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Estimating the Level of $SO_2$and Other pollutants Emissions from Power Stations in Kuwait Using Air Quality Index

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Abstract: The concentrations of SO_2 emissions released from Kuwaiti power plant are discussed in this paper. The level was assessed utilizing the upsides of Air Quality Index - AQI pointer, which is estimated hourly, every day and yearly. The air quality was observed at four unique local locations in Kuwait throughout the span of a year. Air Quality Index (AQI) is utilized here to survey the degree of SO_2 outflows from such power stations in Kuwait. The QAI has a relation with the rate of pollutants emissions which is determined in this paper. It was found by comparing the studied power plants in Kuwait that Mutla power plant has the higher SO_2 concentrations followed by Mansouriya, then Jahra and finally Rabia in 2008, this is refer for the emission reduction technology followed in each of the four studied power plants. Also depending on Air Quality Index (AQI) values it was found that AQI at the three power plant (Jahra, Mansouriya and Al-Qurain) is in good level of air pollution. In 2021, the Doha power plant has a higher values of SO_2, then Al-Qurain area, Al-Mansouriya area and Al-Jahra area respectively.

Keywords:air quality index; meteorological data; sulphur dioxide, power plants.

1. Introduction

The deterioration of urban air quality has been linked to serious health problems. Pollutants from power plants, such as sulfur dioxide gas (SO_2), can have serious health repercussions if levels in the ambient air reach dangerously high levels. In order to comprehend the impact of SO_2 emissions, mathematical models are frequently employed to estimate the temporal and geographical distribution of SO_2 emissions in urban regions. Air quality models are used for environmental assessments and decision-making to reduce urban air pollution, as well as for research purposes.

The air quality index (AQI) is a standardized summary measure of ambient air quality that measures the degree of health risk from particle and gaseous air pollution. The US EPA established the index in 1998 to measure ambient air quality using quantities of key air pollutants such as PM10, PM2.5, ozone, SO_2, NO_2, and CO. Following that, France, the United Kingdom, and Germany developed a comparable, index-based method of expressing health risk. In Poland, there is no such environmental warning system, however some testing has taken place in the Katowice area and the city of Gdansk. However, under environmental conditions, the practical relevance of AQI in Poland is dubious [28].

Pollutant concentrations are measured using automated air monitoring stations, which allows for speedy data processing and translation to the AQI scale. The AQI value range is organized into seven categories, including "good," "moderate," and "dangerous" air quality zones [1]. The air quality zone is rated "good" if the AQI is between 0 and 50. The air quality zone is termed "moderate" if the AQI is between 51 and 100. The air quality zone is classed as "dangerous" if the AQI score exceeds 100. A similar three-tiered arrangement has been utilized throughout Europe [28].

The AQI is calculated by the Environmental Protection Agency (EPA) for five primary air pollutants for which national air quality limits have been set to protect public health.

1. Ozone at ground level
2. Particulate matter/particle pollution (PM2.5/pm 10)
3-Carbon Monoxide (CO)
4-Sulfur dioxide (SO_2)
5-Nitrogen dioxide (NO_2)

Different countries report air quality exploitation totally different purpose scales. Within the U. S., as an example, a rating between zero and fifty is taken under consideration good on a 500-point scale. A rating of 301 to 5 hundred is taken under consideration dangerous. Exploitation EPA-developed customary equations, these

raw prices area unit reworked into one AQI value for every waste product (ground-$_{level}$ gas, particle pollution, CO, and sulfur dioxide).

Categories of the Air Quality Index

-Good (0–50) -Minimal Influence

-Satisfactory (51–100) - Some sensitive persons might expertise slight respiratory problems.

-Moderately polluted (101–200) - May cause breathing difficulties in persons with lung illness such as asthma, as well as discomfort in people with heart disease, children, and the elderly.

-Poor (201–300) - May cause breathing issues in persons exposed for an extended period of time, as well as discomfort in people with heart condition.

-Very Poor (301–400) - May cause respiratory sickness in persons who are exposed for an extended period of time. People with lung and heart disorders may be particularly affected.

-Severe (401-500) - May cause respiratory problems in healthy persons, as well as major health problems in people with lung/heart illness. Difficulties might occur even with mild physical exertion.

Table 1 summaries AQI levels and their classification.

Table 1. Air Pollution Level (US-EPA 2016 standard) [22]

AQI	Air pollution level
0 - 50	Good
51 -100	Moderate
101-150	Unhealthy for Sensitive Groups
151-200	Unhealthy
201-300	Very Unhealthy
300+	Hazardous

Objectives of Air Quality Index (AQI)

The main aim of AQI is examination air quality conditions in varied cities/locations. It additionally aids within the identification of incorrect standards and ineffective observation procedures. The air quality index (AQI) aids in assessing changes in air quality (improvement or degradation). The air quality index (AQI) educates the public about environmental conditions. It is especially beneficial for persons suffering from ailments that have been exacerbated or caused by air pollution. The following groups of persons are particularly vulnerable to air pollution:

-Those suffering from lung disorders such as asthma, chronic bronchitis, and emphysema.

- Children, including adolescents

-Active persons of all ages who exercise or work outside extensively

-Some healthy persons are more vulnerable to ozone than others.

The Kuwait Air Quality Index (KAQI) could be an easy technique for the final public to be told concerning the state of air quality around Kuwait's thirteen air quality watching stations. The KAQI's objective is to assist you understand the importance of local air quality to your health. The KAQI measures the quality of your air as well as any potential health consequences. Consider the KAQI to be a scale with a 0 to 500 range. The number 100 refers to the pollutant's Kuwaiti National Ambient Air Quality Standard, which is the level established by the Kuwait Environment Public Authority (KEPA) to safeguard public health. The higher the

KAQI value, the more polluted the air is and the greater the health danger. The KAQI is color-coded into five categories of health risk to make it easier to understand. The KAQI is computed for five primary air pollutants controlled by the National Environment Law No 21's List of Executive Orders (210/2001), for which the Environment Public Authority of Kuwait has established national air ambient quality guidelines to safeguard public health:

1. Sulfur Dioxide (SO_2)
2. N2O (Nitrogen Dioxide) (NO2)
3. Ozone at Ground Level (O3)
4. Carbon Monoxide (CO) (CO)
5. Particulate Matter (PM)-10 microns (PM-10).

When any of the following pollutants' KAQI value exceeds 100, the air quality is considered unhealthy—first for some sensitive people, then for everyone as the KAQI number climbs. Government agencies use the Air Quality Index (AQI) [1] to convey to the public the current or predicted level of air pollution. [2] [3] Formalized paraphrase As the AQI grows, so will the hazards to public health. Each country has its own air quality index, which correlates to different national air quality standards. The AQI threshold has an effect on the degree of air pollution, as shown in Table 1 [21].

Several studies have been conducted in Kuwait to estimate SO_2 emissions from power plants, such as Bouhamra and Abdul-Wahab in el. [8]. They ran a statistical analysis on the data acquired by the University of Kuwait's Air Pollution Mobile Laboratory. The experimental study is based on a mobile laboratory that has been operating in the Mansouriya residential neighborhood for a month. [19] Presented the findings acquired by utilizing the Integrated Industrial Resources Short-Term (ISCST3) model to determine the SO_2 concentration created by Kuwait's current power plants. It is fully dependent on heavy fuel oil and assumes that the background SO_2 concentration is zero. Azmi et al. [20] Use the Short-term Dispersion Source Complex Model (ISCST4.5) to predict the environmental ground concentration of SO_2 and NOx emitted by the power plants of the selected recipients in Kuwait.

There are many studies discussed this issue, Marais and colleagues (2019) [23] reported that the annual emissions of two kinds of harmful micro particles (PM2.5), sulfur dioxide (SO_2) and nitrogen oxides (NOx), from fossil fuel power plants in Africa are about equal. From 2012 to 2030, it will more than treble, from 2.5 to 5.5 Tg SO_2 and 1.5 to 2.8 Tg NOx. They included these emissions into a GEOS-Chem model nested on the African continent in order to estimate ambient PM2.5 concentrations and assess the sickness burden (excess mortality) associated with future exposure to fossil fuel use. They also calculated the 48,000 avoidable deaths in 2030 (95 percent confidence interval: 6000-88000), the vast majority of which occurred in South Africa (10400), Nigeria (7500), and Malawi (2400). The death rate of power plants was Three times the fatality rate of power plants. Transportation. The sensitivity of illness burden to population growth or air quality differs geographically, implying that emission reduction efforts would be most successful in Southern Africa, but population increase is the key driver everywhere else. Using the AERMOD-ISC diffusion model, Al-Awadhi and Yassin (2010) [24] evaluated the impact of SO_2 emissions from power plants in Kuwait. The SO_2 emissions from 15 chimneys were studied to establish pollutant dispersion patterns and the risk of such emissions negatively affecting the adjacent population. SO_2 surface concentrations are replicated using a year's worth of meteorological data. This level is calculated using models that simulate hourly, daily, and annual concentrations. For a year, the air quality in four different residential neighborhoods was investigated. The simulated concentration is validated by comparing it to the observed concentrations in four separate locations within the residential area. According to the results, the simulated concentration is extremely close to the observed value. The model performance is also satisfactory. The hourly and daily concentration of the simulation model exceeds the KW-EPA limit. This indicates that there is a significant influence of SO_2 emission from the power station in ambient air quality.

The total emissions of nitrogen oxides (NOx), sulfur dioxide (SO_2), and particulate matter (PM) from coal-fired power plants in Anhui Province (China) were investigated by Dai et al. (2019) [25] to evaluate the impact of control measures based on the Continuous Emission Monitoring System (CEMS) Air emissions. Total NOx, SO_2, and PM emissions declined dramatically between 2013 and 2017, and are predicted to be 24.5 kilotons (kt), 14.8 kt, and 3.0 kt, respectively, in 2017. Emissions in 2017 were lowered by about 79.0 percent, 70.1 percent, and 81.2 percent compared to the 2013 baseline, owing mostly to the use of high-efficiency

emission control techniques such as desulfurization, denitrification, and dust removal devices, as well as selective catalysis (SCR).

Pachouri and Saxena (2020) [26] established new ecological criteria, their current stage of implementation, concerns, roadblocks, and the way forward. Similarly, coordinated and intentional measures are necessary to meet the timetables for control of the relative diversity of contaminations in all power plants, particularly those in the region of force, which are far behind schedule. Alhajer et al. (2019) [27] created unit-based emissions inventories for Kuwaiti power frameworks based on a variety of criteria such as fuel information and usage, burning innovation and productivity, unit limit, and heater kind. The concentrate to boot assessed the longer term discharges of Roman deity, SO_2, CO, CO_2, and PM10 up to the year 2030 utilizing a variable relapse model also as anticipating future energy interest. The outcomes showed that yearly (2010–2015) outflows of all air poisons, blackball SO_2 and PM10, distended over the review timeframe. CO had the most effective increment of forty one.9%, whereas SO_2 levels diminished the foremost by thirteen over the 2010 levels, thanks to the substitution of weighty heating oil. Energy utilization in 2015 remained at around 86 PJ, with inflammable gas, gas oil, raw fossil fuel, and weighty heating oil creating up fifty one.2%, 10.7%, 3.1%, and 35%, singly. Energy request was projected to develop at AN annualized pace of two.8% by 2030 contrasted with 2015 levels.

The projected discharge rates showed that, of the 5 air toxins, SO_2 and PM10 area unit relied upon to diminish by 2030 by thirty fourth and 11 November, separately. Nevertheless, prime month to month emanations of SO_2 would in any case simply be Bastille Day lower contrasted with the 2015 month to month traditional. Apparently, emanation levels area unit projected to increment by thirty four.3%, 54.8%, and 71.8% for CO_2, NOx, and CO, on an individual basis, by 2030 contrasted with 2015 levels. Befittingly, a lot of aspiring objective of renewables entrance ought to be taken on to minimize outflow levels going ahead.

The current evaluation examined the influence of the Doha East and Doha West power plants on the surrounding air quality in Kuwait using an AQI marker. To do this, the SO_2 emanation rate of Doha East and Doha West power stations for one year was compared to earth science data. To measure the degree of SO_2 fixation, AQI values were used in Mutla, Jahra, Rabia, and Mansouriya. The current review sought to ascertain the environmental degrees of SO_2 emissions. These might be detrimental to the KW-EPA (Kuwait Climate Public Power). Close Air Quality Principles that establish the global standard for SO_2 outflows in urban areas.

Determining AQI mathematically

Formation of sub-indices (I1, I2,...., In) for n waste product variables (X1, X2...., Xn) is distributed as sub-index functions that square measure supported air quality standards and health effects. Mathematically this can be expressed as

$$AQI_i=f(X_i),\ i=1, 2..., n \quad (1)$$

Each sub-index represents a relationship between waste material concentrations and health effects. The purposeful relationship between sub-index price (AQIi) and waste material concentrations (Xi). Aggregation of sub-indices, AQI_i is carried out with some mathematical function such that [29]:

$$AQI = F(I_1, I_2, ..., I_n) \quad (2)$$

Which can be written as:

$$AQI = \text{Aggregated Index} = \Sigma w_i I_i \ (\text{For } i= 1, ..., n) \quad (3)$$

Where, $\Sigma w_i = 1$, Ii= sub-index for pollutant I, n = number of pollutant variables
And w_i= weightage of the pollutant.

Or

$$AQI = Max\ (I1, I2, I3... In) \quad (4)$$

2. Area Description and Meteorological data

Doha East and Doha West power stations were chosen as the two power plants that have the greatest impact on the air quality above residential areas in Kuwait. Figure one depicts a map of Kuwait as well as the locations of the Doha East and Doha West power stations in relation to Kuwait City and other places in Kuwait. The 2 power stations are placed in port, placed around fifteen click to the west of Kuwait City as shown in Fig. 1. Doha East and Doha West power stations are designed to work exploitation differing kinds of fuel (mixed firing option), together with gas and liquid oil merchandise like gas, significant heating oil (HFO), fossil fuel and heating oil. One amongst the foremost necessary properties of fuel is their sulfur content. SO_2 is made by burning of fossil fuels. The SO_2 emissions are directly proportional to the sulfur content within the fuel, and also the amount of fuel consumed. Therefore, the accuracy of the SO_2 estimates depends on the degree of exactness with that sulfur content within the fuel is rumored. Each Doha East and Doha West power stations have 2 chimneys. Every chimney of Doha West contains four stacks. Doha East differs slightly, because it contains four stacks within the one chimney and 3 stacks within the alternative. The emissions from these power stations are a cause for major concern in terms of the deteriorating close air quality. It's so necessary to review the impact of the community on the close air quality in and round the close power stations region. During this study, the dispersion of a typical waste substance SO_2 generated from Doha East and Doha West power plants was investigated. Figure 1 depicts the location of many power plants in Kuwait.

Figure 1 Location of some power plants in Kuwait

Other areas studied during this work includes:
-Capital Governorate (Al-Mansouriya) and Al-Mutla regions as shown below.
Mansouriya could be a region within the Capital Governorate and a suburbia of Kuwait as displayed in (Figure 2), its people involves 8352 of each 2008 [2] .

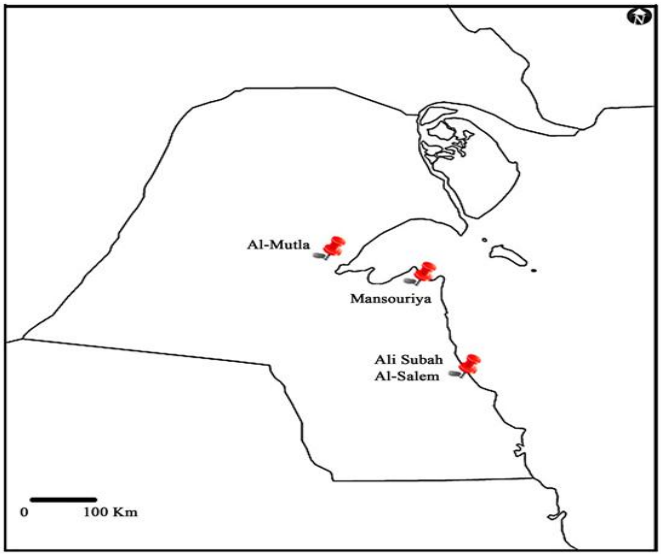

Figure 2. Location map of sampling area

3. Results and Discussion

Table 1 and Table 2 show the KW-EPA ambient air quality standards for residential areas in 2008.

Table 1: K-EPA ambient air quality standards for residential areas

Time		Hour*		Day**		Year	
		ppb	µg/m^3	ppb	µg/m^3	ppb	µg/m^3
SO_2***		170	444	60	157	30	80

* Average hour to not occur quite double throughout the amount of thirty days on constant same site.
** Daily average (24 hours) mustn't occur quite once throughout the year.
*** ought to apply in residential dominated areas that lie on the border of industrial areas.

Table 2: Daily SO_2 concentrations in the studied plants

Months	Locations				
	Mutla	Jahra	Rabia	Mansouriya	Overall
May	Not available	0.8724	Not available	0.9621	0.9172
June	0.8718	0.6972	Not available	0.7596	0.7762
July	0.8871	0.9042	Not available	0.8755	0.8889
August	0.7645	0.7023	0.7157	0.8645	0.7617
September	0.9431	0.6873	0.8022	0.5558	0.7471
Average R^2	0.8666	0.7727	0.759	0.8035	0.8004
AQI					

The concentrations of SO_2 results can be summarized in the following Tables 3 for each pollutants in three areas within the years 2013 to 2017 at different times of the years.

Table 3. CUSUM for SO_2 of Al-Mutla and Al-Mansouriya areas

SO_2		Seasons		
Location	Years	Winter (6Dec.-15 Feb.)	Spring (16 Feb.-20 May)	Summer (21 May-5 Dec.)
Al-Mutla	2013	-	-	-
	2014	-	-	-
	2015	-	-	−20
	2016	76.41	27.75	−78.89
	2017	97.94	55.61	−99.87
	2013-2017	89.6	72.57	−36.96
Al-Mansouriya	2013	96.52	−76.6	−94.94
	2014	67.15	−5.99	−68.89
	2015	-	90.87	−94.86
	2016	99.36	−56.12	−97.31
	2013-2016	97.22	−34.54	−69.2

Figure 3 shows the pollutants concentrations of Doha power plant in 2021 and AQI

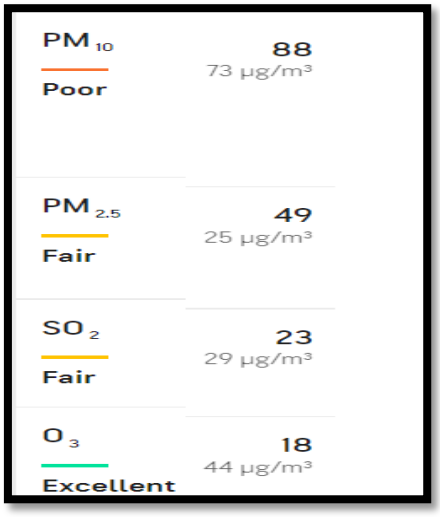

Figure 3 Pollutants concentrations of Doha power plant in 2021

Using equation (4)
AQI = Max (88, 49, 23, 18)= 88 which can be described as (Poor) of air quality.

While in Jahra power plant, figure 4 shows the concentrations pollutants in 2021, SO_2 about 7µ g/m3.

Figure 4 Pollutants concentrations at Al-Jahra PP.

The AQI for Jahra area comparing with Kuwait as whole is shown in figure 5.

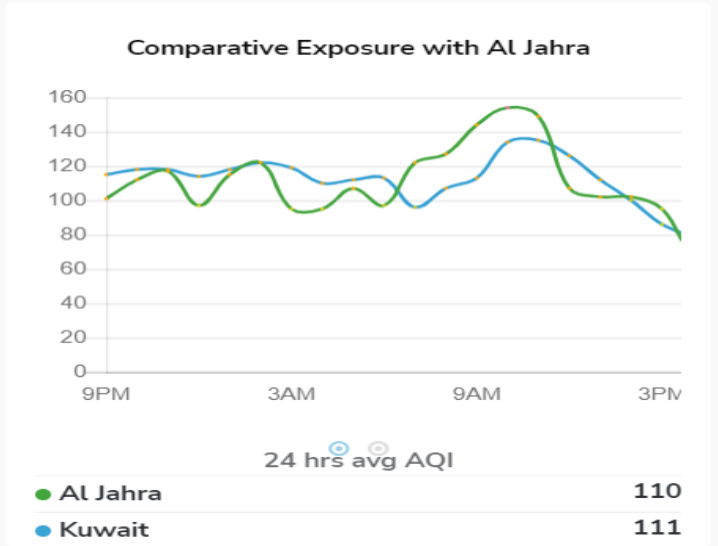

Figure 5. AQI of Jahra area compared with Kuwait average (2021)

Figure 6 shows the historic Air Quality of Jahra area at different times in 2021.

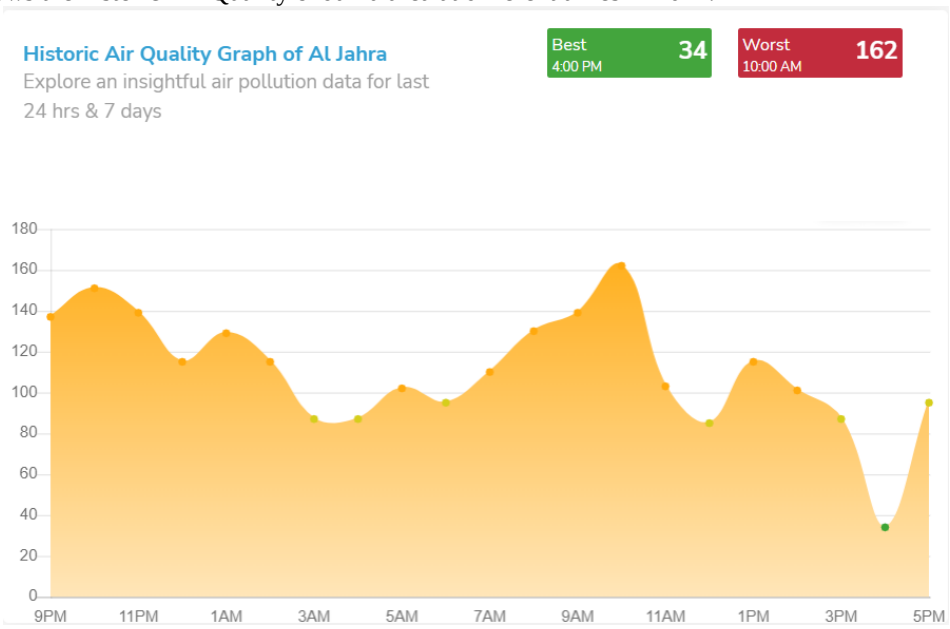

Figure 6. The historic Air Quality of Jahra area at different times in 2021

Figures 7-9 show the real time AQI of three different areas(Al-Qurain, Jahra and Mansouriya) taken in 16 Dec. 2021 at 18:00 o'clock. The figures also show the concentrations of all pollutants as minimum and maximum values.

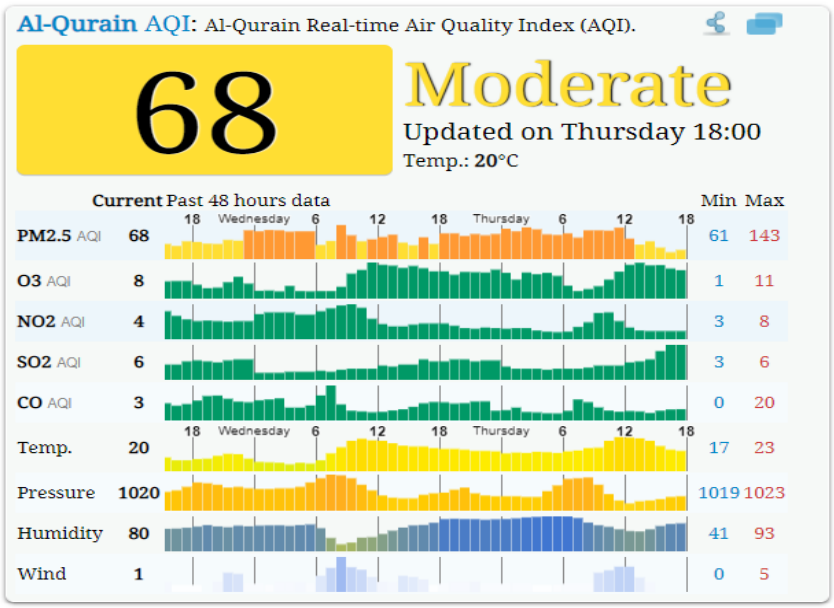

Figure 7. AQI and pollutants concentrations at Al-Qurain area in 2021

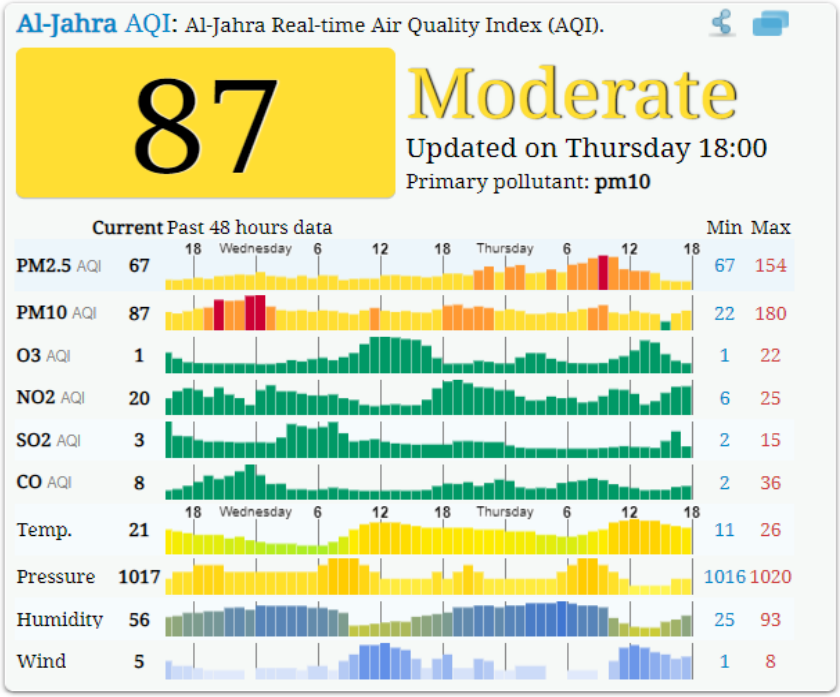

Figure 8. AQI and pollutants concentrations at Al-Jahra area in 2021

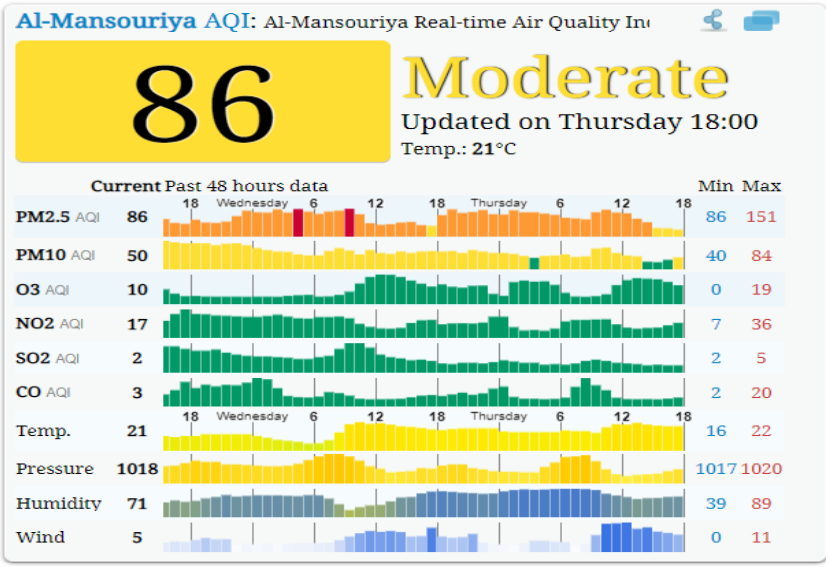

Figure 9. AQI and pollutants concentrations at Al-Mansouriya area in 2021

Figure 10 shows a comparison of maximum and minimum values of SO_2 concentrations (AQI –SO_2) between the four studied areas: Doha PP, Al-Qurain area, Al-Mansouriya area and Al-Jahra area.

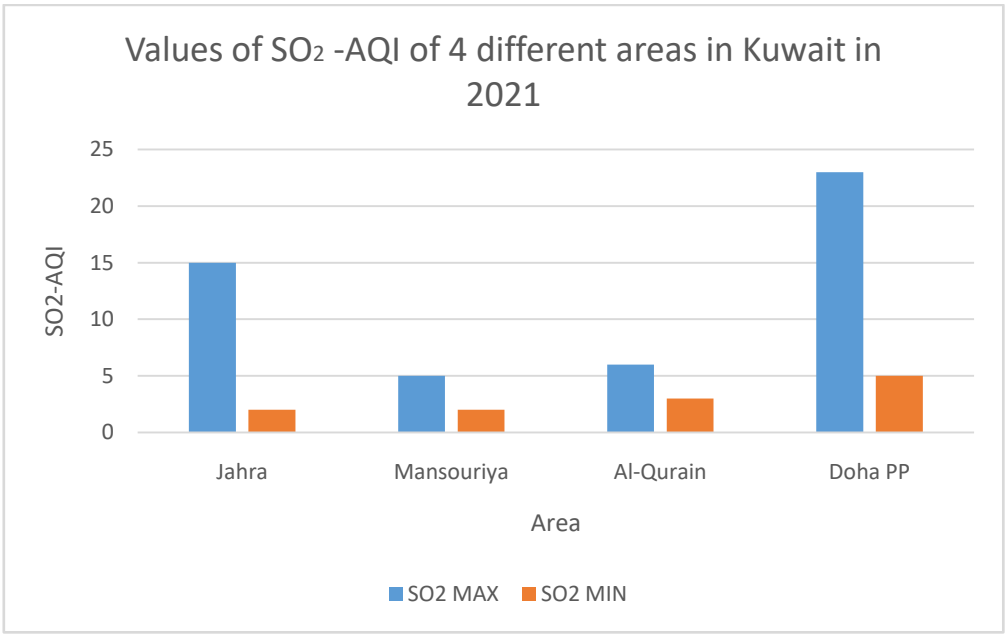

Figure 10. Comparison of maximum and minimum values of SO_2 concentrations (AQI –SO_2) between the four studied areas

It is found that there is a high relationship between AQI and pollutants concentrations specially SO_2. It is proved that as the SO_2 and other pollutants increase AQI increase, Doha area has a maximum AQI-SO_2, then Jahra, Al-Qurain and finally Mansouriya area.

Conclusions

The following conclusions can be drawn:

-SO_2 concentrations exceeded the KW-EPA hourly SO_2 concentration threshold in most residential areas;

-Most of the most hourly SO_2 concentrations occurred in could, June, July, August, and September, that is the peak period;
-The hourly SO_2 violations occurred over the height amount, and the majority of the violations throughout the height amount were distributed over Kuwaiti calendar month, July and August;
-The distribution of the hourly and daily SO_2 violations area unit subtle northwest and southeast from the DohaEast and DohaWest power stations.
-The AQI of SO_2 at the 3 powerhouse (Jahra, Mansouriya and Al-Qurain) is in sensible level of pollution.
-There may be a sensible relationship between space emissions and its AQI, as these concentrations will increase AQI will increase and a lot of impure and dangerous areas is noticed.

References

[1]. Pruchnicki, J., Air Pollution Dispersion Models As Used In Poland In Regional Development Planning, ReDohathe international institute for Applied System Analysis. Poland, 1977.
[2]. Pratil S.B., Patil R.S. , Estimation of a quantitative air quality impact assessment score for a thermal power plant, Atmospheric Environment, 34B, 3, pp.443-448, 1990.
[3]. Hosanna E., Aunela-Tapola L., Kinnunen V., Larjava K., Mehtonen A., Salmikangas T., Leskela J., Loosaar J., Emission factors and annual emissions of bulk and trace elements from oil shale fueled power plants, The Science of the Total Environment, 198, pp. 1-12, 19.
[4]. Gouveiaa, C., Cerdeiraa, .R., Garciaa, J.M., Nogueirab, M. and Coelhoa, L.M.R., Numerical Modelling for Studying the Impact of Urban Air Pollution in Natural Reserves around Setúbal City. IEMSS Conference, 2004.
[5]. Villegas, L.M.T., Cervantes, T.M.G., Gómez, I.R., Bravo G.V., Zuk, M., Bracho, R.L. and Bremautz, F.A., Evaluating The Impacts Of Power Plant Emissions In Mexico. 9th Int. Conf. on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, 1-4 June, Germany, pp.385-389, 2004.
[6]. Palau, J.L., Pérez-Landa, G., Meliá, J., Segarra, D., and Millán, M.M., A Study Of The Dispersion Of A Power Plant Plume On Complex Terrain Under Winter Conditions In The Iberian Peninsula. EMS Annual Meeting Abstracts, Vol. 1, 00389, 2004.
[7]. Bhanarkar, A.D., Rao, C.C.V. and Pandit, V.I., Air pollution modeling for power plant site selection. International Journal of Environmental Studies, Volume 62, Number 5, October, pp. 527-534(8), 2005.
[8]. Lopez M.T., Zuk M., Garibay V., Tzintzun G. Iniestra R., Fernandez A., Health impacts from power plant emissions in Mexico" Atmospheric Environment 39, pp.1199-1209, 2005.
[9]. Rodriguez M.A., Carreras-Sospedra, Medrano M. Brouwer J., Samuelsen G.S., Dabdub D., Air quality impact of distributed power generated in the south coast air basin of California 1: Scenario development and modeling analysis" Atmospheric Environment 40, pp.5508-5521, 2006.
[10]. Racoceanu, C. and Diaconu, B.M., Study of Pollutants Dispersion Resulting From Lignite Combustion In Power Generation. Annals of the University of Craiova, Electrical Engineeringseries, No. 30, pp.208-21, 2006.
[11]. Racoceanu, C. and Capatina, C., Cross-Boundary Pollution Due To The Activity Of A Thermal Power Station. Journal of the University of Chemical Technology and Metallurgy, 41, 1, pp. 103-106, 2006.
[12]. Yousif, S.A., Salem, A.A., Nassar, Y.F. and Bader, I.F., Investigation of pollutants dispersion from power stations. International journal of energy research, vol. 30, no15, pp. 1352-1362, 2006.
[13]. Khlaifi, A., Ionescu, A. and Candau, Y., Pollution source identification based on a Gaussian model of dispersion coupled with a genetic algorithm- application in a real industrial area of the greater Paris. International Conference on Approximation Methods and Numerical Modeling in Environment and Natural Resources, Granada (Spain), July 11-13, 2007.
[14]. Demael, E. and Carissimo, B., Local Atmospheric Dispersion Modelling Of Trace Constituents Issued From Nuclear Power Plant: A Comparison Using A CFD and ADMS with Wind Tunnel Data. Geophysical Research Abstracts, Vol. 9, 09662, 2007.
[15]. Kho, W. L., Sentian, J., Radojevi, M., Tan, C. L., Law, P. L., &Halipah, S., Computer simulated versus observed NO_2 and SO_2 emitted from elevated point source complex. (4 (2): 215-222, 2007.
[16]. Yousefi, H., Ehara, S. and Noorollahi, Y., Air Quality Impact Assessment of Sabalan Geothermal Power Plant Project, Nw Iran. Thirty-Third Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, January 28-30, SGP-TR-185, 2008.

[17]. Tuaycharoen, P., Wongwises, P., Pan-Aram, R. and Satayopas, B., Nitrogen Oxide (NOx) Dispersion Model for Khanom Power Plant Area. International Conference on Environmental Research and Technology. pp.653-657, 2008.
[18]. Bouhamra, W.S. and Abdul-Wahab, S.A., Description of outdoor air quality in a typical residential area in Kuwait, Environmental Pollution 105, pp.221-229, 1999.
[19]. Ramadan, A.A., Al-Sudairawi, M., Alhajraf, S. and Khan, A.R., Total SO_2 Emissions from Power Stations and Evaluation of their Impact in Kuwait Using a Gaussian Plume Dispersion Model. American Journal of Environmental Sciences V.4, N. 1, pp. 1-12, 2008.
[20]. Al- Azmi, B. N., Nassehi, V., & Khan, A. (2008). Impact of emissions from power stations on the ambient air quality of selected urban areas in Kuwait. American Journal of Environmental Sciences.
[21]. NOAA's National Weather Service/Environmental Protection Agency - United States Air Quality Forecast Guidance". airquality.weather.gov. Retrieved 20-211-2021.
[22]. US-EPA (2016). National Ambient Air Quality Standards. (https://www.epa.gov/criteria-air-pollutants/naaqs-table. Retrieved 20-211-2021.
[23]. Marais A., Rachel F. Silvern, AlinaVodonos, EleonoreDupin,Alfred S. Bockarie, Loretta J. Mickley, and Joel Schwartz (2019). Air Quality and Health Impact of Future Fossil Fuel Use for Electricity Generation and TransDohain Africa. Environ. Sci. Technol. 2019, 53, 13524−13534.
[24]. Al-Awadhi1 & Yassin (2010). Evaluating the impacts of SO_2 emissions from power stations in Kuwait. WIT Transactions on Ecology and the Environment, Vol 136.
[25]. Dai H. , Dawei Ma , Renbin Zhu, Bowen Sun and Jun He (2019). Impact of Control Measures on Nitrogen Oxides, Sulfur Dioxide and Particulate Matter Emissions from Coal-Fired Power Plants in Anhui Province, China. Atmosphere 2019, 10, 35; doi: 10.3390/atmos10010035.
[26]. Pachouri, R. and A. K. Saxena. 2020. Emissions Control in Thermal Power Stations – Issues, Challenges, and the Way Forward. New Delhi: The Energy and Resources Institute
[27]. Alhajeri N., Fahad M. Al-Fadhli and Ahmed Z. Aly (2019). Unit-Based Emissions Inventory for Electric Power Systems in Kuwait: Current Status and Future Predictions. Sustainability 2019, 11, 5758; doi:10.3390/su11205758.
[28]. MałgorzataKowalska, LeszekOśródka, Krzysztof Klejnowski, Jan E.Zejda, EwaKrajny, MarekWojtylak (2009). Air Quality Index and Its Significance inEnvironmental Health Risk Communication. Article in Archives of Environmental Protection · January 2009.
[29]. SHASHI SHEKHAR (2014). National Air Quality Index. Central pollution control board –India 2014.