

A COMPREHENSIVE GUIDEBOOK: HOW TO MONITOR AIR QUALITY

COLLECT DATA

VISUALIZE

INTERPRET

UNDERSTAND



WPI

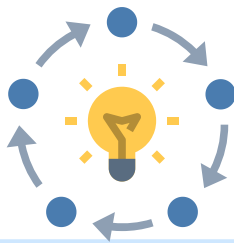


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Anyone can conduct air monitoring.
Let us show you how step by step.



The Atmotube Pro



Monitoring Methods



**Data Management
and Analysis**



Examples

The Atmotube Pro Sensor

The Atmotube Pro is an air pollution microsensor. It is equipped to measure particulate matter (PM1, PM2.5, PM10) and volatile organic compounds (VOCs). Below is the effective range and the measurement uncertainty. The Atmotube has two flow holes just below the button. The sensor measures the air quality in a small chamber between the holes.



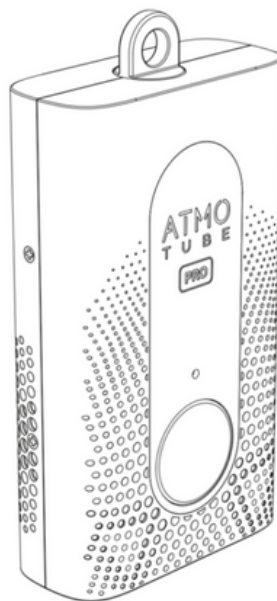
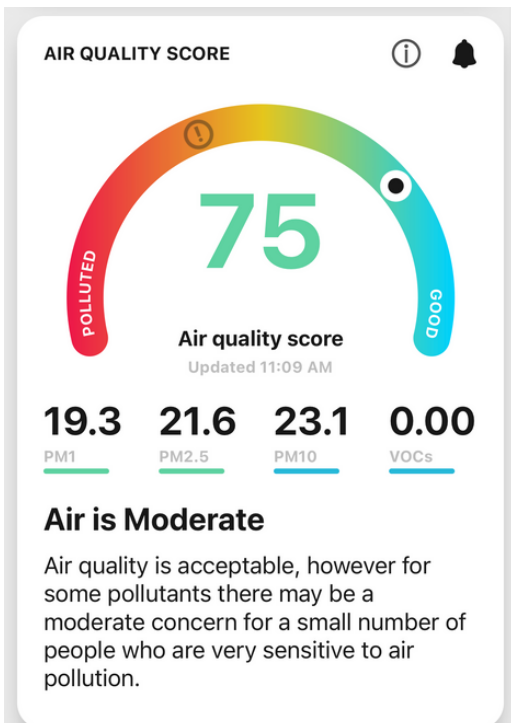
Atmotube	PLUS	PRO
TVOC output range	0 - 60 ppm	
TVOC typical accuracy	15% of measured value	
PM output range	-	0 - 1000 $\mu\text{g}/\text{m}^3$
PM typical accuracy	-	PM1, PM2.5 0 to 100 $\mu\text{g}/\text{m}^3$, [$\pm 5 \mu\text{g}/\text{m}^3 + 5\%$ m.v.] 100 to 1000 $\mu\text{g}/\text{m}^3$, $\pm 10\%$ m.v.
		PM10 0 to 100 $\mu\text{g}/\text{m}^3$, $\pm 25 \mu\text{g}/\text{m}^3$ 100 to 1000 $\mu\text{g}/\text{m}^3$, $\pm 25\%$ m.v.
Temperature	$\pm 0.5^\circ\text{C}$ ($\pm 0.9^\circ\text{F}$)	
Humidity	$\pm 3\%$ RH	
Pressure	± 1 hPa	

Using the Atmotube Sensor

The button in the center of the Atmotube turns the sensor on and off. To turn it on hold the button for 4 seconds. An orange light will come on to confirm it is powered on. To turn it off hold the button for 4 seconds again, the light will flash to indicate it is powering off.

Once on, the Atmotube can connect to a phone using Bluetooth. To connect, ensure your phone has Bluetooth enabled and open the Atmotube app. It will begin searching for devices and will display a list of Atmotubes. Unless there are multiple Atmotubes nearby there will typically only be the Atmotube you are using. If it is unable to connect, try restarting the Atmotube and closing out of the app.

Once connected the app will show the home screen where you can see the PM, VOC, and AQS levels.



- GOOD
- MODERATE
- POLLUTED
- VERY POLLUTED
- SEVERELY POLLUTED

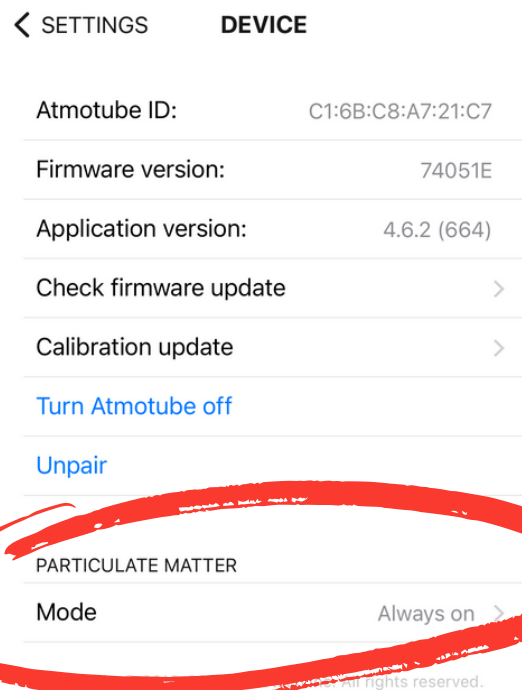
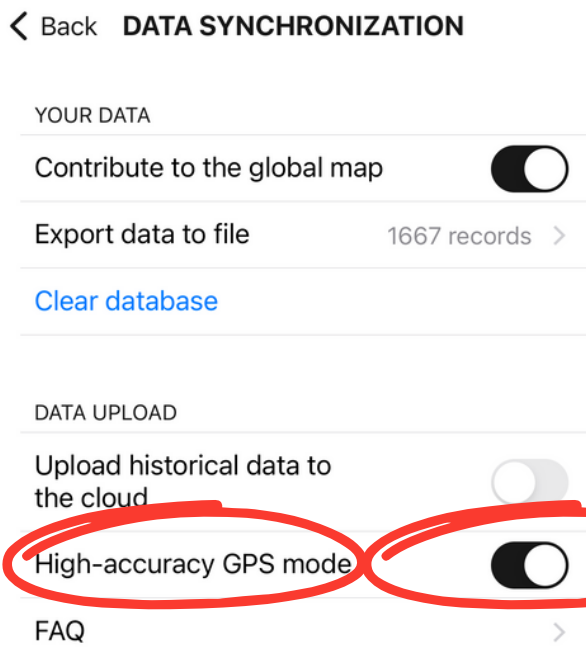
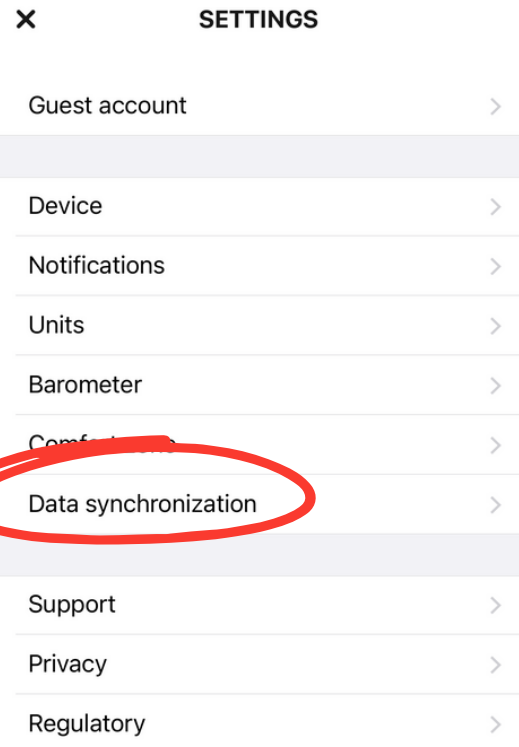
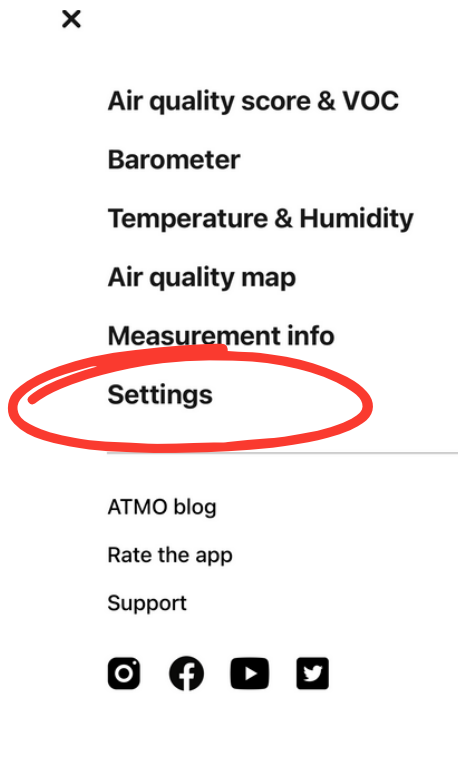


Using the Atmotube Sensor

Before monitoring there are two important settings to change from the default. By tapping the 3 horizontal lines in the home screen you can reach the menu and navigate to the settings list. Under the device set the particulate matter to always on. and under data synchronization enable high-accuracy GPS mode.



Using the Atmotube Sensor



With these settings enabled, monitoring can begin.

Monitoring Methods

There are two ways of monitoring. Stationary and mobile. Stationary monitoring involves sitting with the sensor for a prolonged period to get a precise reading of the air pollution at that spot. This is most effective when monitoring specific spots like a bus stop, or a school. Mobile monitoring involves attaching the sensor and typically walking around an area or along a route to get the air quality in a given zone, like a park or a street. Deciding which method to use is an important step in gathering effective data. In general, using stationary monitoring to measure the air at a specific spot or in a small area works well, while using mobile monitoring to measure the air in a large area or along a route works well.

Stationary monitoring

When using stationary monitoring pick a location to monitor and wait. Generally, a minimum of 30 minutes is recommended at a location, with more time allowing a more precise measurement. However, it is important to be aware of the changes in pollution over time.

For example, when monitoring the air pollution at a school during student drop-off, students may only be arriving during a 15-minute window, in this case, monitoring for longer would not be an option unless choosing to graph the data over time, as will be shown in the analysis section.

Monitoring Methods

Mobile Monitoring

Mobile monitoring

To start, secure the Atmotube in a place where it will not be blocked. Attached to a backpack or a belt loop tend to work well.

It is important to have a plan and a specific area to monitor. It is recommended to look at the area of interest on a map and decide on a route before beginning.

If the mobile data is being used to find an average air pollution level in an area like a park it is important to plan a route that avoids outlying areas. For example, if you are trying to monitor a large park that has a small but polluted café near a corner the data taken from that small area would affect the average and make it not representative of the rest of the park.

Mobile monitoring can also be used to highlight the differences in air quality between areas. For example, monitoring along a road from the city center out into residential areas. This data could be shown on a map to illustrate the change in air quality. The mapping process will be shown in the analysis section.

Monitoring Methods

Note Taking

Note Taking

While monitoring it is always important to take notes. It is a good habit to note anything that may significantly influence the data. This includes general things like the weather, time of day, and when it last rained, as well as specific things like the time when you crossed a street, or when you passed by a construction site that may have higher pollution levels. It is also strongly recommended to take many photos and include them in the notes.

Monitoring Methods

Note Taking

Example of Field Notes

11/7/23 - Main Boulevard Monitoring

- We monitored the main boulevard and parts of the block today. It did not rain last night and was sunny today with no sign of rain for the past few days.
- We began monitoring at 9:25 and went down the boulevard towards the block.
- We then took a left entering the block area at 9:43, at this time streets began to get narrower and the average AQS was lower than it was in the very open boulevard with lots of air and trees.
- Then at 9:50 we entered the roundabout area of the block and continued north of the roundabout and left the area at 9:52
- Then there was a construction site we ran into at 9:54 at the AMA restaurant location, this construction was all inside an already made building because of this the AQS was not affected very much with their only being a very sharp decrease for less than 1 minute. This dropped the AQS from 85 to 62 for a very short period. We then exited the construction at 9:55 and continued walking the block.
- We then turned around on the block and walked back in the same direction we came.
- We then passed a gas station at 10:02 where for 1 minute the pollution dropped to 0. It resumed back to normal numbers at 10:03
- Then at 10:08 we returned off the block, back on the boulevard, to walk back to the square where we started.
- We finally got back to our starting place at 10:18 and ended monitoring then.

Overall, the main boulevard is filled with trees, and the bike lane acts as a buffer between the sidewalks and roads. Because of this, air pollution data wavered with an AQS of 85-90, which is relatively good. As we made our way into the block, the AQS dropped down to around 80 until the end of the roundabout, and once we made our way to the inner roads, the AQS dropped significantly, to about 50-70. One data altering factor was we walked past a gas station which tanked our data to 0. There was nothing else besides this and the daily data altering factors (like smoking etc.)

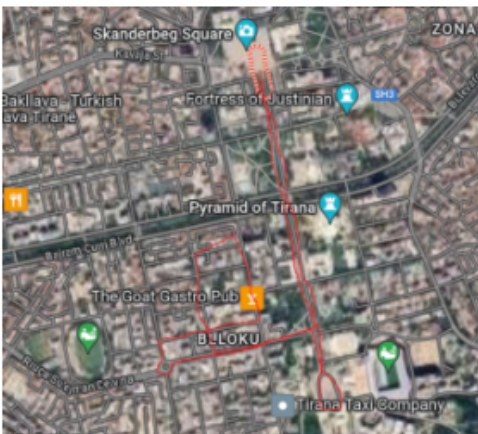
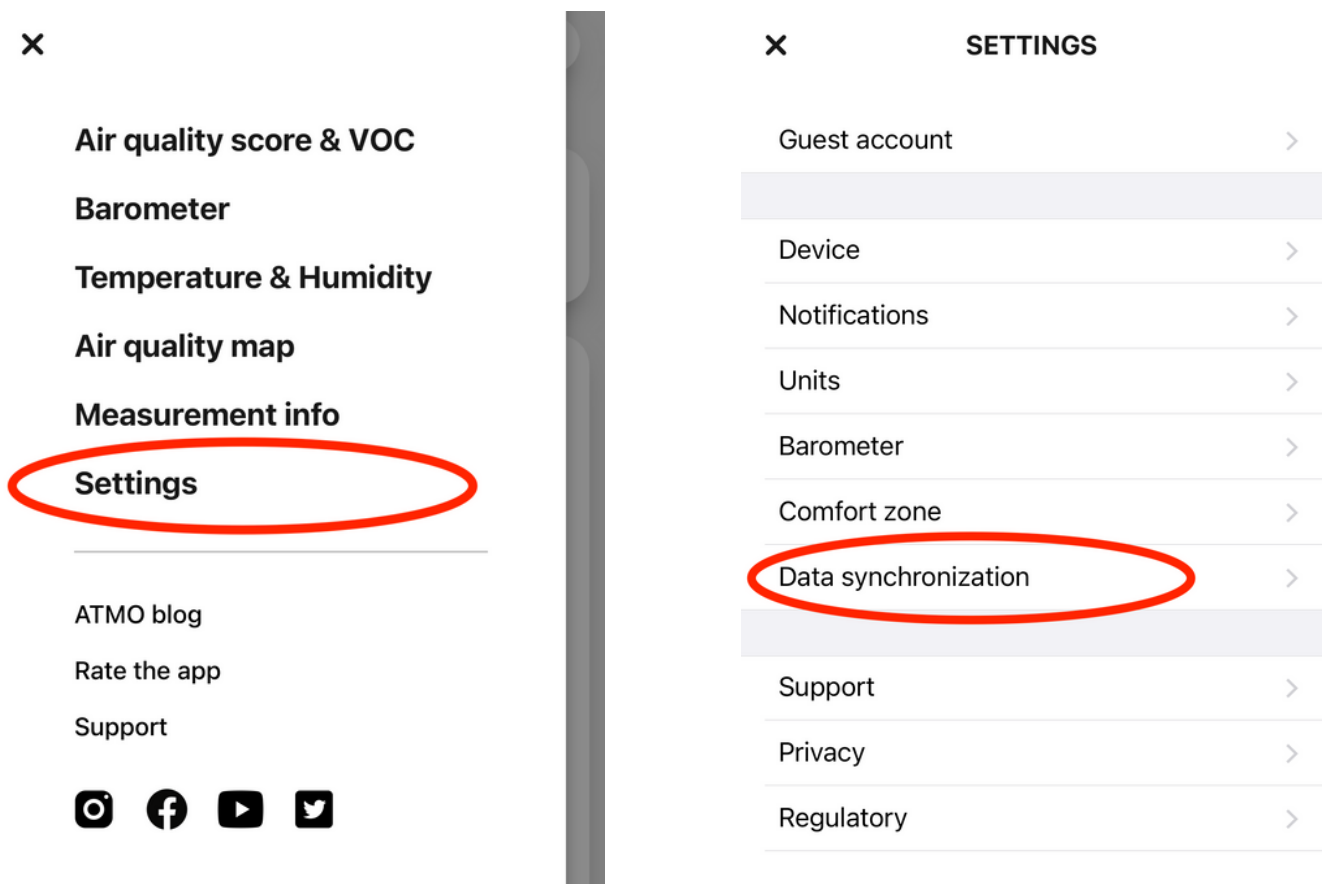


Image of the path walked

Data Management and Analysis

Exporting and Opening

Once data has been taken it needs to be exported and analyzed. To export data from the Atmotube app go to settings, data synchronization, and choose “Export data to file”. Then choose to share and send the data to your computer in whatever way is most convenient for you, such as sending the file in an email to yourself. Then download the file onto your computer.



Data Management and Analysis

< Back DATA SYNCHRONIZATION

YOUR DATA

Contribute to the global map

Export data to file 1338 records >

[Clear database](#)

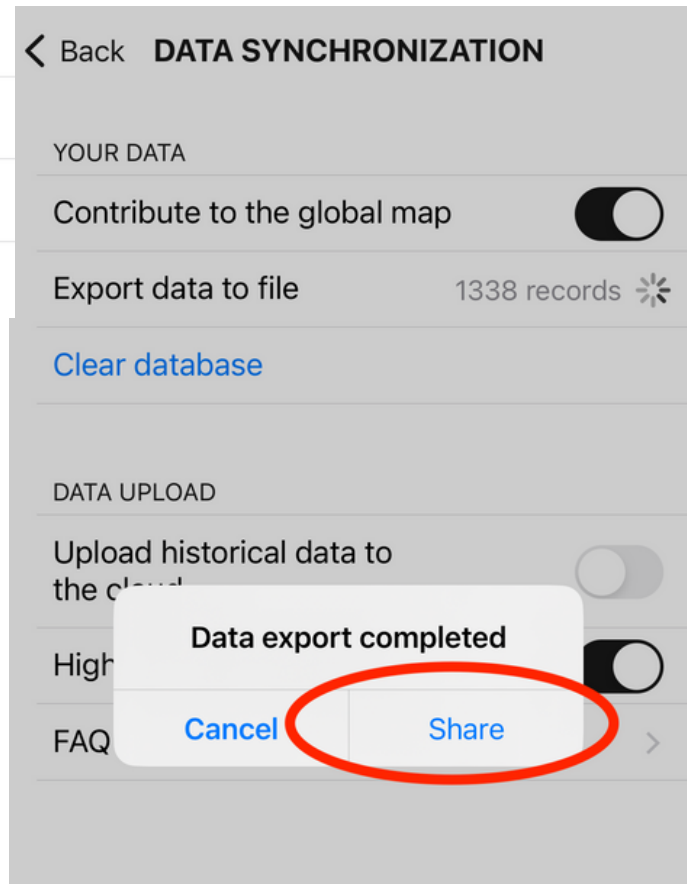
DATA UPLOAD

Upload historical data to the cloud

High-accuracy GPS mode

FAQ >

The data file can be opened in the free web browser program Google Sheets. You will need a free Gmail account to use this program. The option to create an account will be available when opening the site.



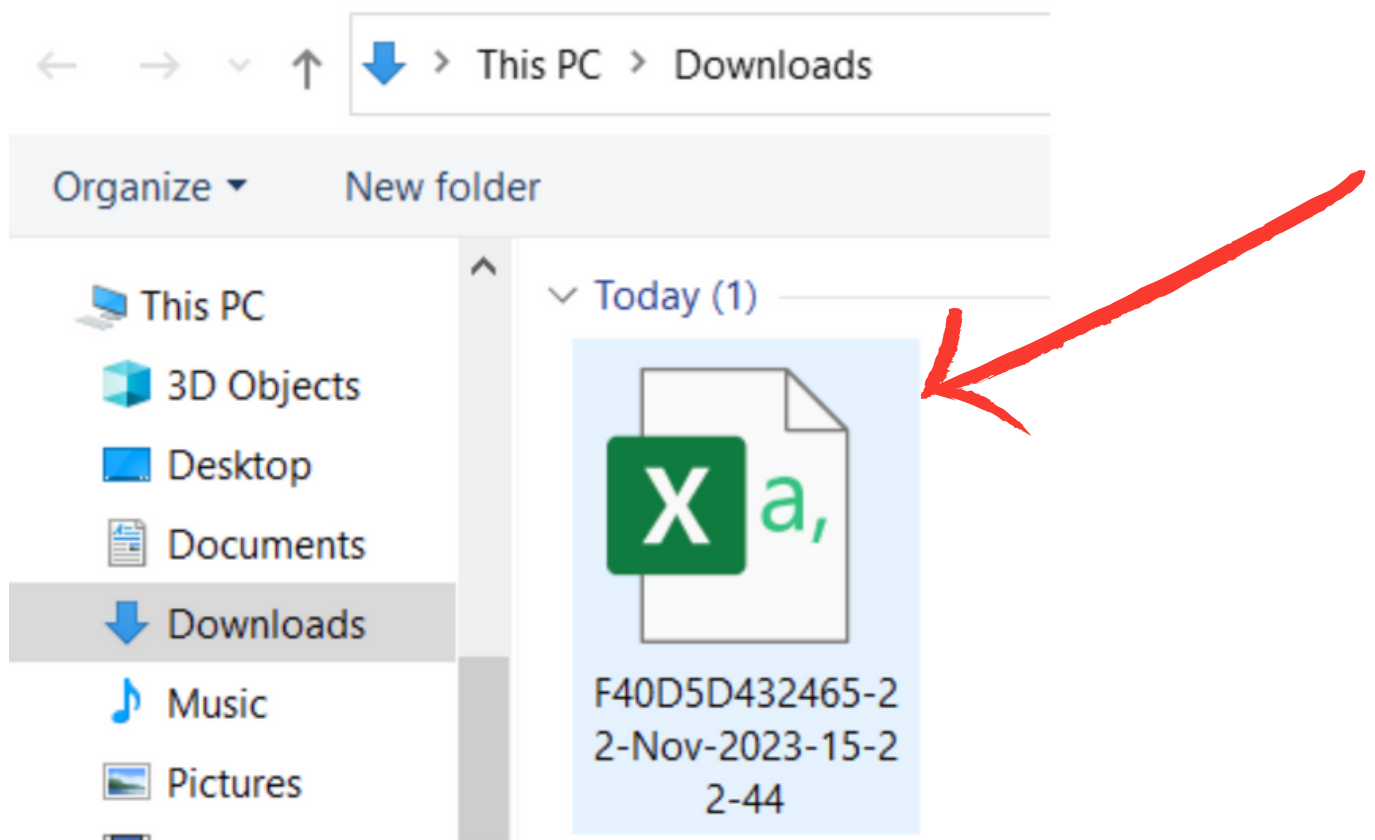
Data Management and Analysis

Once Google Sheets is open hover the cursor over the file and drag it down to import.

The image shows a screenshot of the Google Sheets interface. The title bar reads "Untitled spreadsheet" with a star icon. The menu bar includes "File", "Edit", "View", "Insert", "Format", "Data", "Tools", "Extensions", and "Help". The "File" menu is open, displaying options: "New", "Open", "Import", "Make a copy", "Share", "Email", "Download", "Rename", "Move to trash", "Version history", "Make available offline", "Details", "Settings", and "Print". A red arrow points from the "Import" option in the menu to the "Import file" dialog box below. The dialog box features the Google Drive logo and the text "Import file". At the bottom of the dialog, there are four tabs: "My Drive", "Shared with me", "Recent", and "Upload", with "Upload" being the active tab.

Data Management and Analysis

From here you can browse your PC files to find the data where you downloaded it to your PC. It will usually be in a downloads folder.



Once the data is open in sheets it will appear like this. If the date column appears as “XXXXXXX”, simply double-click the first box and press enter and it should display correctly.

Data Management and Analysis

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	VOC, ppm	AQS	Temperature, °C	Humidity, %	Pressure, mbar	PM1, ug/m³	PM2.5, ug/m³	PM10, ug/m³	Latitude	Longitude	
2	11/21/2023 10:5	0.203	87	20	47	999.7	7.9	9.7	10.8	41.32991298	19.81013783	
3	11/21/2023 10:5	0.206	86	20	46	999.7	10	11.7	13	41.32913208	19.80991406	
4	11/21/2023 10:5	0.215	87	21	47	999.9	8.6	10.5	11.3	41.32913208	19.80991406	
5	11/21/2023 10:5	0.251	70	22	43	999.9	24.2	26.9	28	41.32788086	19.81041798	
6	11/21/2023 10:5	0.247	85	22	42	999.9	7.2	8.8	10.1	41.32788086	19.81041798	
7	11/21/2023 10:5	0.274	83	23	40	999.9	6.9	8.5	9.4	41.32791138	19.81078942	
8	11/21/2023 10:5	0.327	80	24	40	999.8	13.6	15.7	16.9	41.32827759	19.81117593	
9	11/21/2023 10:4	0.357	78	24	40	999.8	11.8	13.8	14.5	41.32809448	19.81125451	
10	11/21/2023 10:4	0.599	68	25	43	999.8	19.9	22.1	23.5	41.32809448	19.81122119	
11	11/21/2023 10:4	0.618	67	25	43	999.9	18.7	21	22.2	41.32809448	19.81122119	
12	11/21/2023 10:4	0.578	68	25	43	999.9	18.7	20.9	22	41.328125	19.8112952	
13	11/21/2023 10:4	0.592	68	25	42	999.9	20.5	23	24	41.328125	19.8112952	
14	11/21/2023 10:4	0.602	68	25	42	999.8	20.4	22.6	23.5	41.328125	19.8112952	
15	11/21/2023 10:4	0.623	67	25	42	999.9	21.4	24.1	25.1	41.32806396	19.81119049	
16	11/21/2023 10:4	0.59	68	25	42	999.8	19.5	22	23	41.32806396	19.81119049	
17	11/21/2023 10:4	0.638	67	25	43	999.9	19.4	21.9	22.8	41.32806396	19.8111405	
18	11/21/2023 10:4	0.654	67	25	43	999.9	19.6	22.1	23.2	41.32806396	19.8111405	
19	11/21/2023 10:3	0.641	67	25	43	1000	19.9	22.2	23.1	41.32806396	19.8111405	
20	11/21/2023 10:3	0.617	67	25	43	999.9	21.2	23.9	24.7	41.32806396	19.8111405	
21	11/21/2023 10:3	0.662	67	25	43	1000	20.8	23.4	24.3	41.32806396	19.81121797	
22	11/21/2023 10:3	0.675	66	25	43	1000	20.5	22.9	24	41.32806396	19.81121797	
23	11/21/2023 10:3	0.625	67	25	43	1000	21.4	23.7	24.7	41.32806396	19.81121797	
24	11/21/2023 10:3	0.634	67	25	43	1000	21.1	23.5	24.8	41.32806396	19.81121797	
25	11/21/2023 10:3	0.615	68	25	43	1000.1	20	22.6	23.6	41.32806396	19.81121797	
26	11/21/2023 10:3	0.688	66	25	44	1000	20.1	22.5	23.6	41.32809448	19.81124459	

In the datasheet, you can delete data before and after the desired monitoring period. Select multiple rows by selecting a box and shift clicking another box then right-click and choose to delete rows. The same process can be used to remove other necessary data points based on the field notes from that session.

Data Management and Analysis

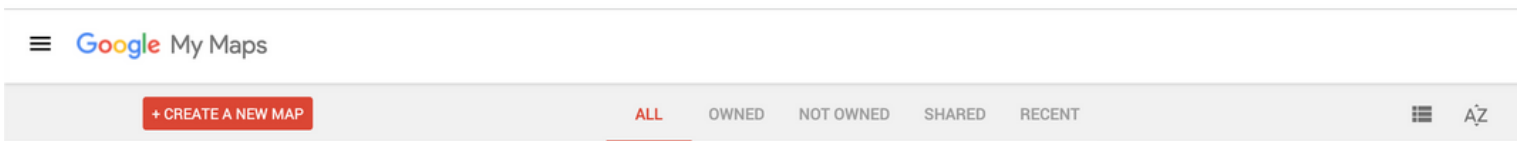
The screenshot shows a Google Sheets spreadsheet with a context menu open over rows 2-11. The menu options include Cut (Ctrl+X), Copy (Ctrl+C), Paste (Ctrl+V), Paste special, Insert 10 rows above, Insert 11 columns left, Insert cells, Delete rows 2 - 11 (circled in red), Delete columns A - K, Delete cells, Create a filter, and Insert link. The spreadsheet data is as follows:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Date	VOC, pprr	AQS	Temper	Humidi	Press					gitude	
2	11/21/2023 10:	0.203	87	20	47	9					9.81013783	
3	11/21/2023 10:	0.206	86	20	46	9					9.80991406	
4	11/21/2023 10:	0.215	87	21	47	9					9.80991406	
5	11/21/2023 10:	0.251	70	22	43	9					9.81041798	
6	11/21/2023 10:	0.247	85	22	42	9					9.81041798	
7	11/21/2023 10:	0.274	83	23	40	9					9.81078942	
8	11/21/2023 10:	0.327	80	24	40	9					9.81117593	
9	11/21/2023 10:	0.357	78	24	40	9					9.81125451	
10	11/21/2023 10:	0.599	68	25	43	9					9.81122119	
11	11/21/2023 10:	0.618	67	25	43	9					9.81122119	
12	11/21/2023 10:	0.578	68	25	43	9					19.8112952	
13	11/21/2023 10:	0.592	68	25	42	9					19.8112952	
14	11/21/2023 10:	0.602	68	25	42	9					19.8112952	
15	11/21/2023 10:	0.623	67	25	42	9					9.81119049	
16	11/21/2023 10:	0.59	68	25	42	9					9.81119049	
17	11/21/2023 10:	0.638	67	25	43	9					19.8111405	
18	11/21/2023 10:	0.654	67	25	43	9					19.8111405	

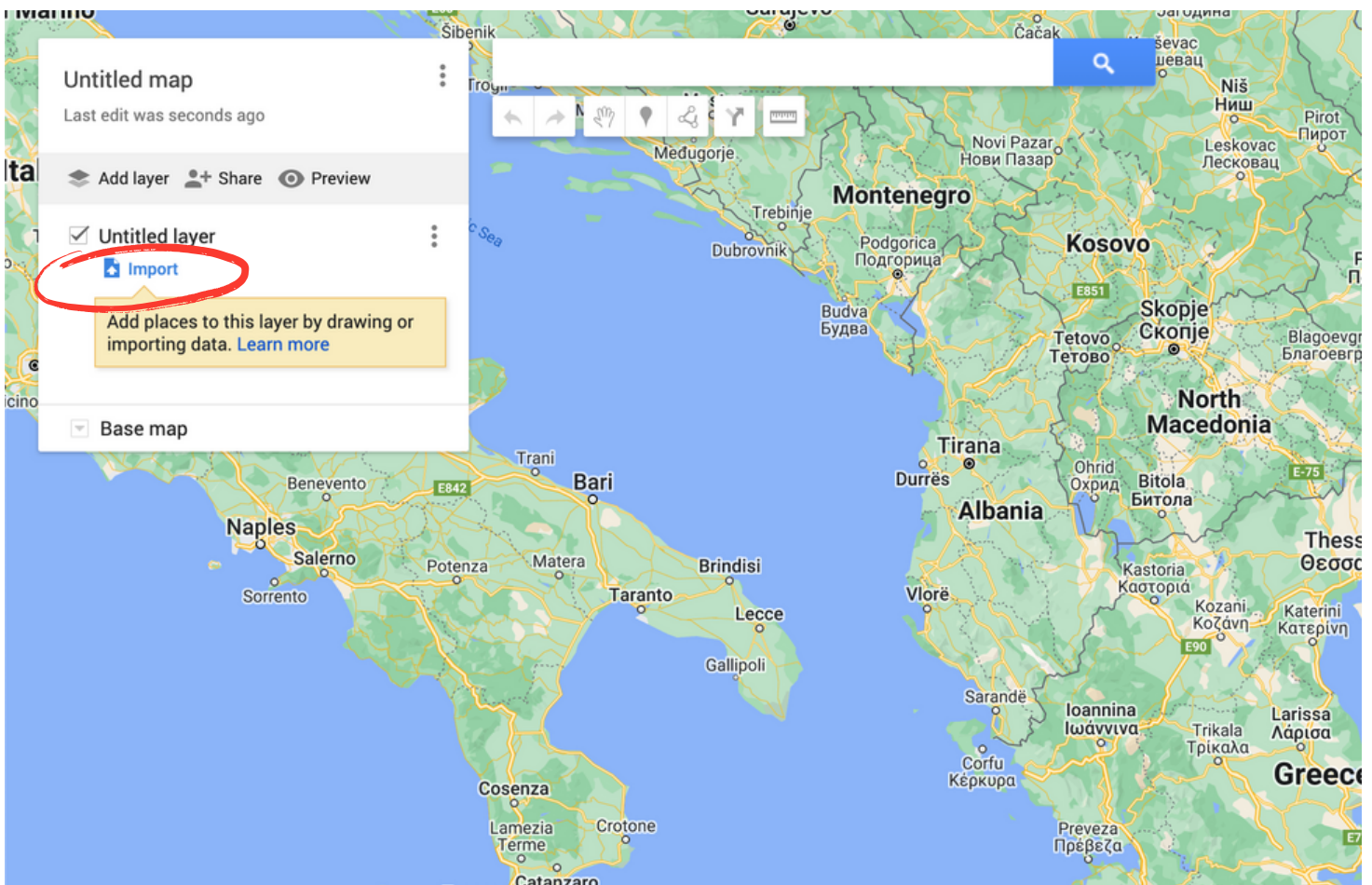
Once the extraneous data has been removed, it is recommended to save a copy of the data by using the file button at the top left of the window. By saving a copy it avoids overwriting the original data file so that it can still be retrieved if necessary. When saving the copy, it is recommended to include the data and the location in the file name to avoid confusion. A possible name could be “10.10.2023 New Boulevard”. It is also recommended to move both the original file and the edited file to a designated folder for easier access.

Creating a Map

To map the data using Google MyMaps search “Google MyMaps” or visit “google.com/maps/d/u/0/”. Similar to Google Sheets you will need a free Gmail account to sign in. From the map site select “Create New Map” highlighted in red.



This option will take you to a new map page.



Creating a Map

Once in the map, select the import option and upload the edited data file. This will prompt you to select the latitude and longitude from the list of column titles.

These options may be selected by default, or they can be manually selected. After this, MyMaps prompts the user to select what the points will indicate. This will generally be PM2.5 or PM10. Only one can be selected at once.

Choose columns to position your placemarks

Select the columns from your file that tell us where to put placemarks on the map, such as addresses or latitude-longitude pairs. All columns will be imported.

Temperature, ĚšC ?

Humidity, % ?

Pressure, mbar ?

PM1, ug/m³ ?

PM2.5, ug/m³ ?

PM10, ug/m³ ?

Latitude (latitude) ?

Longitude (longitude) ?

Continue Back Cancel

Choose a column to title your markers

Pick a column to use as the title for the placemarks, such as the name of the location or person.

Date ?

VOC, ppm ?

AQS ?

Temperature, ĚšC ?

Humidity, % ?

Pressure, mbar ?

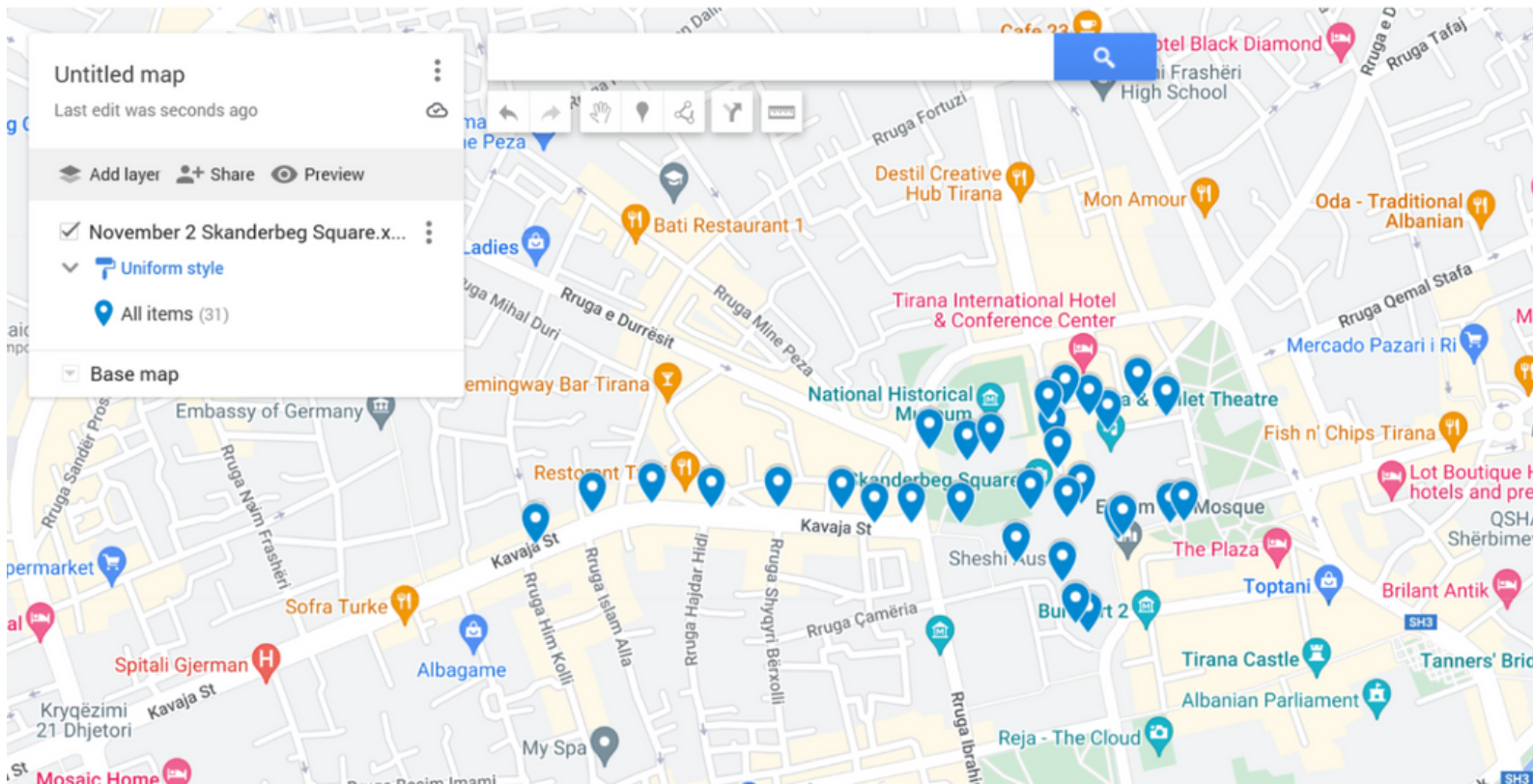
PM1, ug/m³ ?

PM2.5, ug/m³ ?

Finish Back Cancel

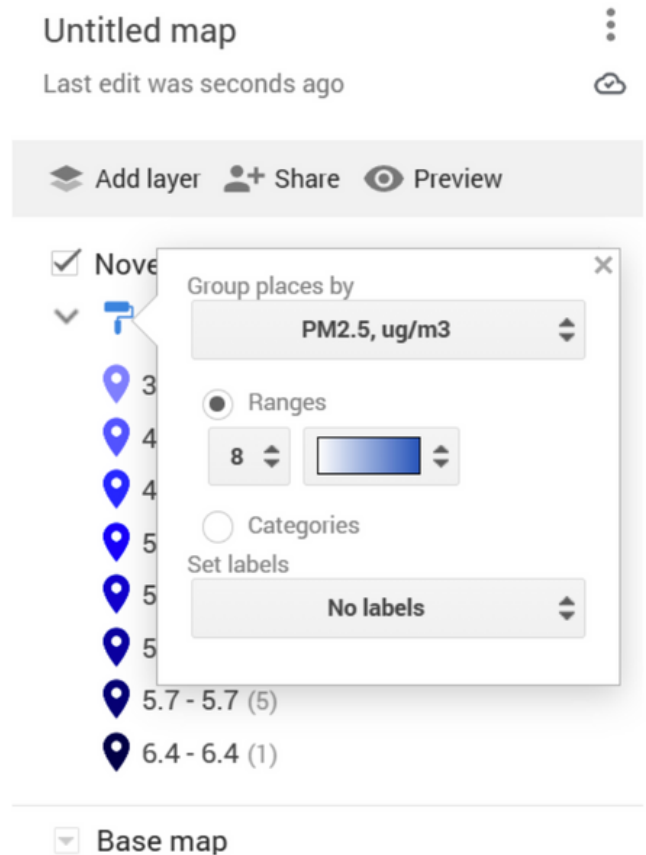
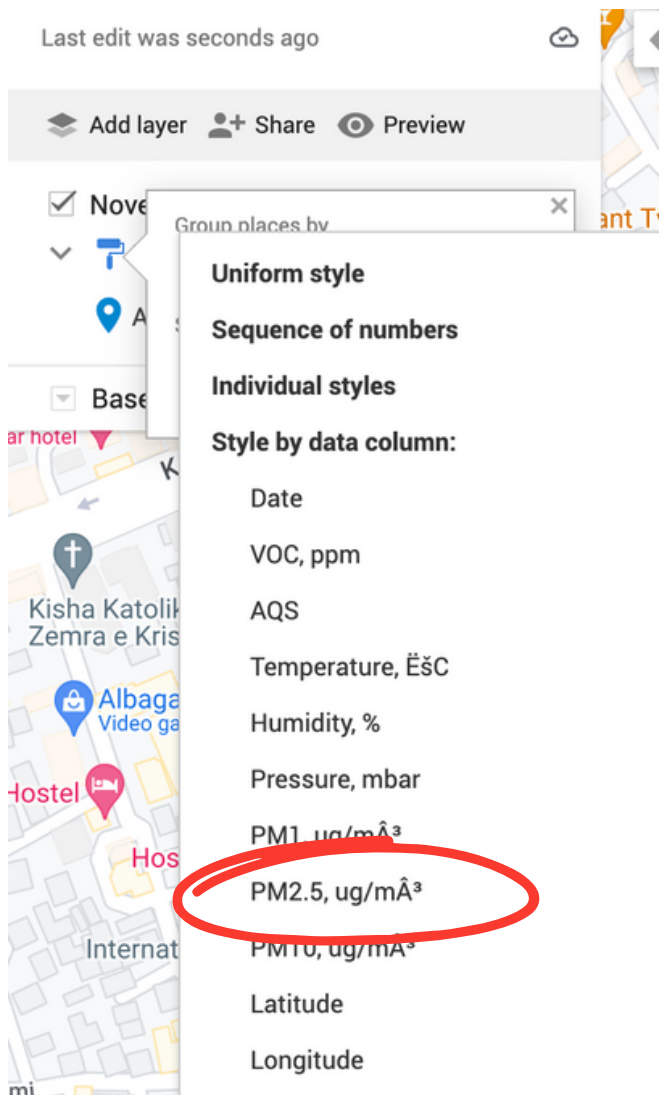
Creating a Map

After selecting “Finish” the map will be generated.



Here all of the data points are shown based on their coordinates. Each point has been named by its PM2.5 value as selected in the previous menus. To color each point according to the pollution levels, select “Uniform style” in blue on the menu to the left of the map. Then choose PM2.5

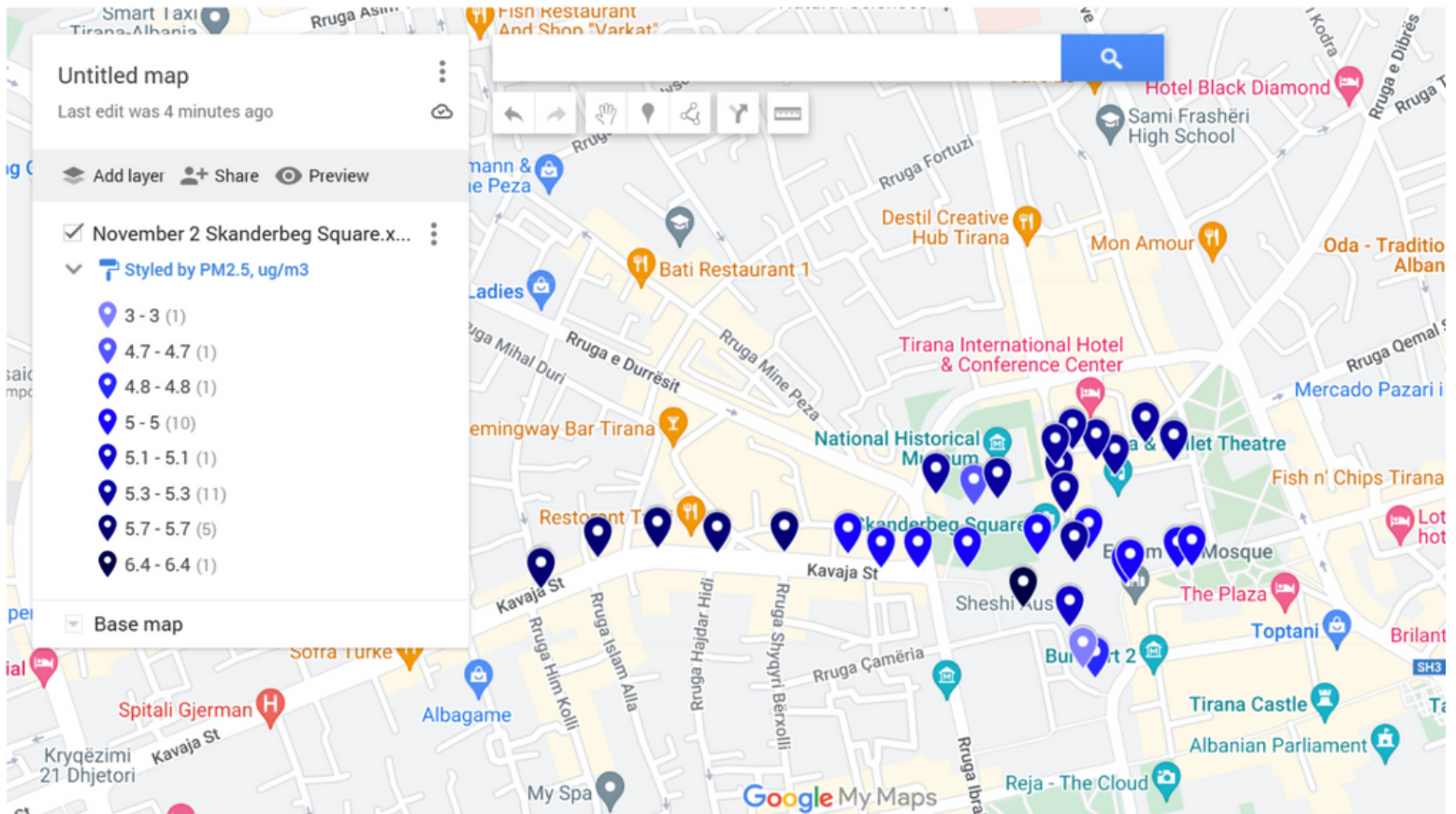
Creating a Map



The number of ranges can be increased to show more detail in variation. Alternatively, ranges can be individually selected and colored. This can be useful to show which areas exceed a limit.

Creating a Map

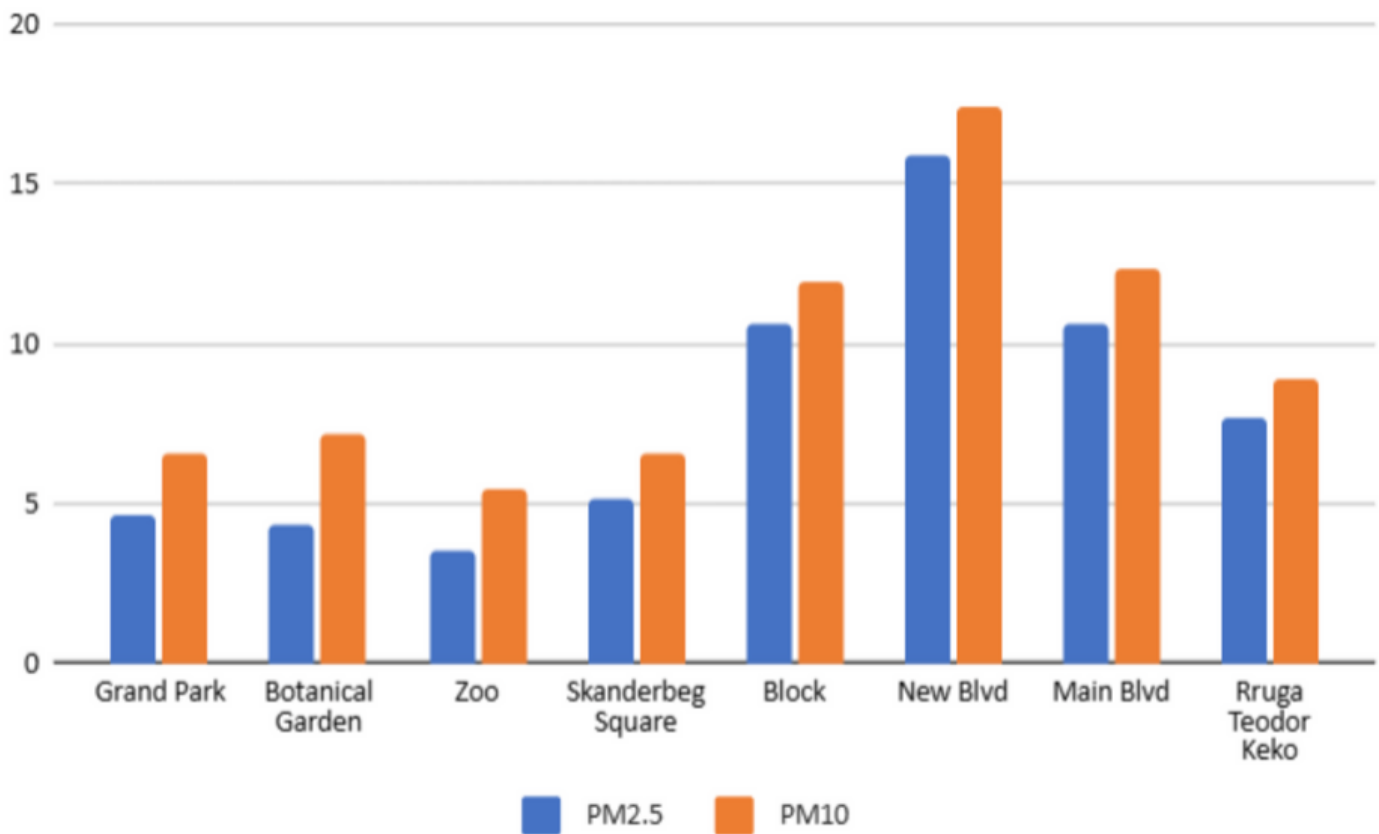
Updated Final Map



Now that the pollution levels are indicated by color it is easy to see how the levels change along a route, with darker colors indicating more polluted areas and lighter colors indicating less pollution. This is an example of walking Kavaja Street to go explore Scanderbeg Square. The dark points along Kavaja Street show that the PM2.5 levels there were the highest, which makes sense as it is a busy street with lots of traffic. Then in Skanderbeg Square the air quality is highly varied. Lastly, the light blue points at the south of the Square along the garden indicate the best air quality of anywhere along the route.

Graphing

Graphing is another powerful tool to understand and visualize data. Three kinds of graphs that each illustrate data in different ways are a bar chart, a box and whisker plot, and a pollution over time graph.



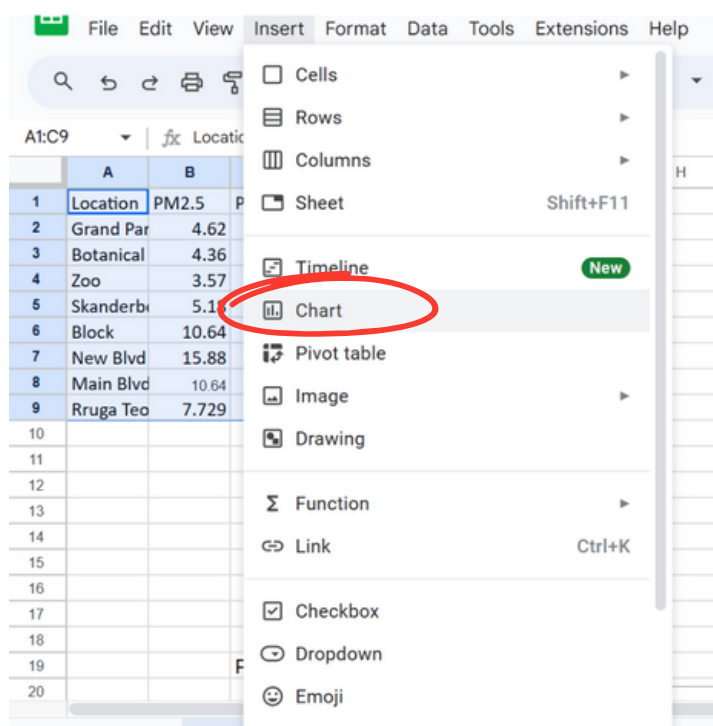
A bar chart is a useful way to visually compare pollution levels. This example above shows the average PM2.5 and PM10 levels across seven areas. Data can be averaged using the “=average()” formula as shown below. Once the pollution levels are formatted into a table as shown below, choose “insert” from the tool bar at the top of the screen and select chart.

Bar Chart

Once the bar graph has been generated it can be edited by selecting it and accessing the chart editor panel on the right. The panel should pop open when the graph is selected but it can also be opened by clicking the three vertical dots in the top right corner of the graph.

	C	D	E	F
19	PM2.5, ug/m ³		Average PM2.5	
20	9.7		<u><code>=average(C20:C31)</code></u>	
21	11.7			
22	10.5			
23	26.9			
24	8.8			
25	8.5			
26	15.7			
27	13.8			
28	22.1			
29	21			
30	20.9			
31	23			

	A	B	C
1	Location	PM2.5	PM10
2	Grand Par	4.62	6.57
3	Botanical	4.36	7.18
4	Zoo	3.57	5.44
5	Skanderbe	5.18	6.6
6	Block	10.64	11.97
7	New Blvd	15.88	17.41
8	Main Blvd	10.64	12.4
9	Rruga Teo	7.729	8.94
10			

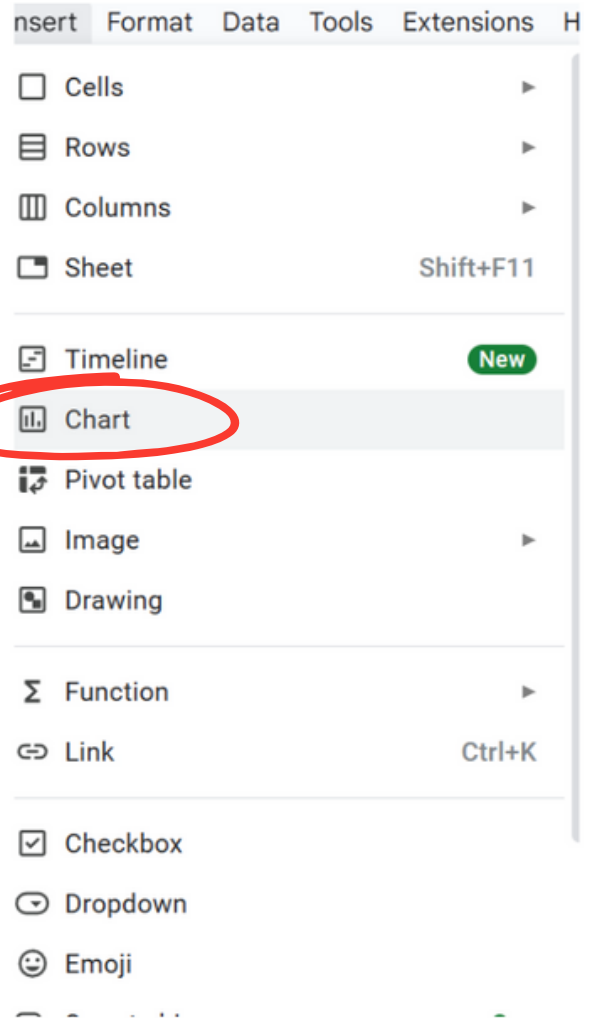


Box and Whisker Plot

A box and whisker plot is a useful way to communicate both the average pollution in an area and the highest and lowest values in an area.

In air pollution, this is useful to highlight the acute exposure risks in an area or location.

To make a box and whisker plot arrange the full data from the desired scenarios into a table as shown below. Select the whole data and insert a chart. Then in the chart editor menu select the candle stick style. Note that Google Sheets does not offer as much customizability as Microsoft Excel. If Excel is available it would recommended to make box and whisker plots there rather than in Google Sheets



I	J	K	L	M	N	O	P	Q	R	S	T	U	V
Botanical	3.7	3.9	4.0	3.8	4.0	4.2	3.8	3.4	3.5	3.3	3.6	3.1	3.1
Grand Par	6	7.3	7.1	7.6	6.7	6.7	6.7	6.7	6.1	10.7	8	8	8
Rruga Teo	7.7	5.3	5.9	5.5	6.0	7.1	6.6	8.7	9.2	8.5	14.4	12.7	8.7
The Block	4.3	9.1	11.9	11.6	11.9	11.4	14.9	10.5	10.2	7.8	7.2	13.6	11.5
The Main	5.9	4.7	5.8	7.5	6.8	10.8	11.7	6.1	5.3	10.4	10.6	10.2	4.7
The New	16	16	19.4	19.3	24	27.2	19	17.6	17.6	17.6	17.6	17.6	17.6

Box and Whisker Plot

Chart editor ×

Setup

Customize

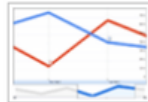
Chart type

Candlestick chart

Other

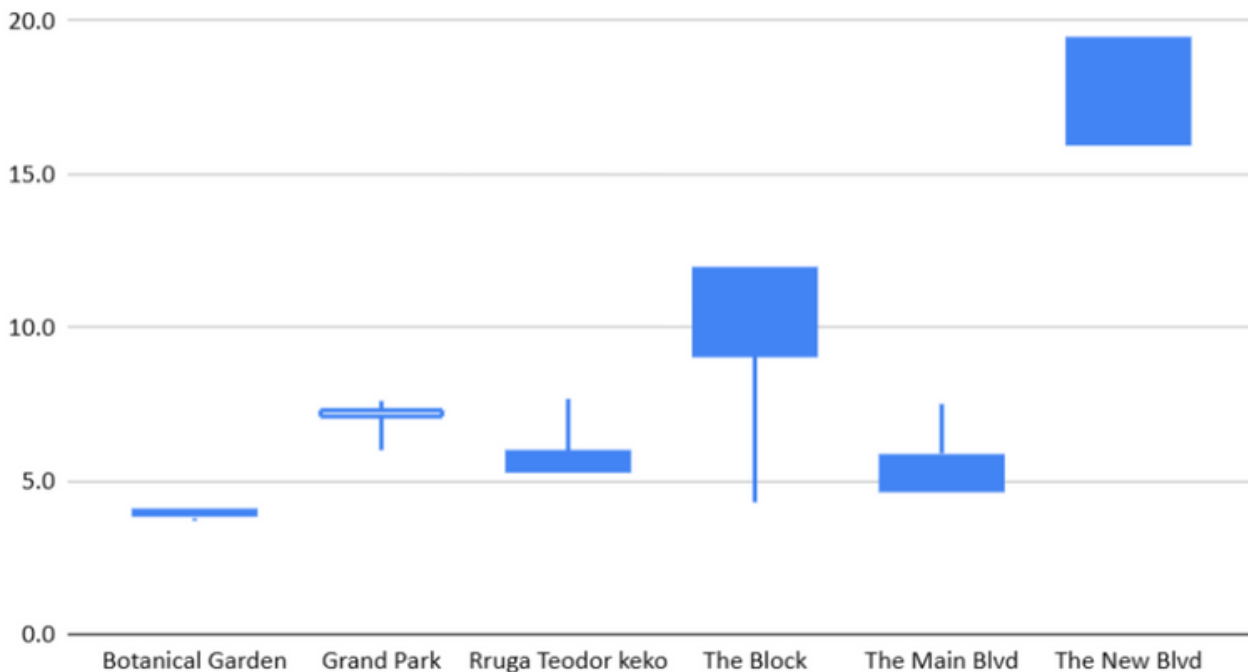


Total
\$1,024



A	B	C	D
14	25	36	47
25	36	47	58
36	47	58	69

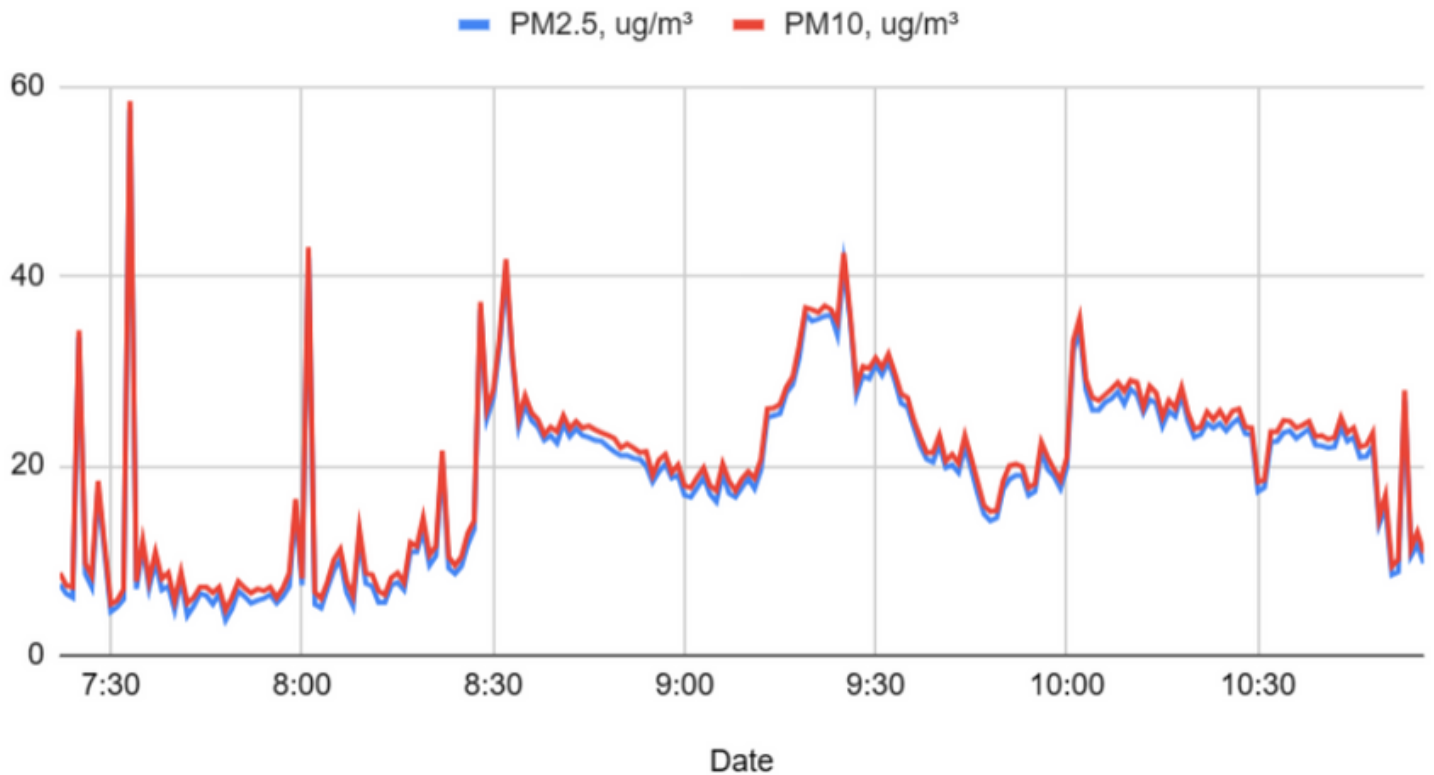
Botanical Garden, Grand Park, Rruga Teodor keko, The Block...



Pollution over time graph

A pollution over time graph is a useful way to show data from a stationary monitoring session, such as levels at a school during drop-off, or levels at a bus stop during morning traffic.

PM2.5, ug/m³ and PM10, ug/m³



Pollution over time graph

To make a pollution over time graph format the data as shown below, with one column for time and a separate column for each pollutant. It can also be helpful to only use time in the date column. This can be done by entering the time for the first two data points, selecting both, and using the blue circle to drag down, automatically filling the boxes below it.

T	U
Date	
11/21/2023 10:56	10:56
11/21/2023 10:55	10:55
11/21/2023 10:54	
11/21/2023 10:53	
11/21/2023 10:52	
11/21/2023 10:51	
11/21/2023 10:50	
11/21/2023 10:49	
11/21/2023 10:48	
11/21/2023 10:47	
11/21/2023 10:46	
11/21/2023 10:45	
11/21/2023 10:44	
11/21/2023 10:43	
11/21/2023 10:42	
11/21/2023 10:41	



After this Select the time and data and choose to insert a chart. From chart setting choose the line graph style. If it is not selected by default, set the date column to be the x-axis of the graph. Now you can see how the pollution levels Vary over time to be able to see when areas are most and least polluted.

T	U
Date	
11/21/2023 10:56	10:56
11/21/2023 10:55	10:55
11/21/2023 10:54	10:54
11/21/2023 10:53	10:53
11/21/2023 10:52	10:52
11/21/2023 10:51	10:51
11/21/2023 10:50	10:50
11/21/2023 10:49	10:49
11/21/2023 10:48	10:48
11/21/2023 10:47	10:47
11/21/2023 10:46	10:46
11/21/2023 10:45	10:45
11/21/2023 10:44	10:44
11/21/2023 10:43	10:43
11/21/2023 10:42	10:42
11/21/2023 10:41	10:41
11/21/2023 10:40	10:40



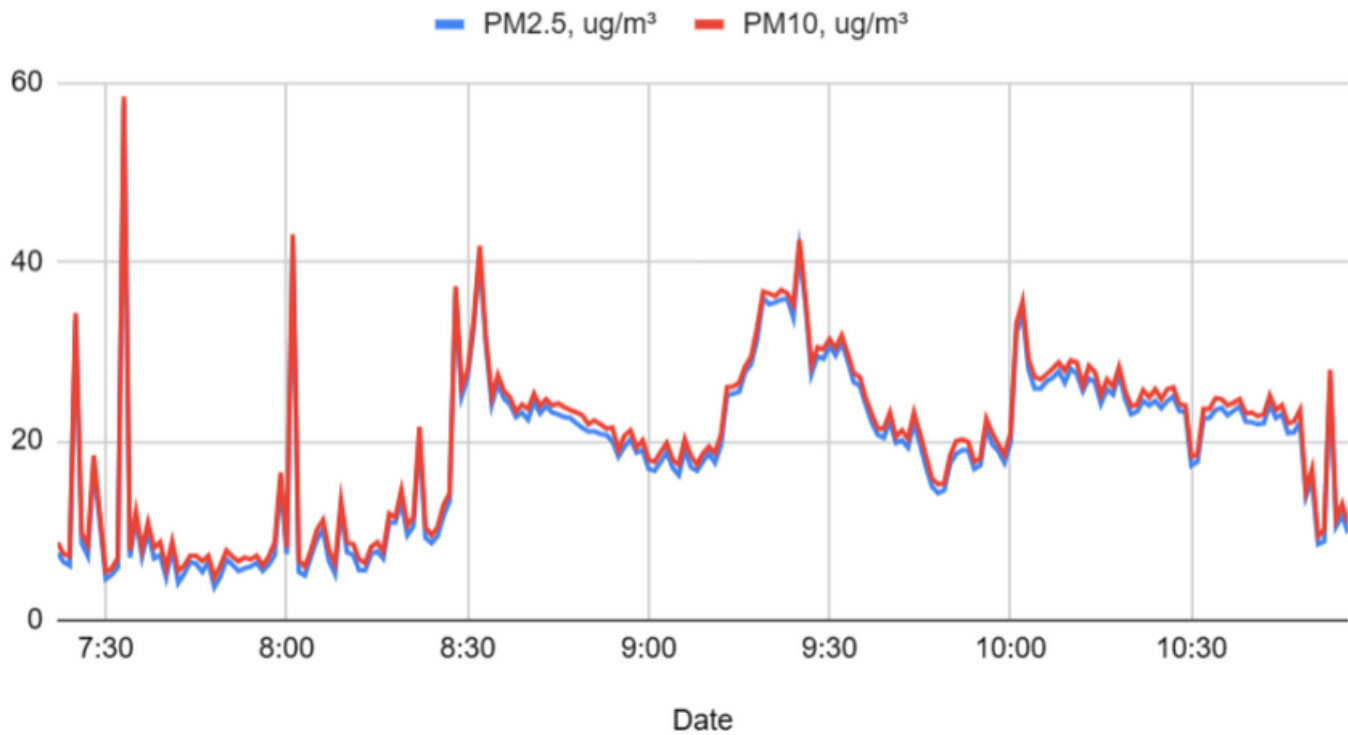
Pollution over time graph

T	U	V	
Date	PM2.5, ug/m ³	PM10, ug/m ³	
10:56	9.7	10.8	
10:55	11.7	13	
10:54	10.5	11.3	
10:53	26.9	28	
10:52	8.8	10.1	
10:51	8.5	9.4	
10:50	15.7	16.9	
10:49	13.8	14.5	
10:48	22.1	23.5	
10:47	21	22.2	
10:46	20.9	22	
10:45	23	24	
10:44	22.6	23.5	
10:43	24.1	25.1	
10:42	22	23	
10:41	21.9	22.8	
10:40	22.1	23.2	

After this Select the time and data and choose to insert a chart. From chart setting choose the line graph style. If it is not selected by default, set the date collum to be the x-axis of the graph. Now you can see how the pollution levels Vary over time to be able to see when areas are most and least polluted.

Pollution over time graph

PM2.5, ug/m³ and PM10, ug/m³



Final Result

More Resources

The Atmotube technical specification, and technical assistance

This site has a lot of technical information on the Atmotube Pro, as well as a question and answer section and information on getting further help.

<https://atmotube.com/atmotube-support/atmotube-technical-specification>

Contact Atmotube

For further technical assistance or questions about Atmotube reach out to info@atmotube.com

More Resources

Monitoring examples, and recommendations

For detailed examples of how these monitoring techniques can be used, as well as recommendations for further projects, and strategies on using data to make change see the report created by the WPI EDEN Center group.

It can be accessed by searching “Monitoring Air Pollution in Tirana: A Citizen Science Approach” on the WPI Index

[https://digitalwpi.wpi.edu/catalog?utf8=✓ &search_field=all_fields&q=Monitoring+Air+Pollution+in+Tirana%3A+A+Citizen+Science+Approach](https://digitalwpi.wpi.edu/catalog?utf8=✓&search_field=all_fields&q=Monitoring+Air+Pollution+in+Tirana%3A+A+Citizen+Science+Approach)

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**FEEL FREE TO EMAIL ANY OF US WITH ANY
QUESTIONS!**

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