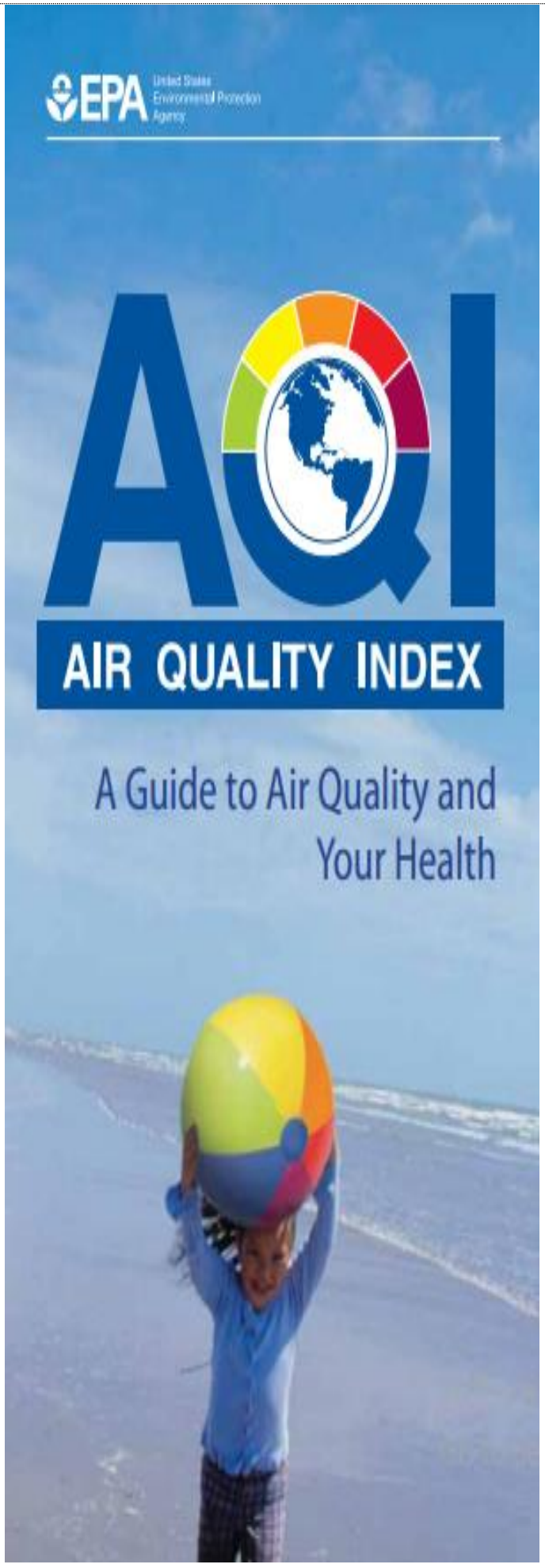
TEHRAN UNIVERSITY OF MEDICAL SCIENCES

Institute for Environmental Research (IER)

Center for Water Quality Research (CWQR)

Feb. 2024



"The ozone levels have reached a critical threshold today."

"The forecast indicates that particle pollution levels will be detrimental to individuals with sensitivities."

"Today, the air quality in the area is exceptionally poor."

These alerts may be encountered through various media channels such as radio, television, or newspapers. However, it's essential to comprehend their significance based on your circumstances:

- *Engaging in outdoor activities*
- *Supervising children playing outdoors*
- *Being an elderly individual*
- *Coping with heart or lung conditions*

This publication aims to facilitate your understanding of accessing local air quality information and safeguarding your well-being accordingly.

Manual of software

Title

Air Quality Index (AQI) calculator

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1.Introduction

Human well-being is significantly influenced by air quality, which undergoes fluctuations due to changing weather conditions on a daily and even hourly basis. In major urban centers, air quality monitoring systems play a pivotal role in translating air quality-related data into an Air Quality Index (AQI) and disseminating pertinent information to the populace. Consequently, the AQI serves as a critical instrument for assessing air quality, understanding the health implications of air pollution, and devising protective measures against it.

Broadly, the AQI serves as a metric for daily air quality reporting, offering insights into the purity or pollution levels of the air and elucidating the associated health ramifications. Specifically, the AQI focuses on elucidating the health effects stemming from exposure to polluted or unhealthy air. This index is computed for five standard air pollutants: suspended particles, nitrogen dioxide, ground-level ozone, carbon monoxide, and sulfur dioxide. The overarching objective behind the development of this software is to facilitate the calculation, determination, and dissemination of the Air Quality Index (AQI).

2. Different Health-Related Air Quality Levels

To facilitate comprehension, the Air Quality Index (AQI) is categorized into six distinct levels, each correlating with varying degrees of impact on human health. These levels are delineated as follows:

Good: With an AQI ranging from 0 to 50, air quality is deemed satisfactory, posing minimal to no health risks. Represented by the color **green**, this category signifies favorable air quality conditions. In our context, air of this quality is commonly termed "pure," though this designation lacks scientific substantiation, and "good" accurately describes this condition.

Moderate: Falling within the AQI range of 51 to 100, air quality remains acceptable, albeit with potential health considerations for a select few. While individuals sensitive to suspended particles, nitrogen dioxide, and ozone may experience respiratory symptoms, the general populace is unaffected. Displayed in **yellow**, this category is sometimes labeled as "healthy," yet the term lacks scientific merit, and "moderate" aptly characterizes this state.

Unhealthy for Sensitive Groups: Spanning an AQI range of 101 to 150, this category signifies conditions where sensitive groups may encounter health effects due to air pollution, while the broader population remains unharmed. Depicted in **orange**, this designation alerts to heightened health risks for vulnerable demographics.

Unhealthy: With an AQI between 151 and 200, air quality deteriorates to a level where adverse health effects are probable for all individuals, with sensitive groups facing more severe consequences. Represented by the color **red**, this category indicates significant health risks posed by air pollution.

Very Unhealthy: AQI readings ranging from 201 to 300 constitute a health warning, signaling that anyone may experience severe health effects due to air pollution. Indicated by the color **purple**, this level underscores the critical nature of the health risks associated with polluted air.

Hazardous: AQI surpassing 300 is deemed hazardous to human health, necessitating urgent attention. Under these conditions, all members of society face severe health effects attributed to air pollution. Represented by a deep **red hue**, this level serves as a dire warning of the imminent health hazards posed by polluted air.

Table 1 illustrates the correlation between the Air Quality Index (AQI) and the degree of health significance, alongside their respective color representations.

Table 1. the association between AQI and the degree of health significance and their corresponding color indicators

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

3. How to calculate AQI:

$$I_p = \frac{I_{Hi} - I_{Lo}}{BP_{Hi} - BP_{Lo}}(C_P - BP_{Lo}) + I_{Lo}$$

- I_P = air quality index (AQI) for pollutant p.
- C_P = measured (rounded) concentration for pollutant p.
- BP_{Hi} = breaking point that is greater than or equal to CP.
- BP_{Lo} = breaking point that is less than or equal to CP.
- I_{Hi} = AQI value corresponding to BP_{Hi}.
- I_{Lo} = AQI value corresponds to BP_{Lo}.

Table 2. Breakpoints for AQI Scale 0-500 (Units: µg/m3 unless mentioned otherwise)

AQI Category (Range)	PM_{10} 24-hr	$PM_{2.5}$ 24-hr	NO_2 24-hr	CO 8-hr (mg/m^3)	SO_2 24-hr
Good (0-50)	0-50	0-30	0-40	0-1.0	0-40
Satisfactory (51-100)	51-100	31-60	41-80	1.1-2.0	41-80
Moderately polluted (101-200)	101-250	61-9-	81-180	2.1-10	81-380
poor (201-300)	251-350	91-120	181-280	10-17	381-800
Very poor (301-400)	351-430	121-250	281-400	17-34	801-1600
Severe (401-500)	430+	250+	400+	34+	1600+

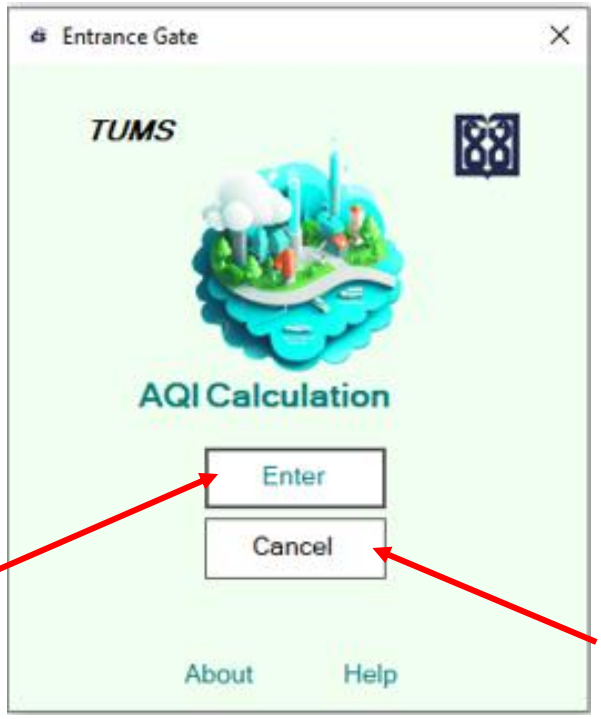
In many regions, the Air Quality Index (AQI) is typically derived from 8-hour ozone measurements. However, in certain areas, using AQI values based on one-hour ozone measurements may be more indicative of potential concerns. In such cases, it is advisable to calculate the AQI using both 8-hour and one-hour ozone values and report the higher of the two values.

4. How to use the software to calculate AQI:

The software provided is intended for calculating the Air Quality Index (AQI) based on predefined formulas and cutoff points outlined in Table 2. The steps to utilize this software are as follows:

1. Download the software's executable (exe) file from the website of the Environmental Research Institute of Tehran University of Medical Sciences. Upon execution, an input window will appear.
2. Before using the software, ensure to install the Access Engine compatible with your system, using the links provided in the help section of the input window.
3. Proceed to the main page of the software by clicking the login button, as illustrated in Figure 4.1.

Login to the main page of calculations



If you attempt to exit the software by selecting the cancel button, you will be unable to proceed along the path and access the main calculation form.

Figure 4.1. Entrance Gate

It is important to note that the help section and program details, including instructions on software usage and designer specifications, are briefly outlined. After clicking the login button, proceed to the main page to perform calculations as described below:

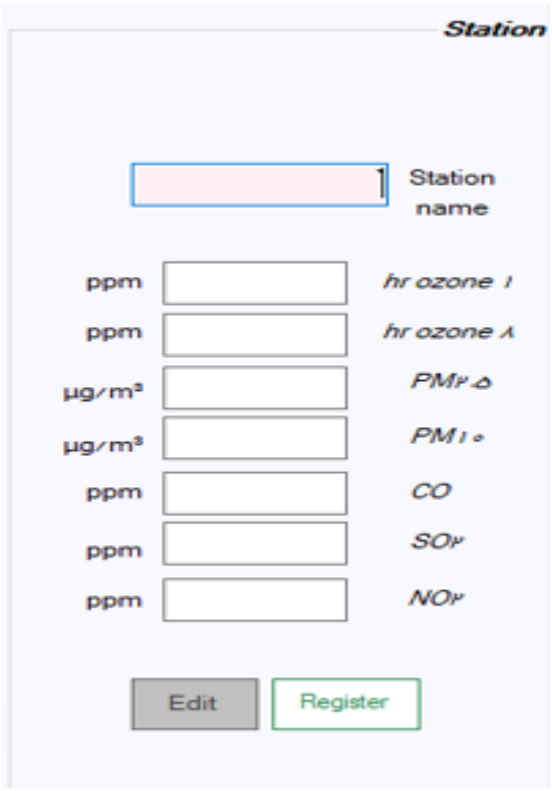


Figure 4.2. Station registration

Within the station registration segment, as depicted in Figure 4.2, input the name of the selected station along with the monitored pollutant concentrations. Subsequently, click the registration button to confirm. In case of any inaccuracies, adjustments can be made using the edit button. Following this, as illustrated in Figure 4.3, the stored data will populate the left section of the software.

Figure 4.3. Station information registration

Upon inputting station-related data, as shown in Figure 4.4, activating the air pollution index calculation button initiates the AQI software's computation for the respective station. Subsequently, it presents the highest AQI level within the city and identifies the station associated with this recorded AQI level.

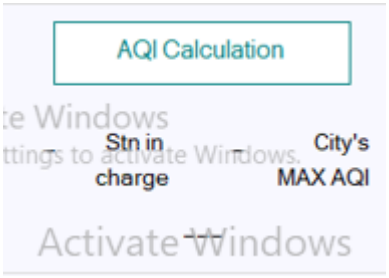


Figure 4.4. Calculation of air pollution index

Utilizing the AQI derived from this segment, as depicted in Figure 4.5, the software showcases the maximum AQI determined by the accountable pollutant, along with corresponding health recommendations, in the lower right section.

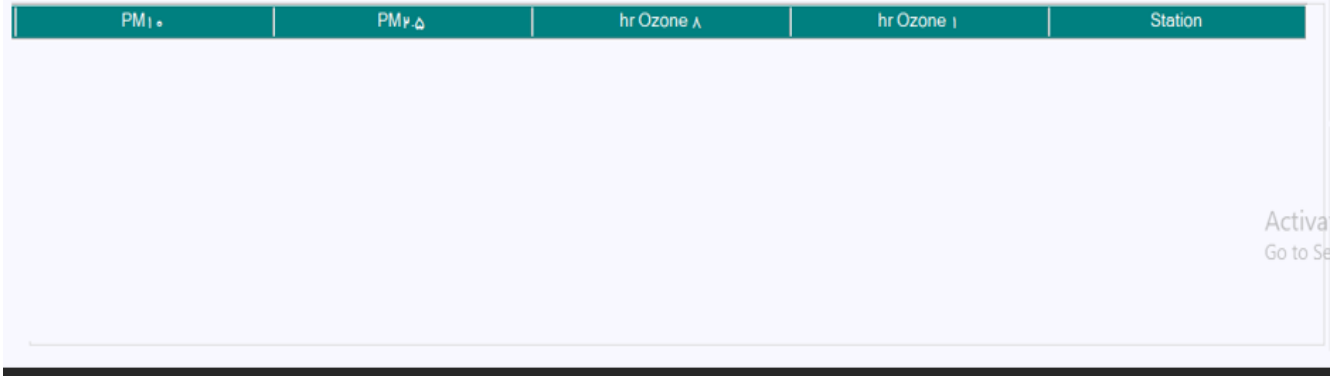


Figure 4.5. Displaying the highest calculated index, specifying the responsible pollutant and health recommendations

5. Ability to delete or edit station data:

The software provides the option to modify or remove station data as illustrated in Figure 4.6. Users can edit or delete station information individually or remove all stations simultaneously by right-clicking on the station name in the upper left section.

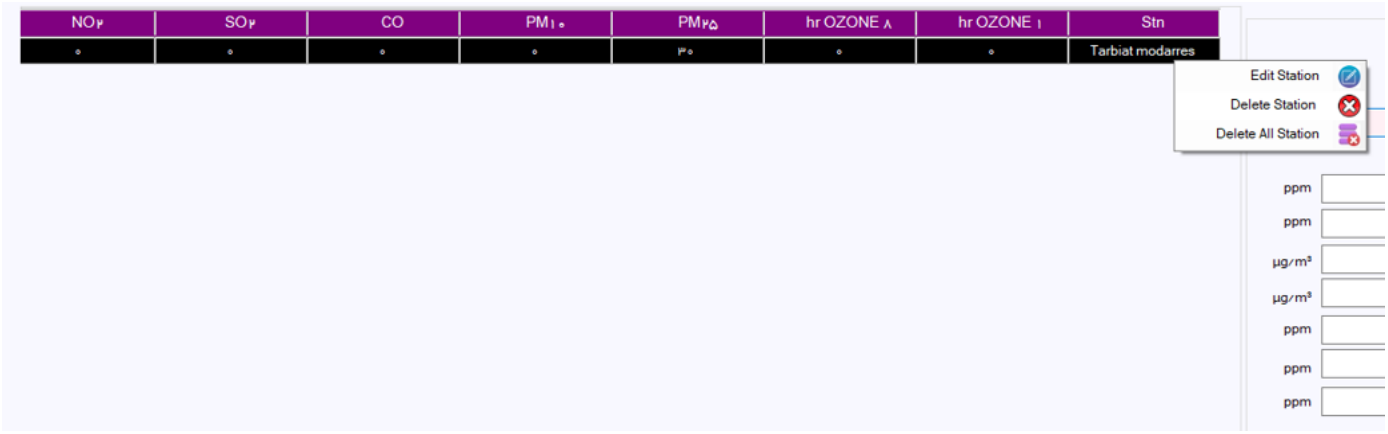


Figure 4.6. Ability to edit, delete or remove all stations

The End…