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Research Paper

Assessment of Air Quality in Can Tho City, Vietnam Using Cluster Analysis

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Abstract
The study was conducted to assess the air quality of Can Tho city. Data including meteorological factors (wind direction, wind speed, temperature, humidity) and air pollutants (TSP, SO_2, NO_2 and noise) of air quality were collected from the Department of Natural Resources and Environment of Can Tho city at 15 monitoring locations (KK01-KK15) in 2020. The air quality parameters were compared with QCVN 26:2010/BTNMT for noise and QCVN 05:2013/BTNMT for ambient air quality. The results wind speeds ranged from 0.28±0.26 to 0.83±0.59 m/s, temperature from 30.13±2.12 to 31.70±2.48 °C, and humidity from 64.16±9.13 to 78.95±3.88%. TSP, SO_2, NO_2 and noise were 171.99±44.86-265.81±18.75 $\mu g/m^3$, 15.01±2.14-45.23±5.39 $\mu g/m^3$, 11.78±1.87-37.64±5.02 $\mu g/m^3$, 68.73±2.48-79.54±1.95 dBA, respectively. In general, air quality parameters were still within the allowable limits, except for noise. All air quality variables in the dry season were higher than those in the wet season except for humidity and wind speed. The air quality in Can Tho city is affected by emissions from vehicles and factories in which intersection locations, major traffic routes and industrial production areas often have higher concentrations of pollutants and noise. Spatial and temporal Cluster analysis showed that air quality in Can Tho city was spatially and seasonally changed. Air monitoring should also focus on toxic air pollutants in future monitoring. The current results provide a scientific basis for future air quality management.

Keywords
Air Quality, Air Pollutants, Nitrogen Dioxides, Sulfur Dioxides, Cluster Analysis

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1. INTRODUCTION

Currently, air pollution is not only a problem of a country, a region but a global problem. The health and longevity of people depend a lot on the freshness of the surrounding air, in all kinds of daily material needs for human life, air is a special necessity (Chan and Yao, 2008). However, the speed of urbanization along with rapid population growth has led to more pollutant emissions that affect the surrounding environment and human health (Srivastava and Pawaiya, 2020; Guttikunda et al., 2014). Human exposure to polluted air is one of the causes of serious health effects, especially in urban areas with relatively high levels of pollution (Ali and Athar, 2008). According to Hung et al. (2018), air pollution not only affects people (especially causing respiratory diseases) but also affects ecosystems and climate change such as greenhouse effect, acid rain and ozone layer depletion, etc. Urban air pollution sources arising from different sources such as traffic, industry, etc. are dominated by population growth and urbanization (Özden et al., 2008). The main urban air pollutants include suflur dioxide (SO_2), nitrogen dioxide (NO_2), carbon dioxide (CO), fine dust particles (PM), total suspended particulates (TSP), and ozone (O_3), volatile organic compounds (VOCs) (Özden et al., 2008; Bhanarkar et al., 2005; Zhang et al., 2016). The dispersion and dilution of air pollutants are strongly influenced by meteorological conditions, especially wind speed, wind direction, temperature, humidity and barometric pressure (Bridgman et al., 2002; Santacatalina et al., 2011; Luvsan et al., 2012).

Can Tho is a city directly under the central government of Vietnam, the most modern and developed city in the Mekong Delta. In addition, Can Tho is currently a grade I city, the economic, cultural, social, health, educational and commercial center of the Mekong Delta region, a central city at regional and national level join with Da Nang and Hai Phong. In the past 10 years (2009-2020), the process of urbanization has taken place rapidly and widely in Can Tho city. The city's economic structure is shifting towards gradually reducing the proportion of agriculture - forestry - fishery, increasing industry - construction and services. With the current growth rate, transportation activities, industries, handicrafts and construction activities are considered as the main sources of air pollution in Can Tho city. According

to Bang et al. (2015), the whole city of Can Tho has about 8 industrial zones/clusters distributed mainly in Cai Rang, O Mon and Ninh Kieu districts and traffic hotspots with large and frequent traffic which are negatively affecting the air quality of Can Tho city. According to Shrivastava et al. (2013), air pollution caused by transportation activities accounts for about 70%. Besides, Chakraborty et al. (2014) also said that the leading cause of air pollution is transportation (51.4%), followed by industry (24.5%). The process of combustion of fuel creates harmful gases that affect the air such as CO_2, CO, SO_2, NOx, Pb, CH_4. This study is to assess the current state of environmental air quality in Can Tho city. The results provide scientific basis for the management as well as the identification of the main sources of pollution in the area.

2. MATERIALS AND METHODS

2.1 Site Description

Can Tho city has a central geographical position in the Mekong Delta, is the main exchange gateway of the Southwest region of Hau River with the Long Xuyen Quadrangle and the southern key region between a network of rivers, interlaced canals, 75km from the East Sea, 1,877 km from Hanoi capital and 169 km from Ho Chi Minh City (by road). Geographic coordinates 9055'08" - 10019'38" North latitude; 105013'38" – 105050'35" East longitude with contiguous position. Total area of Can Tho city with 140,849.9 ha, accounting for 3.5% of the total area of the whole Mekong Delta region; The city has 09 districts, including 05 city districts (Ninh Kieu, Binh Thuy, Cai Rang, O Mon and Thot Not) and 04 rural districts (Phong Dien, Co Do, Thoi Lai and Vinh Thanh) including 85 communes, wards and town with 644 hamlets. Can Tho has a flat topography that is slightly inclined in all directions: the height from the Northeast is lower to the Southwest and the height from the banks of the Hau River is lower to the inland. Can Tho city is under the influence of tropical monsoon climate, with two distinct seasons including the rainy season (from May to November) and the dry season (from December to April next year). The average temperature at the roadside points of Can Tho city in 2020 ranges from 26.5-35.80 °C and the average humidity varies between 46.1-85.2%. The highest number of sunshine hours is near the end of the dry season. The highest rainfall falls in September, October and the lowest in March.

2.2 Air Sampling and Analysis

Data on the air environment used in the study were collected from the Department of Natural Resources and Environment of Can Tho City. Assessment of air quality in Can Tho City in 2020 through 15 monitoring locations representing areas with high traffic density and relatively large industrial scale (KK01-KK15) (Table 1). Specifically, including 04 traffic hotspots: Nguyen Van Linh intersection - 3/2 street, Luu Huu Phuoc intersection - Hoa Binh Boulevard, Vo Van Kiet - Nguyen Van Cu intersection, Highway 1 – Can Tho bridge intersection; 02 environmental monitoring points in the inner city: Le Hong Phong street in front of the entrance to Binh Thuy district administrative area, O Mon district People's Committee; 04 industrial park monitoring positions: Tra Noc 1 and 2 Industrial Park, Hung Phu Industrial Park and Thot Not Industrial Park; 05 locations for monitoring the air environment in the suburbs: Thot Not District People's Committee, the intersection of the Administrative Area - Phong Dien Market, the market center of Thoi Lai town; People's Committee of Co Do district and the junction of National Highway 80 - provincial road 922, Vinh Thanh district. Monitoring the composition of the air environment with a frequency of 04 times/year, corresponding to the dry season (March, December) and the rainy season (May, September). In each monitoring period, samples were collected with 3 repetitions. The air and meteorological factors used in the study included noise, total suspended particulates (TSP), suflur dioxide (SO_2) and nitrogen dioxide (NO_2), wind direction, temperature, humidity and wind speed. The criteria of meteorological factors and noise are measured directly at the field with standard methods by corresponding measuring devices (Table 2). The remaining parameters such as TSP, SO_2 and NO_2 were analyzed in the laboratory of Can Tho City Environmental and Natural Resources Monitoring Center by standard methods (Table 2).

2.3 Data Analysis

Data of air environment were statistically processed by IBM SPSS 20.0 Windows software to determine Mean ± std, Max, Min values, comparing statistically significant differences ($p<0.05$) between locations and time of monitoring (dry season, rainy season). Values of air environment monitoring indicators in Can Tho city in 2020 are compared with the national technical regulation on ambient air quality – QCVN 05:2013/BTNMT and the national technical regulation on language noise (from 6 a.m. to 9 p.m.) – QCVN 26:2010/BTNMT (Table 2). Cluster analysis is a classification method used to divide data into classes or clusters. In which, subjects with similar air characteristics are in the same group, different objects are located in different clusters (Lu et al., 2011; Pires et al., 2008; Saksena et al., 2003). Cluster analysis in the study uses the average value of the air parameters values in 4 monitoring periods at each location to group air quality by observation space. At the same time, the average value of environmental air parameters at each monitoring time (March, May, September, December) is also used to analyze the air quality cluster according to the monitoring time. The classification of objects was represented by a dendrogram. Objects with smaller distances will be classified into a similarity group by Ward method and Euclidean distance. Cluster analysis (CA) using Primer 5.2 software for Windows (PRIMER-E Ltd, Plymouth, UK).

Table 1. Can Tho City's Air Environment Monitoring Locations

No.	Site	Code	Coordinates X	Coordinates Y	Brief Description
1	Nguyen Van Linh intersection - 3/2 Street	KK01	583123	1107986	Impact from traffic activities
2	The intersection of Luu Huu Phuoc - Hoa Binh Boulevard	KK02	585624	1108981	Impact from traffic activities
3	Vo Van Kiet - Nguyen Van Cu intersection	KK03	583846	1110357	Impact from traffic activities
4	Le Hong Phong Street in front of the entrance to Binh Thuy District Administrative Area	KK04	578877	1110649	Impact from traffic activities
5	Tra Noc Industrial Park 1	KK05	577292	1117654	Impacts from industrial activities, transport
6	Highway 1 junction - Can Tho Bridge	KK06	582666	1105618	Impact from traffic activities
7	Hung Phu Industrial Park	KK07	586960	1106187	Impacts from industrial activities, transport
8	O Mon District People's Committee	KK08	568245	1117538	Impact from traffic activities
9	Tra Noc Industrial Park 2	KK09	576059	1118546	Impacts from industrial activities, traffic
10	People's Committee of Thot Not District	KK10	557949	1135937	Impact from traffic activities
11	Thot Not Industrial Park	KK11	553246	1141021	Impacts from industrial activities, transport
12	The intersection of Administrative Area - Phong Dien Market	KK12	572485	1105667	Impact from traffic activities
13	hoi Lai town market center	KK13	562448	1113684	Impact from traffic activities
14	Co Do District People's Committee	KK14	547156	1116105	Impact from traffic activities
15	Highway 80 junction - provincial road 922	KK15	543400	1130102	Impact from traffic activities

3. RESULTS AND DISCUSSION

3.1 Air Quality in Can Tho city in 2020

3.1.1 Wind Direction and Wind Speed

Wind is a particularly important factor in diffusing particulates and chemical vapors in the air. According to Zhang et al. (2015), the wind plays a role in transporting pollutants, the wind determines which direction the pollutant will move, making the concentration of pollutants in the upwind location higher than in the downwind position. Through the monitoring process, the main wind direction in Can Tho city is the Southeast wind (SE) mainly in March and the Southwest wind (NW) in May, September, and December. The results showed that the wind speed of Can Tho city in 2020 fluctuates from 0-1.80 m/s with the average value in four monitoring periods ranging from 0.28±0.26-0.83±0.59 m/s, respectively the lowest at position KK09 and highest at position KK03. Through statistical analysis, the wind speed changes according to the observed locations with four groups of different locations with statistical significance ($p<0.05$) (Table 3). Wind speed variation over time (dry season, rainy season) is statistically significant ($p<0.05$) with wind speed in dry season lower than in rainy season 0.40±0.41 m/s and 0.56±0.33 m/s, respectively (Table 4). According to Turalıoğlu et al. (2005), wind speed is inversely proportional to the concentration of air pollutants, when the wind speed is higher, the air pollutants will be diluted by dispersion. Another study by Verma and Desai (2008) also suggested that wind speed is the main factor governing the dispersion of pollutants in the air, when the wind speed is high, the dispersion of pollutants in the air. The air pollution is also large and when the wind speed is lower, the dispersion of air pollutants is also less.

Table 2. Methods of Measurement and Allowable Limits of Air Quality Parameters

No.	Parameters	Analytical Methods	Limit Values	
			QCVN 05:2013/BTBNMT	QCVN 26:2010/BTNMT
1	Temp	QCVN 46:2012/BTNMT	-	-
2	Humidity		-	-
3	Wind speed		-	-
4	Noise	TCVN 7878-2:2010	-	70 dBA
5	TSP	TCVN 5067:1995	300 $\mu g/m^3$	-
6	SO_2	TCVN 5971:1995	350 $\mu g/m^3$	-
7	NO_2	TCVN 6137:2009	200 $\mu g/m^3$	-

3.1.2 Temperature

Temperature of Can Tho city in 2020 ranges from 26.50-35.80 °C with the average value in four monitoring periods did not much change from 30.13±2.12-31.70±2.48 °C, corresponding to the lowest temperature at KK03 and the highest at KK01. Spatial temperature variation in Can Tho city in 2020 was not statistically significant ($p>0.05$) (Table 3). According to Table 4, the environmental temperature in Can Tho city has a difference between the time of monitoring in the dry and rainy seasons ($p<0.05$). In the dry season, the temperature is about 31.60±2.45 °C, higher than that in the rainy season 30.17±2.03 °C. In the dry season, the sun is hot, the number of hours of sunshine is more, the air temperature is higher than the rainy season. According to Verma and Desai (2008) reported that the difference in pollutant concentration between monitoring stations has the contribution of temperature conditions, high temperature and increased pollutant concentration. According to Akpinar et al. (2008) found that there was the correlation between temperature and SO_2 and TSP concentrations, temperature also affects the concentration of air pollutants but it is not the main parameter affecting the diffusion of pollutants.

3.1.3 Humidity

In conditions of high humidity, particulate matters will stick together into large particles and fall quickly to the ground. However, microorganisms in the air grow rapidly, following dust particles that diffuse widely downwind. The results showed that the air humidity in Can Tho city in 2020 fluctuates relatively large from 46.10 to 85.60% with the average values in four monitoring periods was 64.16±9.13-78.95±3.88%, the lowest and the highest were at KK14 and KK06, respectively. Spatial humidity evolution in Can Tho city formed three groups of locations with statistically significant differences in humidity ($p<0.05$) (Table 4). Air humidity evolution over time (Table 4), the dry season air humidity (67.93±9.09%) was lower than that in the rainy season (71.18±8.01%). In the rainy season, the temperature is low, the rainfall is high, the humidity is high. According to Akpinar et al. (2008) humidity is directly proportional to the pollutant concentration, the higher the humidity, the higher the air pollutants. Another study on the effect of humidity on dust concentration in Baghdad city also showed that air humidity is positively correlated with pollutant concentration (Al-Taai and Al-Ghabban, 2016). Conversely, humidity is also thought to be negatively correlated with pollutant concentrations because it controls the absorption of pollutants (Kartal and Özer, 1998).

3.1.4 Noise

Noise in the study area of Can Tho city in 2020 ranges from 64.80-82.90 dBA with an average of four monitoring periods at about 68.73±2.48-79.54±1.95 dBA, respectively. The lowest at KK09 and the highest at KK01 and KK01 - Nguyen Van Linh intersection with 3/2 street were having many moving vehicles. There were 08/15 monitoring locations with noise exceeding the permissible limit of QCVN 26:2010/BTNMT, 1.00-1.14 times. Noise was divided into 7 groups of locations where it has been fouud statistical significance ($p<0.05$) (Table 3). Noise in dry season was 72.13± 3.87 dBA while it was 71.05±3.67 dBA in rainy season (Table 4). Noise in Can Tho city in 2020 by seasons is not statistically significant ($p>0.05$). Former study in Lao Cai province also reported that noise generated by means of transport at peak hours or vehicles ranged from 66.04 to 74.63 dBA (Hung et al., 2018). Hoa et al. (2020) revealed that noise is the main cause of air pollution in Son La city at the junctions and intersections of main roads, bus stations, market gates, hospital gate or where large construction activities take place. Duyen et al. (2014) showed that noise in the urban and production areas is much higher than that in the rural mountainous area.

3.1.5 Total Suspended Particulates

TSP concentration in the study area of Can Tho city in 2020 fluctuates in the range of 93.30-293.20 $\mu g/m^3$ with the average ranging from 171.99±44.86-265.81±18.75 $\mu g/m^3$. TSP was the lowest at site KK15 (the suburban area of Can Tho City where being less affected by means of transport and industrial and handicraft production activities than other locations) and the highest at KK01 (the intersection Nguyen Van Linh with 3/2 Street, the area with the number of vehicles moving frequently). The concen-

Table 3. Mean Values of Air Quality Parameters

Site	Temp (°C)	Humidity (%)	Wind Speed (m/s)	Noise (dBA)	TSP ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)
KK01	31.70±2.48a	66.56±9.55ab	0.43±0.23ab	79.54±1.95g	265.81±18.75g	45.23±5.39f	37.64±5.02f
KK02	30.39±2.66a	73.03±8.03bc	0.76±0.36cd	75.77±2.71f	254.49±25.01g	30.73±4.36d	25.26±3.88cd
KK03	30.13±2.12a	73.07±7.35bc	0.83±0.59d	75.32±1.76f	250.94±28.01fg	29.48±8.98d	24.91±8.34cd
KK04	30.79±2.35a	69.77±5.53ab	0.44±0.25abc	73.07±1.92de	231.78±56.13cdefg	32.89±19.09de	27.66±15.12cd
KK05	31.02±2.50a	65.91±9.00ab	0.36±0.23ab	69.58±1.98ab	245.89±30.79efg	41.66±11.74ef	30.34±9.90cde
KK06	30.46±2.34a	78.95±3.88c	0.68±0.29bcd	73.23±2.21e	216.37±57.80bcdef	28.68±8.88cd	23.53±8.01bc
KK07	30.68±2.26a	67.70±7.21ab	0.55±0.40abcd	69.35±1.78ab	205.03±35.23bc	20.33±6.80abc	16.88±5.91a
KK08	30.53±2.09a	71.41±9.55ab	0.43±0.39abc	71.17±1.95bcd	236.23±37.77cdefg	33.32±13.53de	25.38±9.23cd
KK09	31.10±2.45a	65.44±8.37ab	0.28±0.26a	68.93±3.04a	243.26±32.66defg	40.78±14.95ef	31.62±8.33def
KK10	30.91±2.81a	68.11±9.43ab	0.48±0.32abcd	71.99±1.45cde	255.85±33.72g	34.25±8.25de	27.25±7.16cd
KK11	31.17±2.41a	71.63±7.23ab	0.41±0.29ab	70.33±2.92abc	244.40±28.46defg	43.22±8.61f	34.77±8.37ef
KK12	30.85±2.20a	70.32±8.22ab	0.42±0.41abc	68.76±1.46a	189.65±38.91ab	17.34±5.57ab	11.78±1.87a
KK13	31.07±2.35a	65.48±10.19ab	0.33±0.30a	69.36±2.30ab	209.84±38.57bcd	16.41±4.65a	13.06±2.24a
KK14	31.58±2.60a	64.16±9.13a	0.46±0.36abcd	68.76±2.89a	214.94±46.46bcde	25.34±13.20bcd	17.79±8.24ab
KK15	30.89±2.51a	71.81±7.06ab	0.43±0.54abc	68.73±2.48a	171.99±44.86a	15.01±2.14a	12.44±1.77a
Min	30.13±2.12	64.16±9.13	0.28±0.26	68.73±2.48	171.99±44.86	15.01±2.14	11.78±1.87
Max	31.70±2.48	78.95±3.88	0.83±0.59	79.54±1.95	265.81±18.75	45.23±5.39	37.64±5.02
QCVN	-	-	-	70 dBA	300 $\mu g/m^3$	350 $\mu g/m^3$	200 $\mu g/m^3$

tration of TSP is spatially fluctuated by forming 7 groups of different positions the values of TSP statistically significantly different ($p<0.05$) (Table 3). TSP concentration between the dry season (229.64±44.94 $\mu g/m^3$) and the rainy season (228.56±45.46 $\mu g/m^3$) was not statistically significant ($p>0.05$) (Table 4). In Tien Yen district, Quang Ninh province, TSP concentration of 62-282 $\mu g/m^3$ is generally lower than that in the present study. Duyen et al. (2014) pointed out the particulates matters in the rural area is relatively low ranges from 62-125 $\mu g/m^3$, while it was high in the crowded production activities and vehicles (105-282 $\mu g/m^3$). In summary, the concentration of TSP in the study area of Can Tho city in 2020 is still within the allowable limit QCVN 05:2013/BTNMT.

3.1.6 Sulfur Dioxide

The SO_2 concentration in the study area of Can Tho city in 2020 varied from 11.20 to 65.50 $\mu g/m^3$, the average SO_2 concentration in four monitoring periods ranged from 15.01±2.14-45.23±5.39 $\mu g/m^3$. As showed in Table 3, SO_2 concentration fluctuates according to the observation space with 6 groups of different positions with statistical significance ($p<0.05$). The SO_2 concentration between the dry season and the rainy season was significantly different ($p<0.05$) with the dry season SO_2 concentration (33.90±14.60 $\mu g/m^3$) was higher than the rainy season (26.72±11.71 $\mu g/m^3$) (Table 4). The main source of SO_2 emissions comes from the combustion of all sulfur-containing fuels such as oil and diesel (Chen et al., 2016; Wakamatsu et al., 2013). Bhanarkar et al. (2005) indicated that SO_2 emissions from industrial sources account for about 77% of the total emissions. The daily SO_2 concentration in urban and industrial areas of Mongolia in the period 1996-2009 was from 27.30±24.70 to 37.33±35.42 $\mu g/m^3$ (Luvsan et al., 2012). In the southwestern region of Chengdu, China, SO_2 emissions are mainly from industries and thermal power plants with an average daily value of 5-61 $\mu g/m^3$. SO_2 could be decreased due to the fuel conversion process from coal to natural gas and restrictions on the construction of houses cement machinery, ceramics and glassware factories (Xiao et al., 2018). In this study, SO_2 concentration in the study area of Can Tho City in 2020 is still within the allowable limit QCVN 05:2013/BTNMT.

3.1.7 Nitrogen Dioxide

NO_2 concentration in the study area of Can Tho city in 2020 fluctuated between 9.50-52.70 $\mu g/m^3$ and the mean NO_2 concentration in four monitoring periods ranging from 11.78±1.87 to 37.64±5.02 $\mu g/m^3$. CA results showed that the NO_2 concentration in the study area formed 6 groups of different locations with statistical significance ($p<0.05$) (Table 3). NO_2 concentration in the dry season (25.62±11.54 $\mu g/m^3$) is higher than that in the rainy season (22.42±9.79 $\mu g/m^3$). NO_2 emitted from fuel combustion, gasoline and diesel-powered vehicles, and industrial boilers (Wakamatsu et al., 2013). In the Kuwait region, the source of NO_2 emissions related to traffic activities contributes approximately 25% of the total pollution, the increase in the number of motor vehicles has caused the increase of NO_2 in the region. Industrial activities, power plants also contribute to the trend of increasing NO_2 concentration (Al-Anzi et al., 2016). In the large city, for example Hangzhou area, China, NO_2 concentration was found to be much higher (118.5±39.3 $\mu g/m^3$) than that found in the current study area (Yu et al., 2014). In short, NO_2 concentration in the study area of Can Tho city is still within the allowable limit QCVN 05:2013/BTNMT.

3.2 Spatial and Temporal Clustering Air Quality in Can Tho city

The results of spatial cluster analysis in Figure 1 showed that air quality in Can Tho city was clustered into four groups. Group I include 2 monitoring locations in suburban areas (KK12 – Intersection of the Administrative Area with Phong Dien Market, KK15 – Intersection of National Highway 80 with Provincial Road 922) with the lowest air pollutants in the 4 groups (Table 5). Group II include many locations with the most similar air quality with 7 locations (KK01 - Nguyen Van Linh intersection with 3/2 street, KK04 - Le Hong Phong street in front of the entrance to Binh Thuy district administrative area, KK05 - Tra Noc 1 Industrial Zone, KK08 – O Mon District People's Committee, KK09

Table 4. Seasonal Variation of Air Quality Parameters

Parameters	Unit	Season		QCVN
		Dry	Wet	
Temperature	°C	31.60±2.45a	30.17±2.03b	-
Humidity	%	67.93±9.09a	71.18±8.01b	-
Wind speed	m/s	0.40±0.41a	0.56±0.33b	-
Noise	dBA	72.13±3.87a	71.05±3.67a	70
TSP	$\mu g/m^3$	229.64±44.94a	228.56±45.46a	300
SO_2	$\mu g/m^3$	33.90±14.60a	26.72±11.71b	350
NO_2	$\mu g/m^3$	25.62±11.54a	22.42±9.79a	200

Table 5. The Mean Values of The Identified Clusters

Parameter	Spatial				Seasonal			QCVN
	Group I	Group II	Group III	Group IV	Group I	Group II	Group III	
Temp.	30.87	31.03	31.11	30.33	32.3	30.9	29.85	-
Humidity	71.06	68.4	65.78	75.01	65.4	70.47	70.39	-
Wind speed	0.42	0.4	0.44	0.76	0.29	0.52	0.56	-
Noise	68.75	72.09	69.16	74.77	72.41	71.85	70.28	70
TSP	180.82	246.17	209.94	240.6	239.5	219.78	226.06	300
SO_2	16.18	38.76	20.69	29.63	39.07	28.74	26.42	350
NO_2	12.11	30.67	15.91	24.57	29.05	22.19	22.17	200

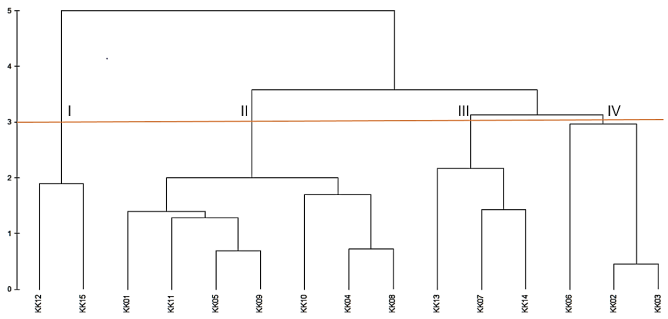

Figure 1. Spatial Clustering Air Quality in Can Tho city

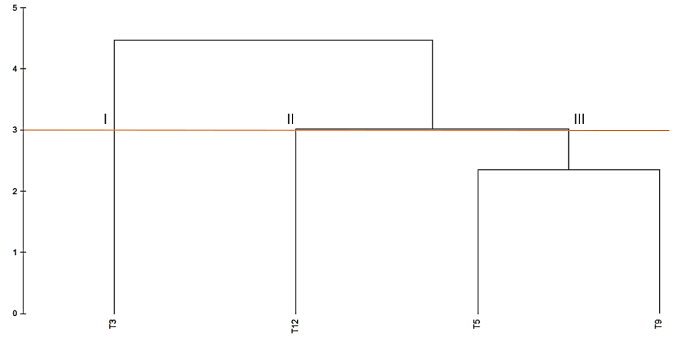

Figure 2. Temporal Clustering Air Quality in Can Tho city

– Tra Noc 2 Industrial Park, KK10 – Thot Not District People's Committee, KK11 – Thot Not Industrial Park), these are locations with many means of transportation, including traffic routes. Due to the locations in the industrial zone, most of the air pollutants in group II are highest among all groups (Table 5). Group III include 3 locations (KK07 – Hung Phu Industrial Park, KK13 – Thoi Lai Town Center, KK14 – Co Do District People's Committee), the area with the second lowest air environment composition after group I. Group IV includes 3 locations. location (KK02 – intersection of Luu Huu Phuoc with Hoa Binh Boulevard, KK03 – intersection of Vo Van Kiet with Nguyen Van Cu and KK06 – junction of National Highway 1 with Can Tho Bridge, area with relatively high meteorological factors) compared to the rest of the groups and is the area affected by vehicle noise (Table 5). In general, air pollutants are affected by the size, number of vehicles and production. industrial and handicraft production in the area.

Figure 2 presented the results of cluster analysis of air quality over time of observation periods. The air quality formed three groups. Group I (March), monitoring time at the end of the dry season, the highest temperature resulted in the lowest air humidity in the 3 groups and the highest air pollutants in all groups (Table 5). Group II (December), the monitoring time is at the beginning of the dry season, the temperature is somewhat lower than the last month of the dry season, due to the influence of late-season rains and a decrease in pollutants compared to March which is still higher than that in the rainy season (Table 5). Group II

include the months in the middle of the rainy season (May, September), high rainfall makes the ambient temperature lower than the dry season months, the humidity is high, the pollutants are somewhat lower than the other groups (Table 5).

4. CONCLUSIONS

The results showed that the area of Can Tho city is influenced by two wind directions, Southwest and Southeast, with wind speeds ranging from 0.28±0.26 to 0.83±0.59 m/s. The temperature in Can Tho city ranged from 30.13±2.12 to 31.70±2.48 °C and the humidity ranged from 64.16±9.13-78.95±3.88%. In general, most of the meteorological factors in the rainy season had higher values than in the dry season, except that the temperature in the dry season is higher than in the rainy season. The air pollutants in Can Tho city in 2020 including TSP, SO_2 and NO_2 were still within the allowable limits of QCVN 05:2013/BTNMT. Noise in some locations exceeded the allowable limit of QCVN 26:2010/BTNMT. The causes of noise pollution as well as some locations with high air pollutant content are concentrated at intersections, main traffic routes with many motor vehicles moving as well as industrial parks. The results of spatial cluster analysis showed that air quality in Can Tho city formed four groups mainly affected by traffic activities, industrial production. Cluster analysis also revealed that air quality is seasonally changed, particularly for temperature and humidity. Air monitoring should also focus on toxic air pollutants in future monitoring.

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