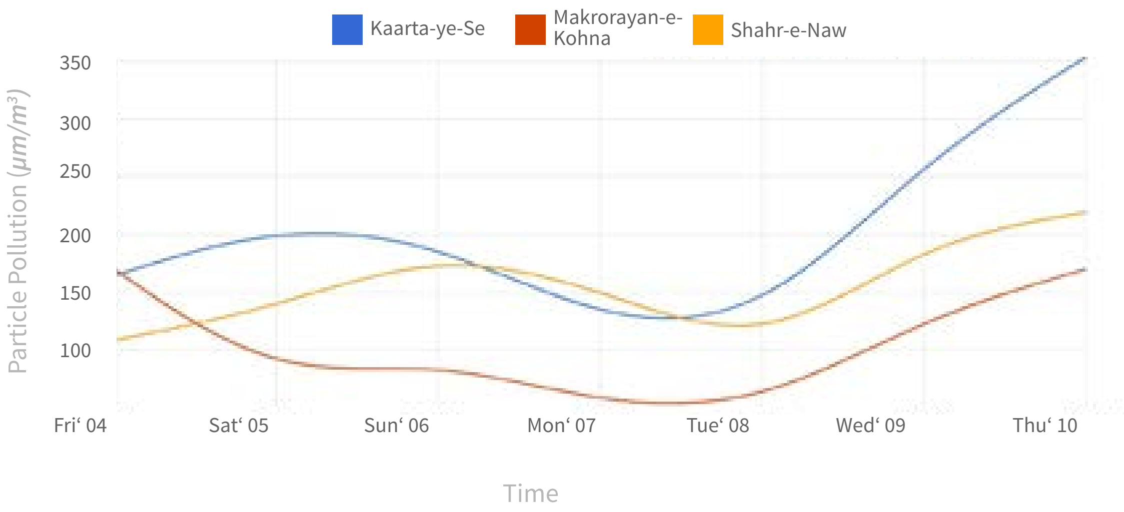
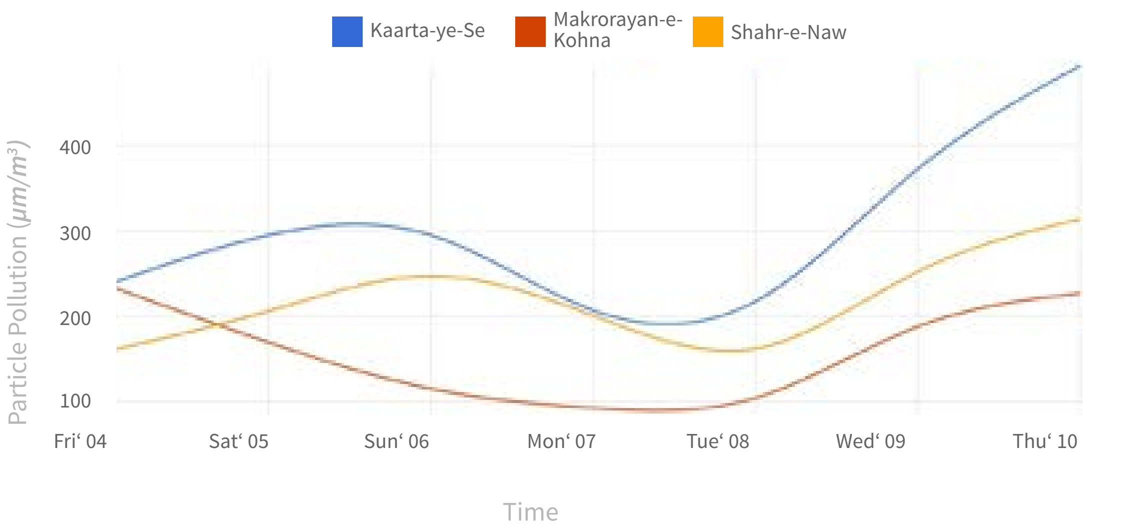



*Figure 15 : PM 10 levels on weekly basis in December 2020*




### *December*

The weekly reading from December indicated that although the emission elevation patterns remained somewhat similar, the weekly average of pollutant concentration in Kaarta-ye-Se surpassed Shahr-e-Naw levels by 37% and Macrorayan-e-Kohna levels by 50%.

## *January*

*Figure 16 : PM 2,5 levels on weekly basis in January 2021*

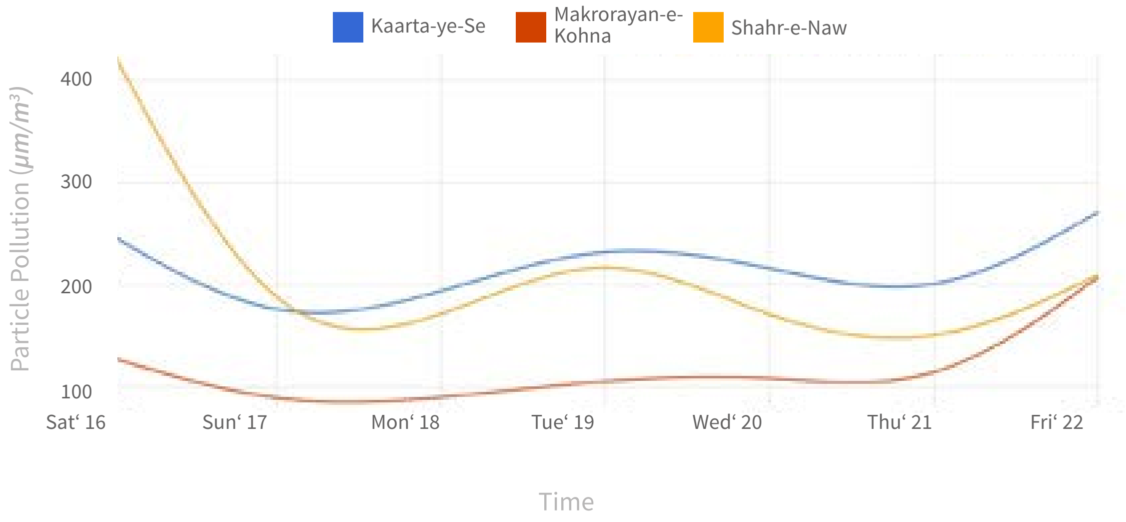
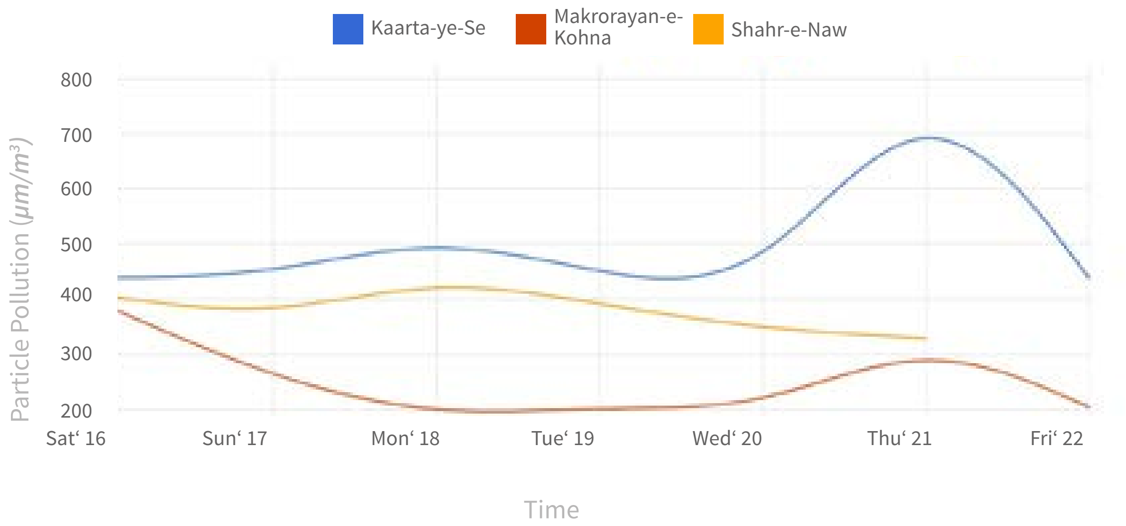



*Figure 17 : PM 10 levels on weekly basis in January 2021*



# DAILY PATTERN

The daily pattern enabled us to analyse the data – which is collected in 5 minute tact – to be assessed on an hourly basis. Concentration levels of PM 2,5 and PM 10 varied in the three locations of Shahr-e-Naw, Kaarta-ye-Se and Macrorayan-e-Kohna but the pattern in terms of rise and fall of PM 2,5 and PM 10 level during the day remained more or less consistent.

## *November*

PM 2,5 and PM 10 levels remained elevated until approximately 2 am the next day. Emission levels fell, reaching a low at approximately 12 noon. Both PM 2,5 and PM 10 levels started to rise approximately after 4 pm and continued to rise consistently reaching a peak of following values by approximately 9 pm:

***Kaarta-ye-Se:***
PM 2,5: 999 µg/m³ - PM 10: 2000 µg/m³

***Shar-e-Naw:***
PM 2,5: 974 µg/m³ - PM 10: 1700 µg/m³

***Macrorayan-e-Kohna:***
PM 2.5: 552 µg/m³ - PM 10: 1100 µg/m³

*Figure 18 : PM 2,5 levels and pattern on hourly basis in one day in November 2020*

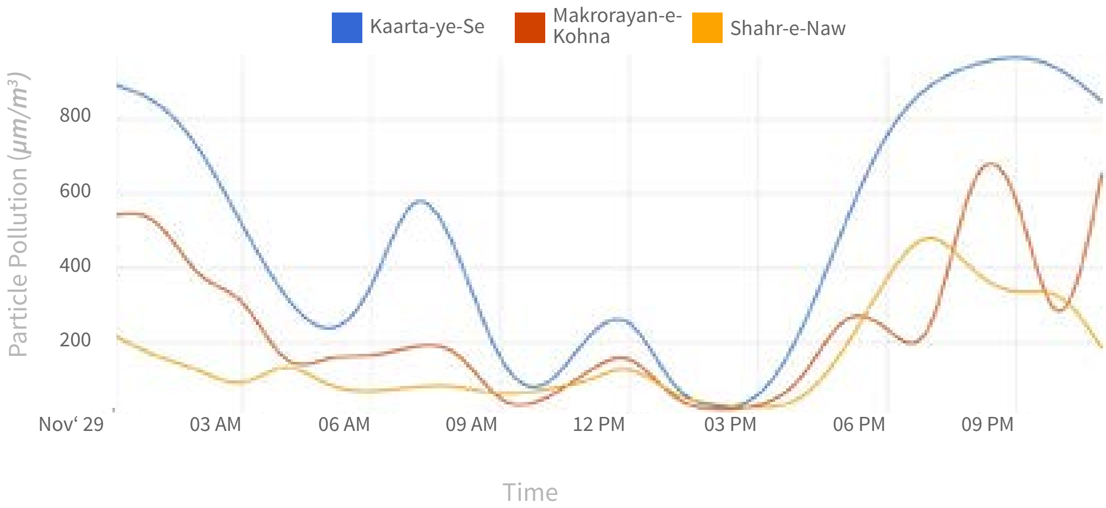
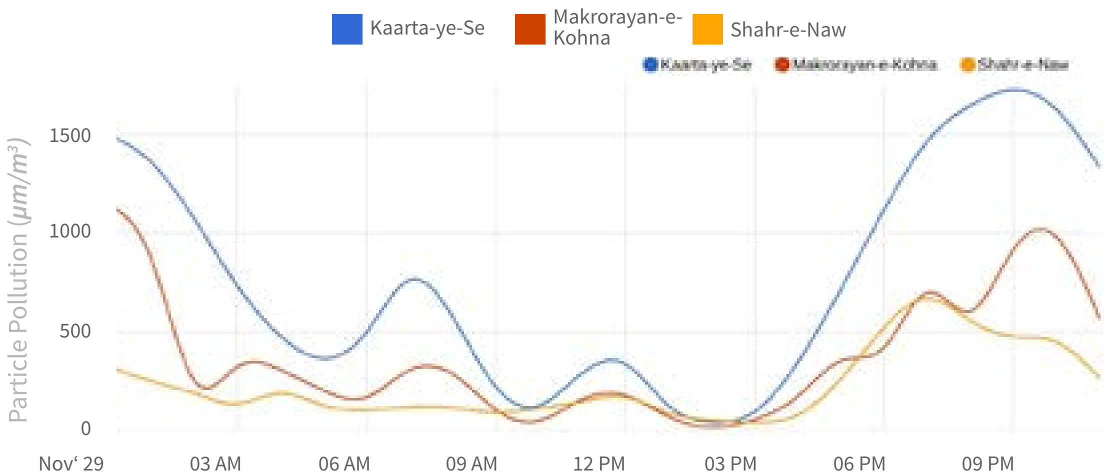



*Figure 19 : PM 10 levels and pattern on hourly basis in one day in November 2020*



### *December*

Hourly emission patterns remained consistent for an exemplary day in December as levels started to fall after midnight reaching a low at approximately 12 noon of the next day. Both PM 2,5 and PM 10 levels started to rise approximately after 4 pm and continued to rise consistently reaching a peak of following values by approximately 9 pm:

***Kaarta-ye-Se:***
PM 2,5: 941 µg/m³ - PM 10: 1880 µg/m³

***Shar-e-Naw:***
PM 2,5: 709 µg/m³ - PM 10: 1340 µg/m³

***Macrorayan-e-Kohna:***
PM 2.5: 1060 µg/m³ - PM 10: 1240 µg/m³

*Figure 20 : PM 2,5 levels and pattern on hourly basis in one day in December 2020*

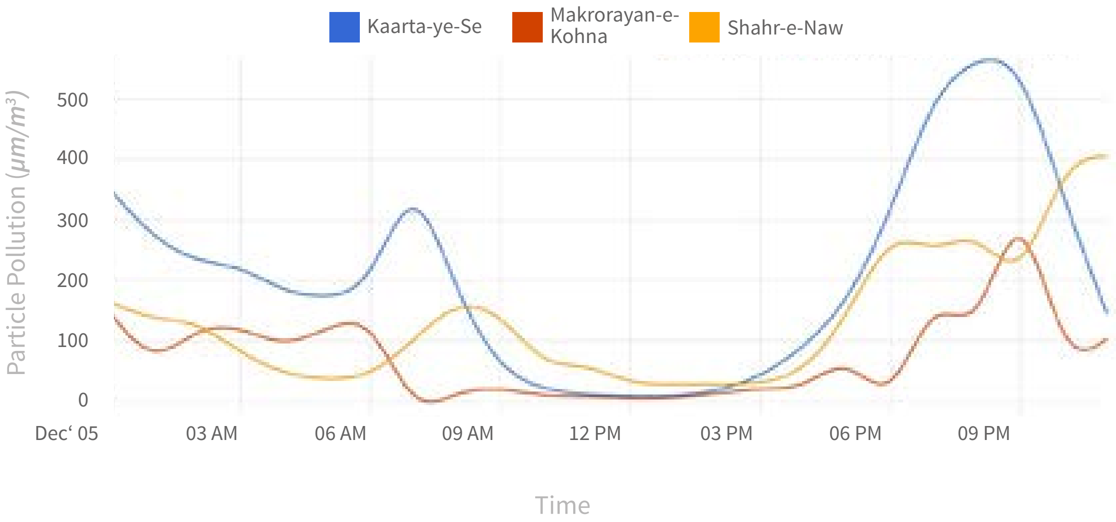



*Figure 21: PM 10 levels and pattern on hourly basis in one day in December 2020*

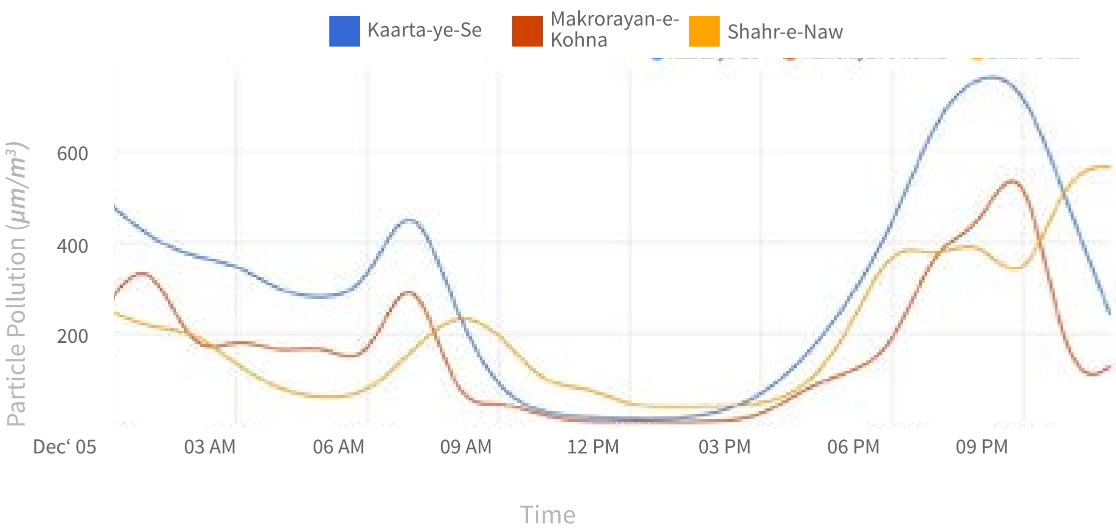


*Figure 22 : PM 2,5 levels and pattern on hourly basis in one day in January 2021*

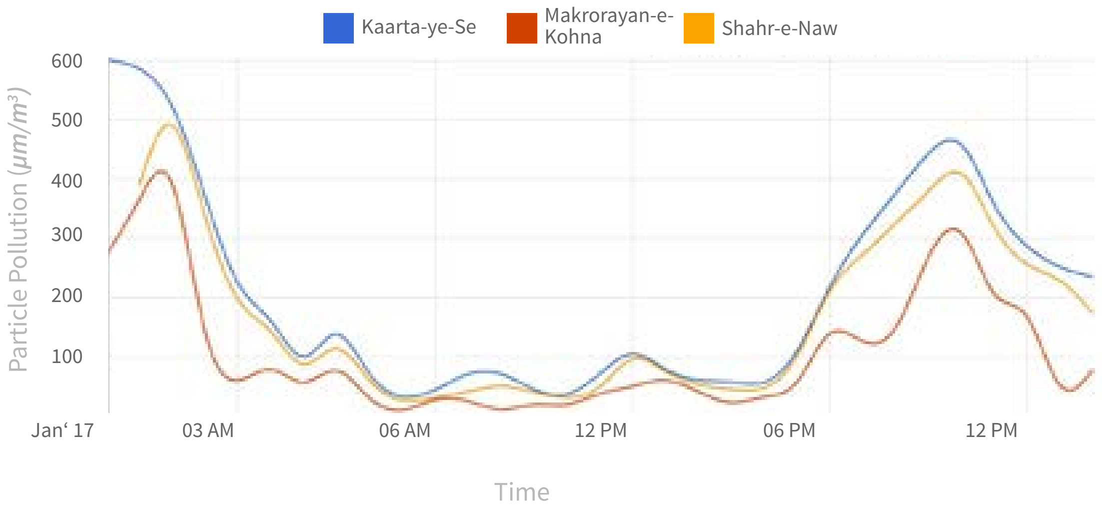
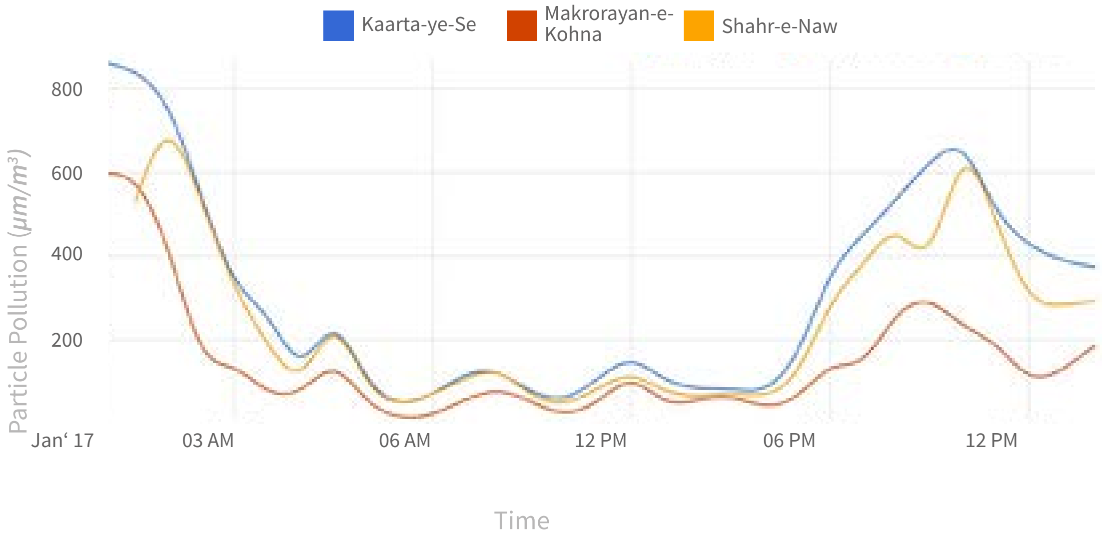



*Figure 23 : PM 10 levels and pattern on hourly basis in one day in January 2021*




### *January*

Emission patterns for an exemplary day in January remained consistent with the reading of November and December as levels started to fall after midnight reaching a low at approximately 12 noon of the next day and rose again after 4 pm and reaching a peak at around midnight.

## EMISSION PROJECTION

Without interventions and mitigation measures, emissions of air pollutants and PM 2,5 and PM 10 are expected to increase in the future. As a result of climate change inter alia leading to rural exodus, and migration to Kabul the population of the city as well as demand for economic growth is expected to increase. In addition, other drivers and sources of emissions such as emissions generated by the transportation sector, waste sector, industrial sector, greenhouse gases, other household related emissions and lack of trees and greenery to counteract these drivers, these sources of emissions are projected to increase as well. These trends are going to lend to an overall demand growth for primary and secondary sources of energy which will eventually demand proper heating facilities.

With a deteriorating security situation that has overshadowed the workings of responsible agencies and authorities at every level of the government, and the absence of a national air-monitoring-system, it remains difficult to take concrete measures and implement the existing policies .[9] For this purpose, OSRA and Digital Bridge emphasize the need for the following recommendations to be taken in consideration by the responsible agencies and authorities.

**9** *To read these policies please refer to https://neis.nepa.gov.af/public/AuigP18Ybp*

# RECOMMENDATIONS

# RECOMMENDATIONS

The findings of this report are critical and are meant to serve as an impulse for concrete and cost-benefit measures to identify sources of emissions of air pollutants including PM 2,5 and PM 10 and respond quickly and on-the-spot/locally, with appropriate and tailored measures .

## RECOMMENDATION 1

Develop a national air quality monitoring system for Kabul city as well as other major cities of Afghanistan in order to quantify air pollutant emissions including SO2, NO, NO2, NOX ,CO, O3, PM 10, PM 2,5 and other Afghanistan specific pollutants. Furthermore, by creating a quantification process to collect data, analyse and evaluate it, the responsible authorities would simultaneously have an emission inventory process that would also allow them to monitor air pollutants as well as greenhouse gases emissions. Both air pollutants and greenhouse gases are generated by the same sources. By integrating air pollutants and greenhouse gases emissions into one inventory system, no separate data collection and duplication measures would be required. As signatory to the Paris Agreement, Afghanistan would contribute to its temperature goals. By using portable devices like the GardBox©, a detailed, localized and precise map of pollutant emissions will be at the authorities disposal.

## RECOMMENDATION 2

Integrate air pollution mitigation measures into sectoral strategies as well as into sub-national planning level. To curb pollutant emissions concrete actions and mitigation measures should be included in implementation plans for priority sectors like electricity, agriculture and most importantly transport, as well as ministries and agencies. Air quality strategies that focus on sources of emissions should also be developed for other cities so that air quality can be improved across the country. This requires the engagement of municipal governments, and the building of technical and human capacity to assess and plan for air quality improvements within their jurisdiction. Incentives to reduce air pollutants in sectoral strategies could be created by quantifying its economic benefits. The GardBox© as an easy-to-install and portable device can provide an ideal solution to identify and monitor indicators within a Monitoring and Evaluation Framework.

## RECOMMENDATION 3

Prohibit raw coal for heating and use briquette fuel instead. The fast-track vice-presidential decree that banned the usage of raw coal for central-heating in some of the posh multi-family complex buildings of Kabul city proved effective during the height of winter. Imposition of high fines, installation of GardBox© devices in order to measure and control the air quality, and subsidize briquette fuel will be effective measures to ensure that prohibition of burning raw coal is effectuated.

### RECOMMENDATION 4

Retrospective Insulation of fire-clay brick exterior walls; reinforced concrete floors and roofs; wooden, PVC and aluminium windows and doors of bungalows, modern courtyard houses and mansions and apartments to regulate energy consumption of buildings in winter as well as summer. It is recommended that the government create schemes to encourage people to invest in retrospective insulation while effectuating monitoring measures that ensure new projects actually implement the measures. A media campaign that raises awareness about the financial and environmental benefits of insulation will be effective in delivering this message.

### RECOMMENDATION 5

Increase technical capacity to measure and track progress on air pollution regularly. A sustainable increase in capacity to assess air pollution in an integrated way is necessary. An increase in technical capacity is required at the national level in Afghanistan to: (i) conduct regular emission inventory, (ii) undertake mitigation assessments, including projecting emissions into the future and assessing implementation of different policies and measures. Collaboration with academics and other institutions that provide additional entities that can help in generating improved and additional data to improve the accuracy and precision of emission estimates.

# ANNEX

## SPECIFICATIONS

| | |
|---|---|
| MEASUREMENT PARAMETERS | PM 2.5, PM 10 |
| MEASUREMENT RANGE | 0.0 - 999.9 $\mu g/m^3$ |
| PM SENSOR RESOLUTION | 0.3 $\mu g/m^3$ |
| PM SENSOR RESPONSE TIME | < 10 seconds |
| RELATIVE ERROR | Maximum of ±15% and ±10 $\mu g/m^3$ |
| CONNECTIVITY | LTE/UMTS/GSM, WiFi, Ethernet |
| COMMUNICATION PROTOCOL | MQTT |
| DATA-LOAD FORMAT | JSON |
| OPERATING VOLTAGE | 5 V |
| CURRENT IN IDLE | 200 $\mu A$ |
| SUPPLY CURRENT | ≅ 350 mA |
| POWER SUPPLY | 5V / 1A (microUSB / USB-C) |
| STORAGE TEMPERATURE | -20 - 60°C |
| OPERATING TEMPERATURE | -10 - 50°C |
| WEIGHT | 400 g |
| DIMENSIONS | 76 x 65 x 16 mm |