City Research Project (Project Year 4)

Citizen's Science and Airbeam

Myanmar

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Citizen's Science and Airbeam Myanmar Project Phase II

City Research Project (Project Year 4), TEI-REAM

Introduction

By using an environmental measurement device called the Airbeam, the trainers have started the workshop on 4 – 5 July 2017 at Bago University, 6-7 July 2017 at Maubin University and 6-7 January 2018 at Dawei University, 28-29 April 2018 at Loikaw University, 1-2 May at Taunggyi University respectively. It is based on the open-source Air casting platform for collecting, displaying and sharing environmental data using a mobile device. The device usually allows users to measure four environmental variables: humidity, sound level, particulate matter (PM2.5), and temperature. Moreover, by uploading on the Air casting platform, the data could share with the others in real time. As device is not only useful as a teaching tool but also a very portable one to make measurements, interpreting the data, and comparing data from different regions, therefore relevant organizations and students can learn about methods of scientific investigation. Furthermore, by findings on the distribution of pollution and the varying levels of pollution from the different regions, this also helps relevant organizations and the students, awareness of environmental and public policy issues. Finally, this will teach relevant organizations and students how to assume different roles and take responsibilities as part of a team in respective geographic regions.

The most important of the device is very useful as a research and advocacy tool to encourage community engagement in dealing with urban environmental issues. On which, citizens can use these findings to engage in shared learning dialogues with municipal officials and other actors about how their cities should address these issues.

Purposes of the workshops

1) To teach participants about what PM 2.5 is, what the sources of PM 2.5 are, and why it is harmful to health. This information showed participants why it is important to monitor PM 2.5.
2) To teach University staffs and other participants how to use the Airbeam device, how to upload the data to the Air casting website, and how to use the website.
3) To help participants start thinking about how they can use the Airbeam device for their teaching, research, and advocacy.

The Workshop Activities

In workshops, day one, the team introduced what PM 2.5 is, what the sources of PM 2.5 are, and why it is harmful to health. This information shared the participants why it is important to monitor PM 2.5. And then, the team demonstrated how to use the Airbeam device, and meanwhile, how to find the Air Casting application, setting up, and connecting the Airbeam to the user's phone or tablet. After the trainees got familiar with the device, then start collecting the data within the University Campus. Then, uploading the data to the Air Casting website, and gave the technique how to use the website. Finally the team helped the participants start thinking about how they can use the Airbeam device for their teaching, research, and advocacy.

Especially, participants divided into two groups to three groups in the training and distributed Airbeam devices to each group and started to collect the data in the morning section. Each group took longer routes around the city to collect air quality data. In the evening section, the trainers demonstrated uploading the data that they collected from their routes by themselves and make the presentation.

These trips were useful because participants could discover which areas had better or worse air quality. All of the participants then discussed the levels of air quality in the cities, where these were sourced from and how they can tentatively reduce by doing more research from their respective specialization. The training workshop concluded with each participant discussing what they had learned and how they plan to use the device in the future. After the workshop, the trainers handed out one device to the University for preceding the research and collecting the data.

In conclusion, the workshops shared hands-on experiences to the participants. Although, the workshop is the very first experience for them, the participants expressed their keen interest and enjoy the whole two consecutive days.

Sources: Myanmar Information Management Unit (MIMU)
Figure (i) The locations of the study areas

The study area

Bago city

Bago, formerly known as Hantharwady, is a city and the capital of the Bago Division in Myanmar. The location of Bago is 17°20'6.76"N, and 96°28'52.86"E. It is located 91 kilometers north-east of Yangon.

Ma-ubin

The location of Ma-ubin or Maubin Township is 16º 43′ 53″ N and 95° 39' 15.88" E and it is a town in the Ayeyarwady Division south-west of Myanmar. It is the seat of the Ma-ubin Township in the Ma-ubin District. Maubin district is plain land and rich in streams.

Dawei

Dawei is a city found in Tanintharyi, Myanmar. It is located 14.07 latitude and 98.19 longitude and it is situated at elevation 13 meters above sea level.

Loikaw

Loikaw is the *capital of Kayah State* in eastern Myanmar. It is located 19°40'40.73"N, 97°12'35.1"E, in the Karen Hills area, near the State's northern tip, just above on the Pilu River. The inhabitants are mostly Kayah (Karenni). Loikaw is slow tempo town with a few attractions. The attraction in this region is to visit different ethnic minorities, trek, and cycle, visit caves and enjoy spectacular scenery. https://en.wikipedia.org/wiki/Taunggyi

Taunggyi

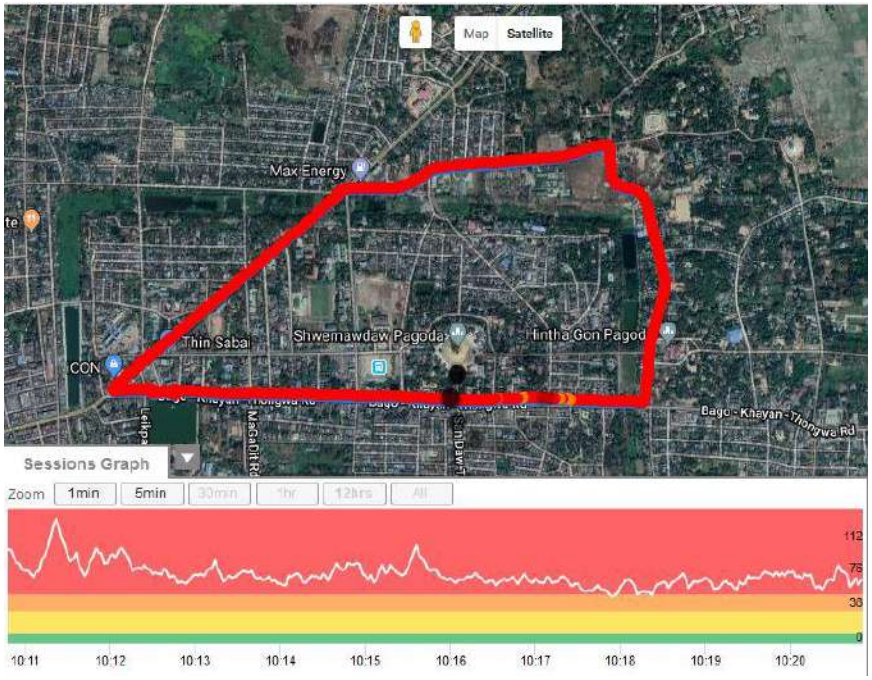
Taunggyi is the capital of Southern Shan State, which lies at 4712 feet above mean sea level. It located between north latitudes 20˚ 45' and 20˚ 50′, and east longitudes 97˚ 01′ and 97˚ 04′. At present, the total area of Taunggyi is 36.15 square kilometers (13.96 square miles) and comprises 22 wards. The total population in 2009 was 161428 people.

Yangon

Yangon is a former capital city of Myanmar. It is located 16.81 latitude and 96.16 longitudes and it is situated at elevation 30 meters above sea level. Yangon has a population of 4,477,638.
https://en.wikipedia.org/wiki/Taunggyi

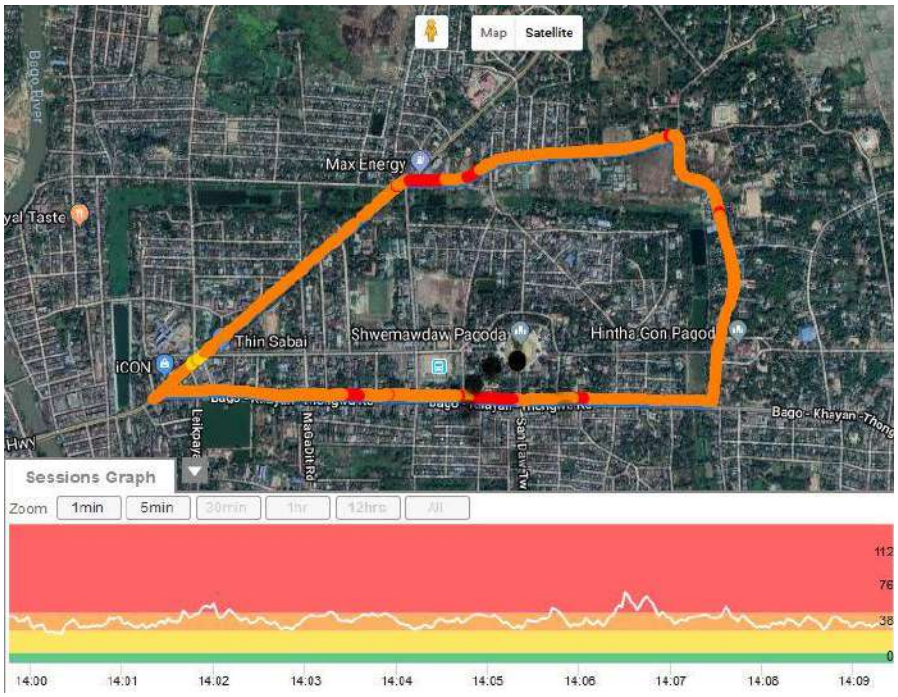
Bago city

Based on the real-time data analysis which shown in the following descriptive figures, the Real-time PM 2.5 Air Quality, in the morning section, Bago selected urban area is up to Unhealthy level 151 to 200 with the PM 2.5 (μg/m^3) of 55.5 to 150.4 . But in the evening, the level of PM 2.5 (μg/m^3) slightly decreased to 35.5 to 55.4 (μg/m^3) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups). Moreover, in the southern part of the city, the PM 2.5 (μg/m^3) conditions are common found as the range between 35.5 to 55.4 and 55.5 to 150.4 with AQI standards of 101 to 150 and 151 to 200.



Sources: Based on Air Casting platform Real-time situation

Figure (2) The morning section sample data collection route in Bago City



Sources: Based on Air Casting platform Real-time situation
Figure (3) The evening section sample data collection route in Bago City

Plate.1 Project co-director Dr. Min Oo giving the training

Plate.2 Photo documentation with Bago University organizers

Plate.3 Project co-director Dr. Min Oo giving the training to the young university students at Bago University

Bago $PM_{2.5}$ sources situation

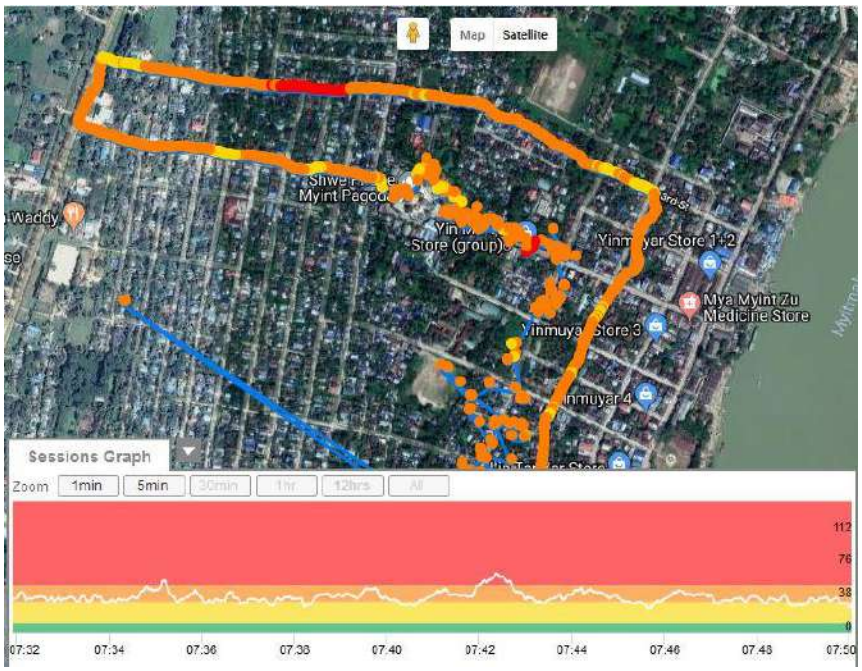
Primarily come from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal and natural sources such as forest and grass fires and also form from the reaction of gases or droplets in the atmosphere from sources such as power plants. These chemical reactions can occur miles from the original source of the emissions. But in Bago City, based on the observational analysis, most of the sources might be from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal and natural sources such as forest and grass fires as the city is not surrounded by industrial intensive activities.

Health awareness

Based on the values index, $PM_{2.5}$ Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. Precautionary Actions should take, especially people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

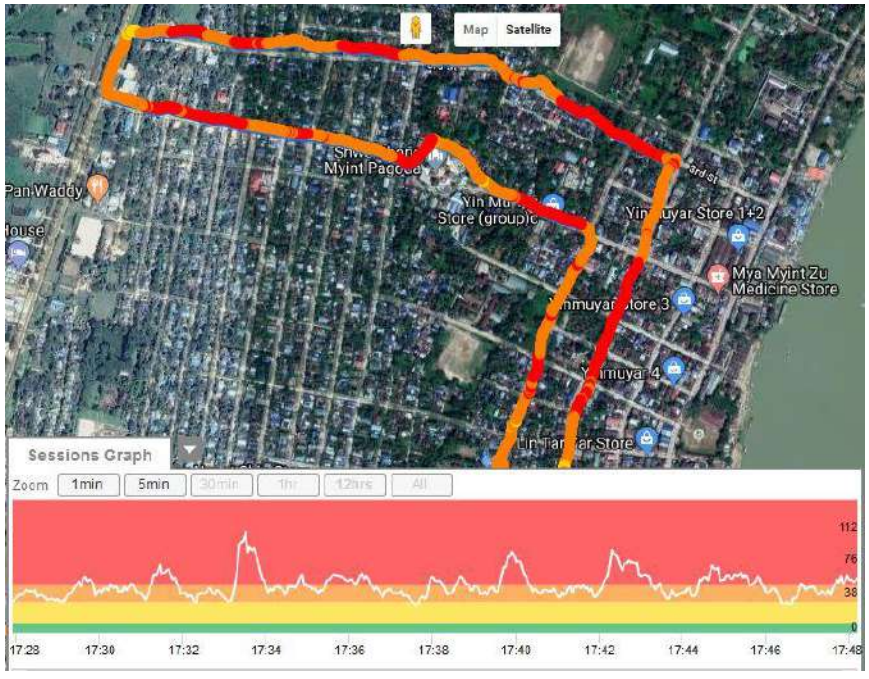
Maubin

In Maubin City, 4 days of Real-time PM 2.5 data analysis had been conducted by the trained participants. Based on the real-time data analysis which shown in the following descriptive figures, in the morning section, the Real-time PM 2.5 ($\mu g/m^3$) could be commonly found as the level of 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups). But in the evening, the level of PM 2.5 ($\mu g/m^3$) slightly increased to 55.5 to 150.4 ($\mu g/m^3$) with AQI standard of Unhealthy 151 to 200 (Unhealthy).



Sources: Based on Air Casting platform Real-time situation

Figure (4) The Morning section sample data collection route in Maubin City



Sources: Based on Air Casting platform Real-time situation

Figure (5) The evening section sample data collection route in Maubin City

Plate (4)Project co-director Dr. Min Oo giving the training

Plate (5)Team members data collection in Maubin City

Maubin $PM_{2.5}$ Sources situation

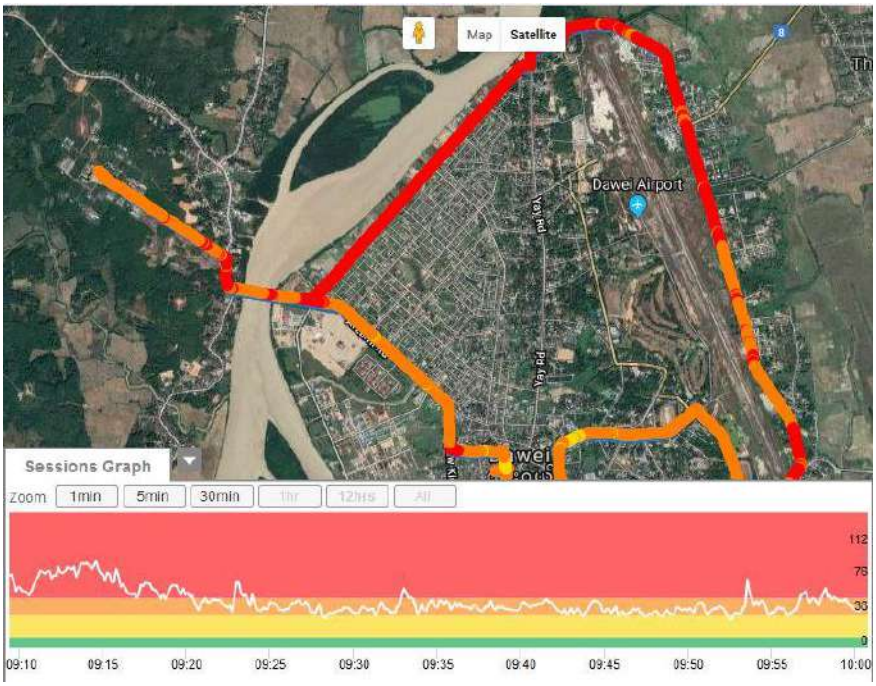
Primarily come from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal and natural sources such as forest and grass fires and also form from the reaction of gases or droplets in the atmosphere from sources such as power plants. These chemical reactions can occur miles from the original source of the emissions. But in Maubin City, based on the observational analysis, most of the sources might be from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal and natural sources such as forest and grass fires as the city is not surrounded by industrial intensive activities.

Health awareness

Based on the values index, $PM_{2.5}$ Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. Precautionary Actions should take, especially people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

Dawei city

In Dawei City, 3 days of Real-time PM 2.5 data analysis had been conducted by trained participants, especially the young university students. Not like Maubin City, as the city is more commercialize and intended to be urbanized, the intensity of Real-time PM 2.5 Air Quality is also higher. Based on the real-time data analysis which shown in the following descriptive figures, in the morning section, the Real-time PM 2.5 Air Quality commonly found in the northern part of the city is in the range of 55.5 to 150.4 ($\mu g/m^3$) with AQI standard of Unhealthy 151 to 200 (Unhealthy). But the southern part of the city, the level of PM 2.5 ($\mu g/m^3$) slightly decreased to 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups). But, in the evening, the level of PM 2.5 ($\mu g/m^3$) sharply downed to 0 to 12.0 ($\mu g/m^3$) with AQI standard of 0 to 50 (Good) and 12.1 to 35.4 ($\mu g/m^3$) with AQI standard of 50 to 100 (Moderate) in the northern part of the city. And only a few 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) could be found in the southern part.



Sources: Based on Air Casting platform Real-time situation

Figure (6) The morning section sample data collection route in Dawei City

Sources: Based on Air Casting platform Real-time situation

Figure (7) The evening section sample data collection route in Dawei City

Plate (6) Opening of Training and Workshop

Plate 7 Regional Minister of Tanintharyi Special division

Plate (8)Data collection by Team members

Plate (9) Photo documentation of Dawei University team

Dawei $PM_{2.5}$ sources situation

In Dawei City, as mentioned above, due to the urban rapid growth, the sources might be from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood. It is important that due to the future potential development (SEZ), the sources high potentially might be from heating oil or coal and the reaction of gases or droplets in the atmosphere from sources such as power plants as these chemical reactions can occur miles from the original source of the emissions should be noted.

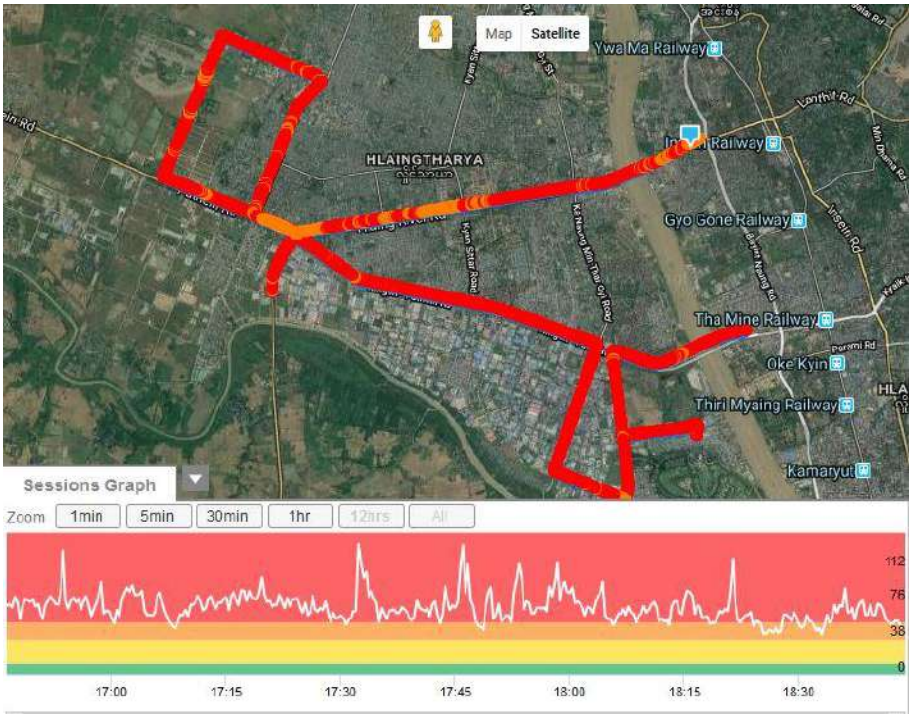
Health awareness

Based on the values index, in Dawei city, spatial and temporal changes of the $PM_{2.5}$ observed. Even some area, especially in the evening, the level of PM 2.5 ($\mu g/m^3$) sharply downed to 0 to 12.0 ($\mu g/m^3$) with AQI standard of 0 to 50 (Good) is concentrated, due to the 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) could be found in most of the areas, Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. So, precautionary Actions should take, especially people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

Yangon

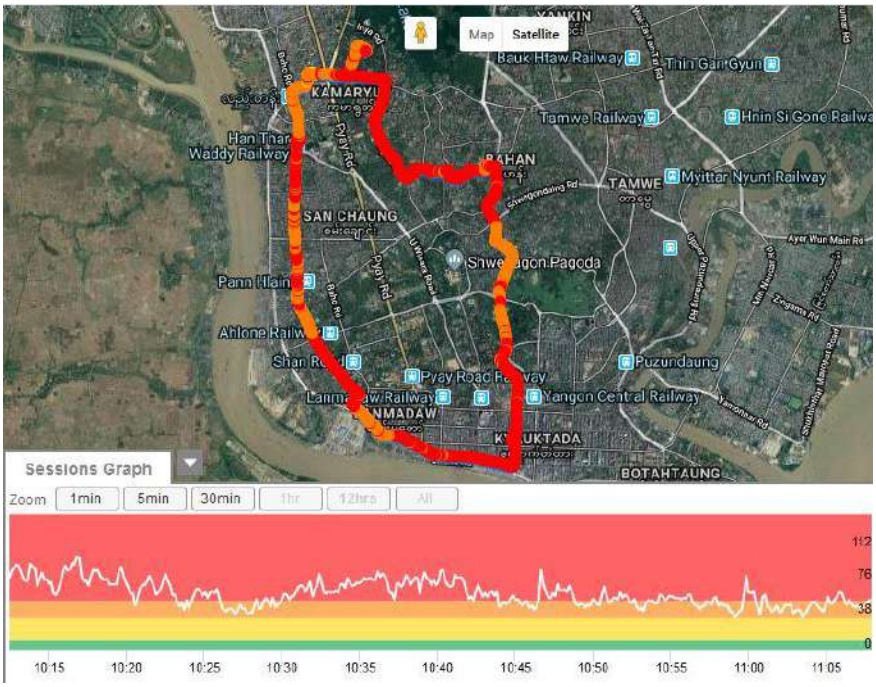
In Yangon City, based on the Real-time PM 2.5 data analysis had been conducted. Not like the others City, as the city is more commercialize and urbanized, the intensity of Real-time PM 2.5 Air Quality is also extremely high. Based on the real-time data analysis which shown in the following descriptive figures, in the Hlaingthayar township, the Real-time PM 2.5 Air Quality intensively found in the selected route is in the range of 55.5 to 150.4 ($\mu g/m^3$) with AQI standard of Unhealthy 151 to 200 (Unhealthy). Only a very few spot of 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) found in the area. It is also due to the fact that the time the data collection was in the time of Htainbin dumping site burning might be emitted abundant of PM 2.5.

Moreover, even the level of PM 2.5 (μg/m^3) not as high as the Hlaingtharyar Township, PM 2.5 Air Quality concentration in the others urban area in Yangon City (see in figure (5) is also extremely high. Commonly found as in the range of 55.5 to 150.4 (μg/m^3) with AQI standard of Unhealthy 151 to 200 (Unhealthy), and only a few 35.5 to 55.4 (μg/m^3) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) could be found in the selected route.



Sources: Based on Air Casting platform Real-time situation

Figure (8) The PM 2.5 data collection in Hlaingthayar, Yangon City



Sources: Based on Air Casting platform Real-time situation

Figure (9) The PM 2.5 data collection in selected route, Yangon City

Plate10. Photo documentation of Yangon University team

Plate (11)Team members data collection in Yangon City

Yamgon $PM_{2.5}$ sources situatin

Urban air pollution, especially in Yangon city is due to the growth in the size of cities, economic development, increasing the number of vehicles and level of energy consumption. Moreover, due to the movement of people into urban areas together with the increase in energy consumption, urban and industrial development leads to the problem of air pollution. Thus, it is urgently need to conduct a wide range of effective measures to reduce the environmental and social impacts associated with the rapid growth of urbanization (Nyan Htun Aung, Minister for Transport).

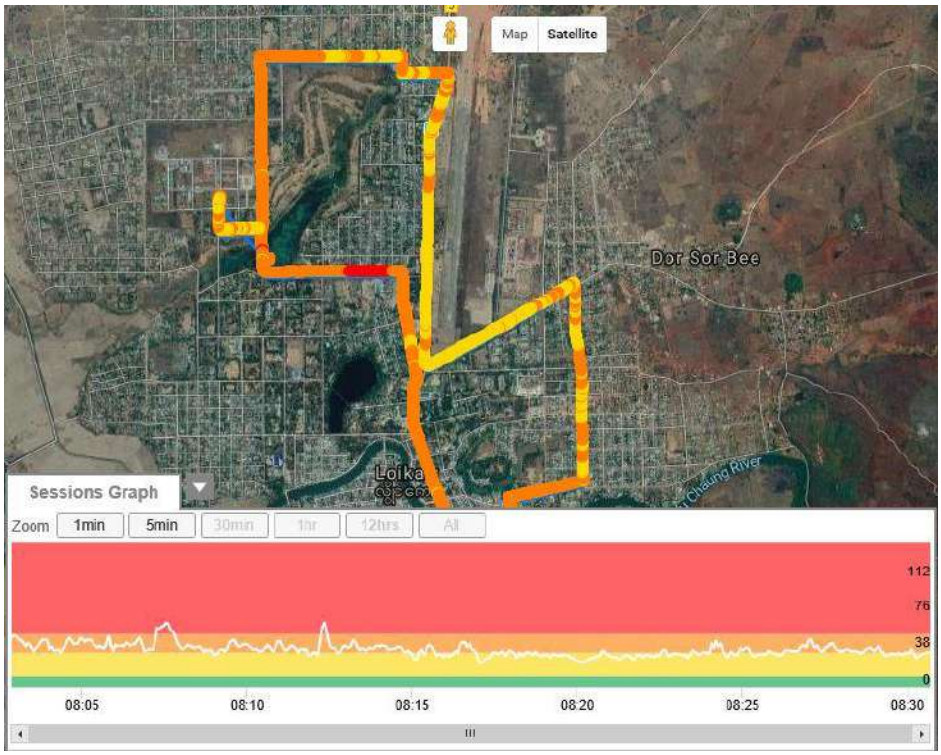
Health awareness

Based on the values index, in Yangon city, as the level of PM 2.5 ($\mu g/m^3$) is in the range of of 55.5 to 150.4 ($\mu g/m^3$) with AQI standard of Unhealthy 151 to 200 (Unhealthy) and the lowest range of 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) found in the area, Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. So, precautionary Actions should take, especially

people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

Loikaw

In Loikaw City, based on the Real-time PM 2.5 data analysis had been conducted on 28-29 April, the intensity of Real-time PM 2.5 Air Quality is also intended to be moderate. Based on the real-time data analysis which shown in the following descriptive figures, in the morning section, the Real-time PM 2.5 (μg/m^3) could be commonly found as the level of 35.5 to 55.4 (μg/m^3) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups).



Sources: Based on Air Casting platform Real-time situation
Figure (10) The PM 2.5 data collection in selected route, Loikaw City

Plate.12 Project co-director Dr. Min Oo giving the training at Loikaw University

Plate.13 Project director Professor Saw Win knowledge sharing on PM 2.5 at Loikaw University

Where does $PM_{2.5}$ come from?

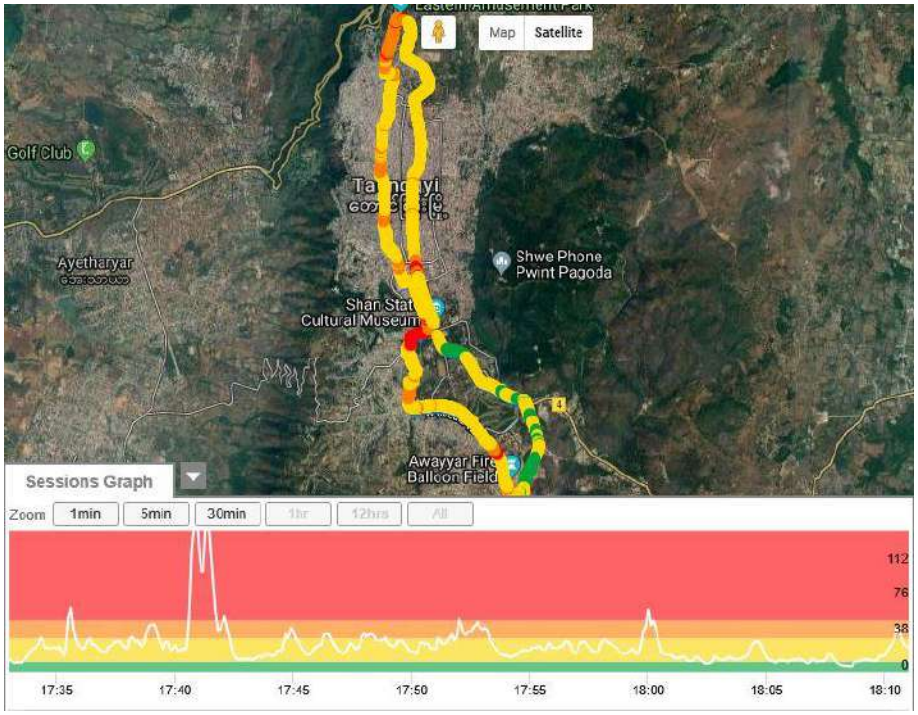
As Loikaw city PM 2.5 primarily come from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil.

Health awareness

Based on the values index, $PM_{2.5}$ Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. Precautionary Actions should take, especially people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

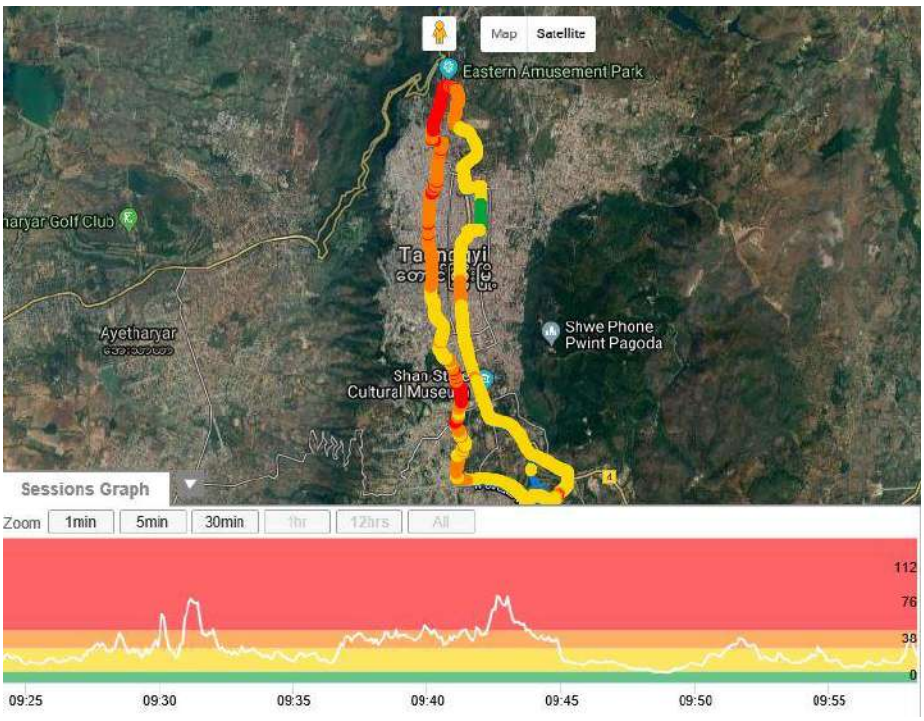
Taunggyi

Taunggyi is the capital of Shan State, and the fifth largest city of Myanmar, and has an estimated population of 380,665 as of 2014. It is a very clean city in Myanmar and won an award of ASEAN's Environmentally Sustainable Cities (E.S.C) in October 2008. However, due to the rapidly urbanized that there are many factors that cause air pollution in Taunggyi. Based on the Real-time PM 2.5 data analysis had been conducted on 1-2 May, the Real-time PM 2.5 Air Quality is also intended to be moderate. Based on the real-time data analysis which shown in the following descriptive figures, in the morning section, the Real-time PM 2.5 ($\mu g/m^3$) could be commonly found as the level of 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups). But, in the evening, the level of PM 2.5 ($\mu g/m^3$) sharply downed to 0 to 12.0 ($\mu g/m^3$) with AQI standard of 0 to 50 (Good) and 12.1 to 35.4 ($\mu g/m^3$) with AQI standard of 50 to 100 (Moderate) in the northern part of the city. And only a few 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups) could be found in the southern part.



Sources: Based on Air Casting platform Real-time situation

Figure (11) Morning section, the PM 2.5 data collection in selected route, Taunggyi City



Sources: Based on Air Casting platform Real-time situation

Figure (12) Evening section, the PM 2.5 data collection in selected route, Taunggyi City

Plate.12 Project co-director Dr. Min Oo giving the training

Plate.13 Project co-director Dr. Min Oo giving the training to the young university students at Taunggyi University

Taunggyi PM 2.5 sources situation

Primarily come from car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, locomotive) exhausts, other operations that involve the burning of fuels such as wood, heating oil or coal and natural sources such as forest and grass fires and also form from the reaction of gases or droplets in the atmosphere from sources such as power plants. These chemical reactions can occur miles from the original source of the emissions. But in Taunggyi City, most of the sources might be from motor cycle car, truck, bus and off-road vehicle (e.g., construction equipment, slow mobile, and locomotive) exhausts, other operations that involve the burning of fuels such as wood.

Health awareness

Based on the values index, $PM_{2.5}$ Health Effects may increase aggravation of heart or lung disease and premature mortality in persons with cardiopulmonary disease and the elderly; increased respiratory effects in general population. Precautionary Actions should take, especially people with respiratory or heart disease, the elderly and children should avoid prolonged exertion; everyone else should limit prolonged exertion.

Key lessons learned from the workshops

1) This was the first time air quality had been measured by citizens in Myanmar. And the air quality measurement is still weak in Myanmar, the participants knowledge on air pollution was greatly enhanced, particularly in regions where air quality had never been monitored.

2) Moreover, all the participants from respective institutions affordably got not only the knowledge but also how to use it from the workshop. Furthermore, they got the experiences to get the air quality data available from the AirCasting website, can share and do the comparisons with the other regions or countries, and think environmental awareness.

3) As the Airbeam device is easy to use, easy for the people to teach others and how to use it. Especially the workshop hosted from Maubin University, even high school students learn the device enthusiatically within one demonstration, and were able to teach his other participants how to use the device.

4) In addition, it is very useful device for the University's researcher to conduct their research more deeply dealing with the environmental issues. Especially, as it can collect the data with the

spatial information and the exportable PM 2.5 values, all the Universities; researchers tentatively hope that they can approach the problems effectively in their respective specialization.

5) All in all, a number of partners have concrete plans to use the devices to enhance their research, teaching, and advocacy.

Challenges, gaps and follow-up actions

1) The numbers of devices available for partners are less than the demand.
2) Most of the participants from respective institutions are willing to get at least one device for one institution to be more effectiveness on environmental awareness.
3) Moreover, most of the participants from respective institutions are willing to held more workshops for them and willing to being introduced new devices if there is also another device dealing with the environmental awareness which as affordably as AirBeam device.
4) Some partners have clear plans of how they will use the device. But most of them are more willing to learn more deeply about the methodologies for how to approach this PM 2.5 and how to reduce it effectively. Therefore, we need to follow with these partners and help them develop their plans.

Discussion and recommendation

1. The trainees are very keen to learn and like to share their experience to other citizens.
2. Some concerned Government officials like to possess their own to do research and share the findings.
3. The participants' young or old, academics or non-academics enthusiastically participated the training.
4. Myanmar needs this kind of training workshop in other secondary cities, also.

Conclusion

Understanding the air pollution problem of a country requires an examination of its geography and climate, the drivers (urbanization, industry and economy, energy, and transport), sources, status, and impacts of air pollution. This Chapter provides an overview of the air pollution challenge in Myanmar (Ohnmar May Tin Hlaing et al., 2014).

According to World Health Organization, Myanmar's air is not only harmful to breathe, it's also among the worst in the world. Myanmar's urban and rural areas combined had a median of 51, and an estimated range of 32 to 80. These national numbers are very similar to China and India – which are often cited for their dangerous levels of air pollution. Based on WHO, upwards of 22,000 deaths per year in Myanmar can be attributed to ambient air pollution. It had the third-highest per capita rate in the WHO Southeast Asia region, with India as number one (Nick Baker , 30 Sep 2016, Myanmar times). Regarding to air pollution, Particulate Matter PM 2.5 is one of the serious issues that cause health problems. Based on the data analysis from Air Casting platform Real-time situation, PM 2.5 Air Quality measurement conducted, in six selected cities, in sampling areas, could be commonly found in the range of 55.5 to 150.4 ($\mu g/m^3$) with AQI standard of Unhealthy 151 to 200 (Unhealthy), and some areas in of the cities, the level of PM 2.5 ($\mu g/m^3$) slightly decreased to 35.5 to 55.4 ($\mu g/m^3$) with AQI standard of 101 to 150 (Unhealthy for Sensitive Groups). It meant that Myanmar's air is in the situation not only harmful to breathe, it's also urgently needed to conduct the research deeply. Even the Road Transport Administration Department has made surprise check inspection with Exhaust Emission Tester for emission control and reducing the emission in line with three phase as 1 st phase - give warning and force to maintain the exhaust system of vehicle, 2nd phase - withdraw the issued vehicle registration certificate and vehicle inspection certificate and 3rd phase - taking punishment (Nyan Htun Aung, Minister for Transport), the action such as the knowledge sharing, participation in activities are still needed to conduct.

In urban air pollution, as the urbanization is the key factors, there are many examples of successful policies in transport, urban planning, power generation and industry that reduce air pollution:

- ***for industry:*** *clean technologies that reduce industrial smokestack emissions; improved management of urban and agricultural waste, including capture of methane gas emitted from waste sites as an alternative to incineration (for use as biogas);*
- ***for energy:*** *ensuring access to affordable clean household energy solutions for cooking, heating and lighting;*
- ***for transport:*** *shifting to clean modes of power generation; prioritizing rapid urban transit, walking and cycling networks in cities as well as rail interurban freight and*

passenger travel; shifting to cleaner heavy duty diesel vehicles and low-emissions vehicles and fuels, including fuels with reduced sulfur content;

- ***for urban planning:*** *improving the energy efficiency of buildings and making cities more green and compact, and thus energy efficient;*
- ***for power generation:*** *increased use of low-emissions fuels and renewable combustion-free power sources (like solar, wind or hydropower); co-generation of heat and power; and distributed energy generation (e.g. mini-grids and rooftop solar power generation);*
- ***for municipal and agricultural waste management:*** *strategies for waste reduction, waste separation, recycling and reuse or waste reprocessing; as well as improved methods of biological waste management such as anaerobic waste digestion to produce biogas, are feasible, low cost alternatives to the open incineration of solid waste. Where incineration is unavoidable, then combustion technologies with strict emission controls are critical*. (WHO, 2 May 2018)

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