

THE STATUS OF PM_{2.5} IN VIETNAM IN 2021

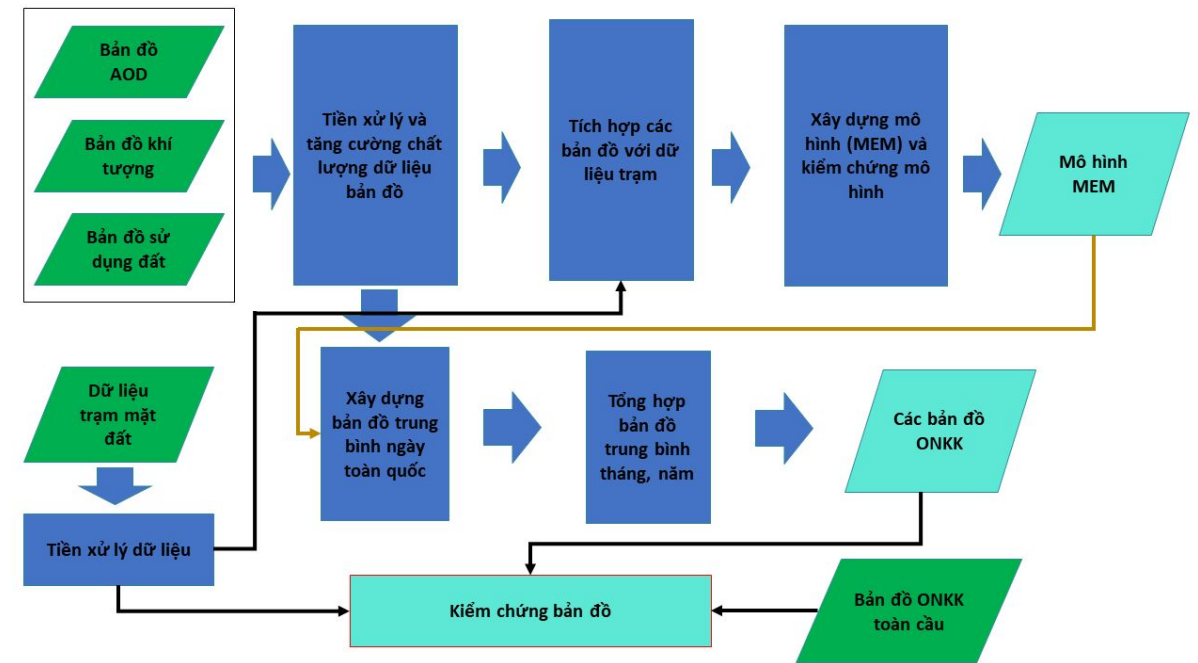
Project “Improving air pollution monitoring and management of Vietnam with satellite PM_{2.5} observation”

CONTENT

- Data
- Method
- The status of $\text{PM}_{2.5}$ in Vietnam in 2021
 - Nationwide
 - Northern region, Central region, Southern region
 - Hanoi, Bac Ninh, Thai Binh, Nghe An, Ho Chi Minh city

Data

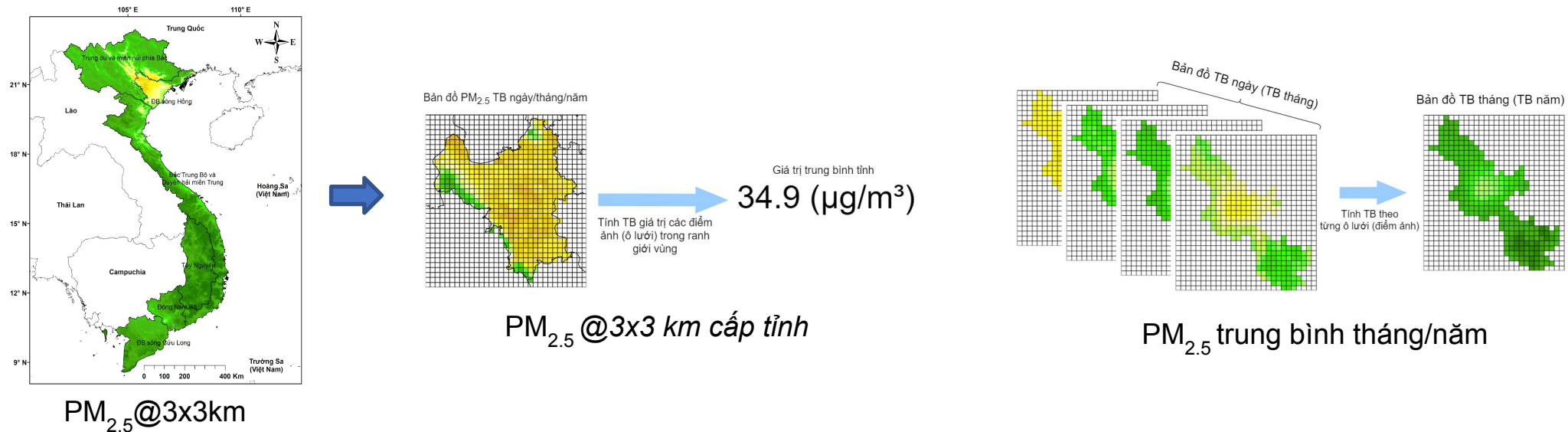
- $PM_{2.5}$ distribution maps calculated from observation station data, satellite images, meteorological data and land use data with the Mixed Effect Model, available to 2021.
- The $PM_{2.5}$ maps are available in a daily frequency and have a spatial resolution of 3kmx3km, covering the entirety of Vietnam



Phương pháp xây dựng bản đồ nồng độ bụi $PM_{2.5}$ trên Việt Nam

Methods

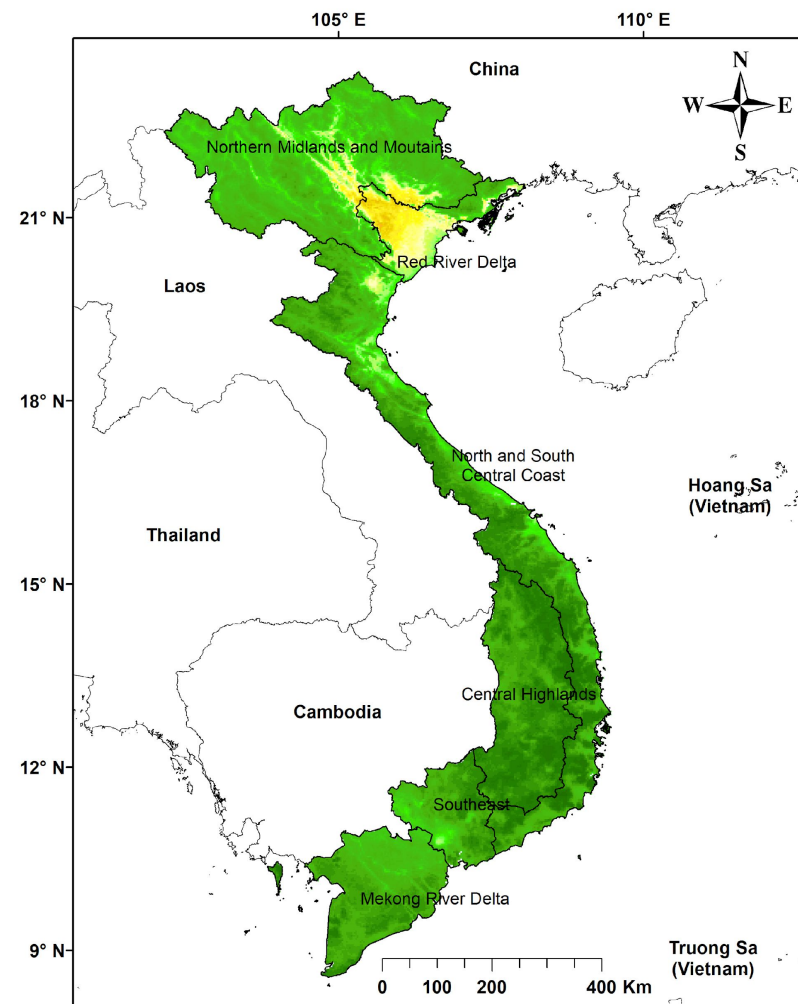
- PM_{2.5} concentration maps were aggregated and analyzed according to multiple spatial levels (national, region, province/city, district) and temporal levels (annual, monthly, daily)..



- The PM_{2.5} maps were combined with the urban area classification map to analyze the Status of PM_{2.5} in urban areas.
- The daily PM_{2.5} maps of Hanoi and Ho Chi Minh city during the social distancing period due to COVID-19 were analyzed to assess the possible effects of social distancing on the levels of PM_{2.5} in those cities.

The Status of PM_{2.5} nationwide

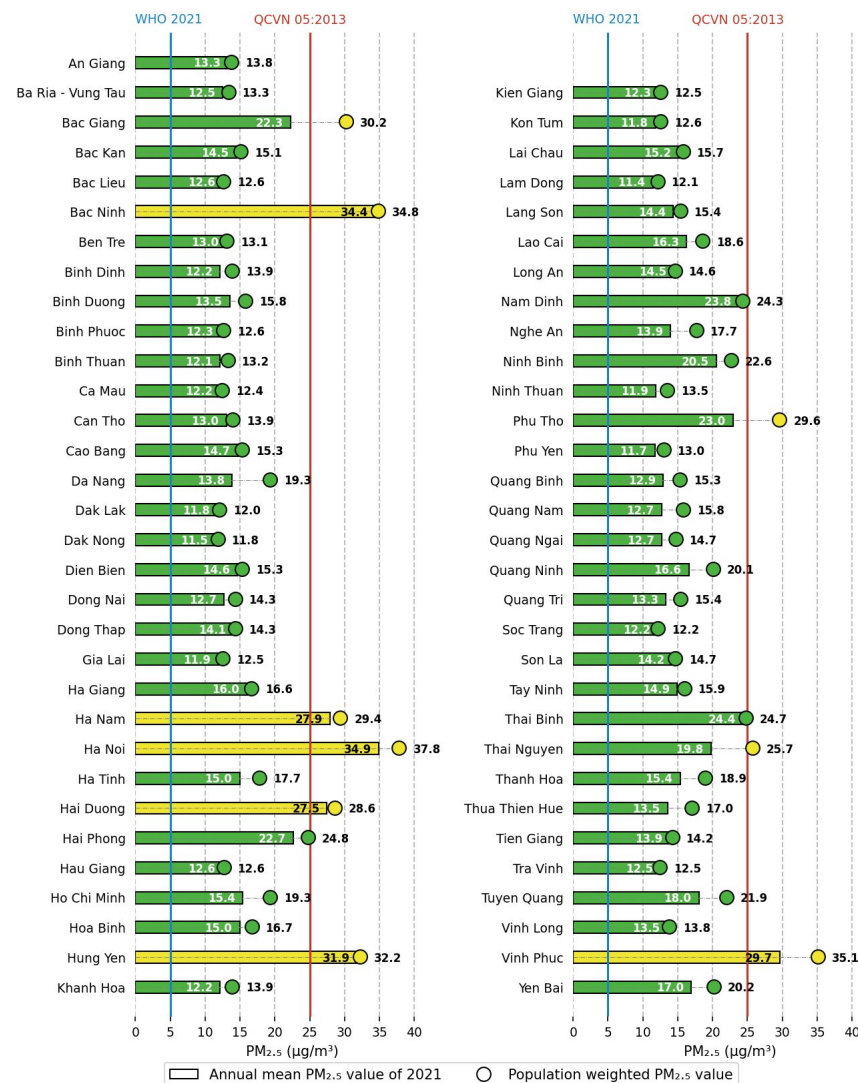
- PM_{2.5} concentration were higher in the North and lower in the South .
- Regions with high levels of PM_{2.5} were located in the Red River Delta.
- Compared to the data of 2020, annual mean PM_{2.5} concentration of 2021 showed an increase from 1,1% to 5,2% in most provinces while a small number of provinces exhibited a decrease in the 1% range, including Long An, Tien Giang, Can Tho, Bac Lieu, Ca Mau and Soc Trang.
- Compared to the data of 2019, annual mean PM_{2.5} concentration of 2021 were lower. The province with the lowest decrease in annual PM_{2.5} concentration in 2021 was Lai Chau (5.8%) and while the highest decrease was in Phu Yen province (10.4 %).



Annual mean of PM_{2.5} concentration in 2021

Annual mean PM_{2.5} per province in 2021

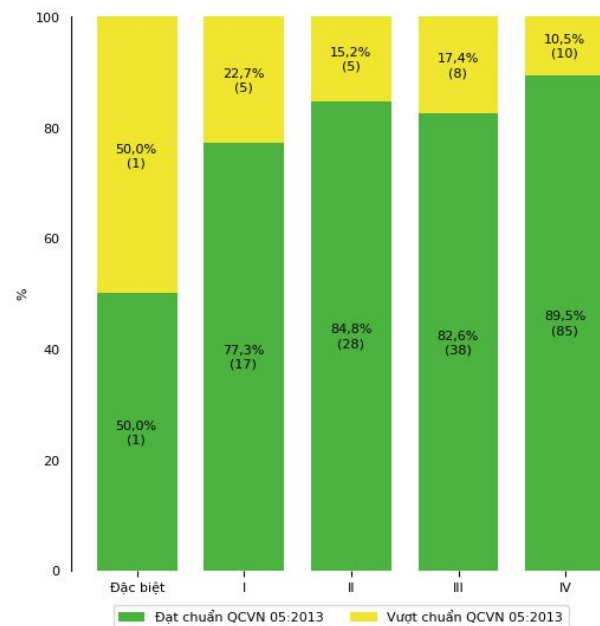
- 6 out of 63 provinces and cities exceeded the national standard QCVN 05:2013/BTNMT. This number is similar to that of 2020 and lower than that of 2019 (10 out of 63).
- In each province, it is observed that the levels of exposure to PM_{2.5} per person (population weighted PM_{2.5}) were higher than the average PM_{2.5} levels of that province.
- Provinces with high PM_{2.5} exposure include Bac Giang, Bac Ninh, Ha Nam, Hanoi, Hai Duong, Hai Phong, Hung Yen, Phu Tho, Thai Binh, Thai Nguyen and Vinh Phuc.



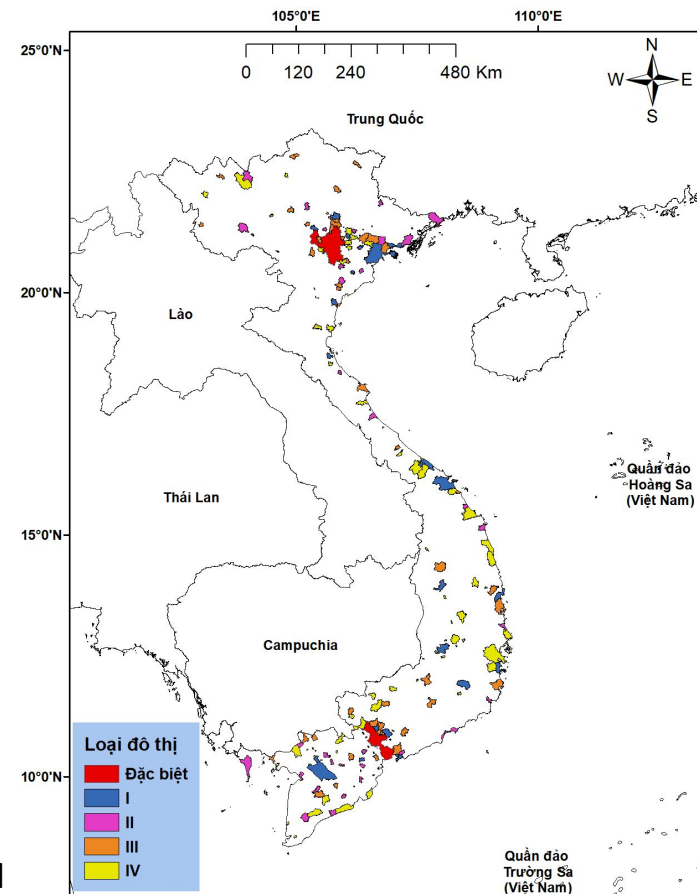
Mean of PM_{2.5} concentration and population-weighted PM_{2.5} concentration by province in 2021

The Status of PM_{2.5} in urban areas

- As of December 2021, Vietnam has 2 cities which are categorized as Special urban areas, Hanoi and Ho Chi Minh city, 22 type I urban areas, 33 type II, 47 type III, 94 type IV and 674 type V areas.
- PM_{2.5} concentration has a tendency to increase as the level of urban development increases.



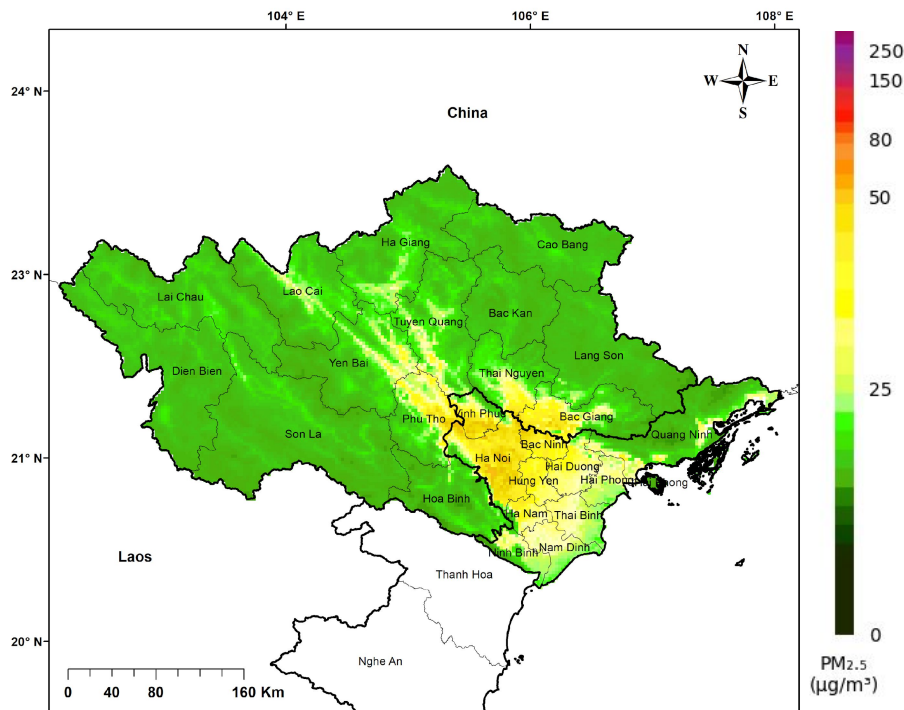
Percentage of urban areas with 2021 averaged PM_{2.5} concentration exceeding QCVN 05:2013/BTNMT



Phân loại đô thị toàn quốc trong giai đoạn năm 2021-2023 (QĐ 241/QĐ-TTG)

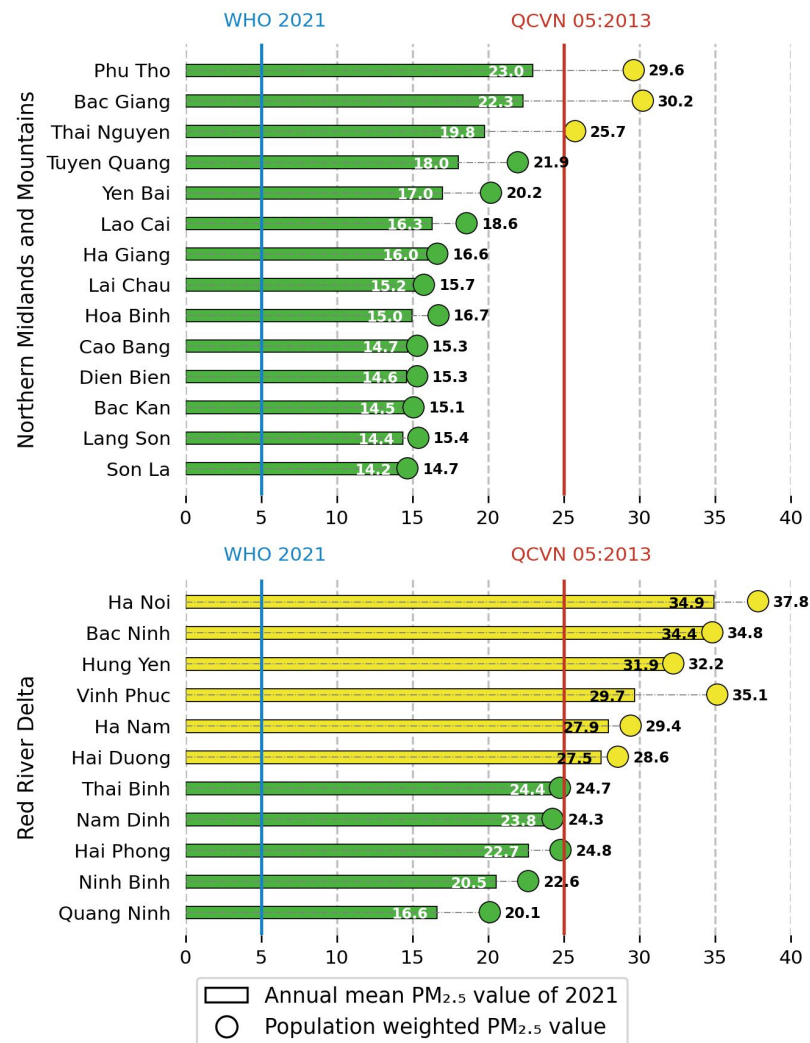
The Status of PM_{2.5} in the Northern region

- The North region consists of 25 provinces and cities, divided into 2 socio-economic regions: Northern Midlands and Mountains (14 provinces) and the Red River Delta (11 provinces).



Annual PM_{2.5} concentrations in 2021 in the Northern region

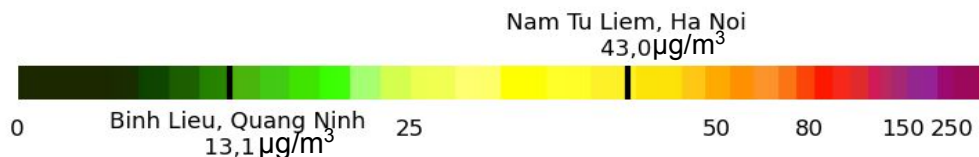
Annual PM_{2.5} concentration in 2021 at provincial level in the North, compared to population-weighted PM_{2.5} concentration



The Status of PM_{2.5} in the Northern region



76% of the provinces/cities in the North met the Vietnam standards (QCVN 05:2013/BTNMT)



Value range of annual mean PM_{2.5} concentration in the Northern districts

The most and least polluted districts in the North in 2021 based on the annual mean PM_{2.5} concentration

Province/ city	District	Province/ city	District
Ha Noi	Nam Tu Liem	Quang Ninh	Binh Lieu
Ha Noi	Thanh Xuan	Son La	Sop Cop
Ha Noi	Thanh Oai	Lang Son	Đinh Lap
Ha Noi	Cau Giay	Hoa Binh	Mai Chau
Ha Noi	Ha Đông	Yen Bai	Mu Cang Chai
Vinh Phuc	Vinh Tuong	Son La	Van Ho
Ha Noi	Bac Tu Liem	Yen Bai	Tram Tau
Bac Ninh	Yen Phong	Son La	Moc Chau
Ha Noi	Hoang Mai	Quang Ninh	Ba Che
Ha Noi	Thuong Tin	Son La	Yen Chau

43.0 µg/m³

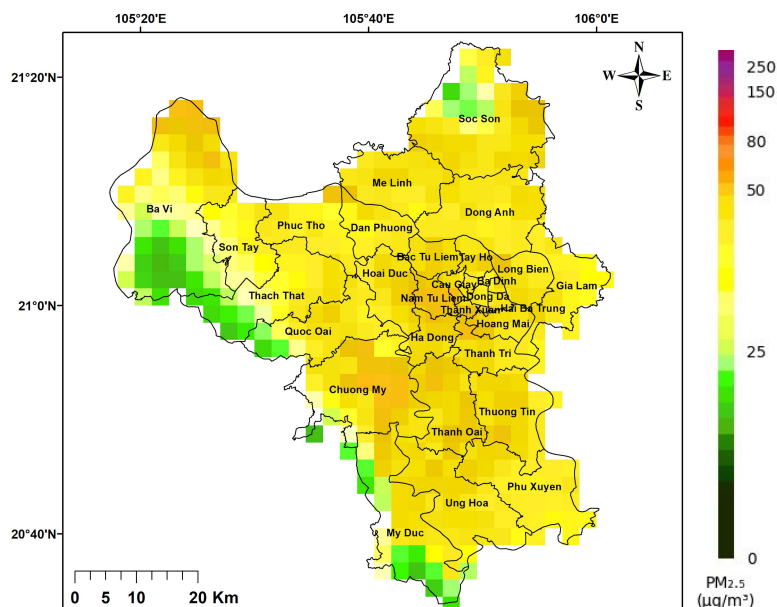
39.0 µg/m³

13.1 µg/m³

13.8 µg/m³

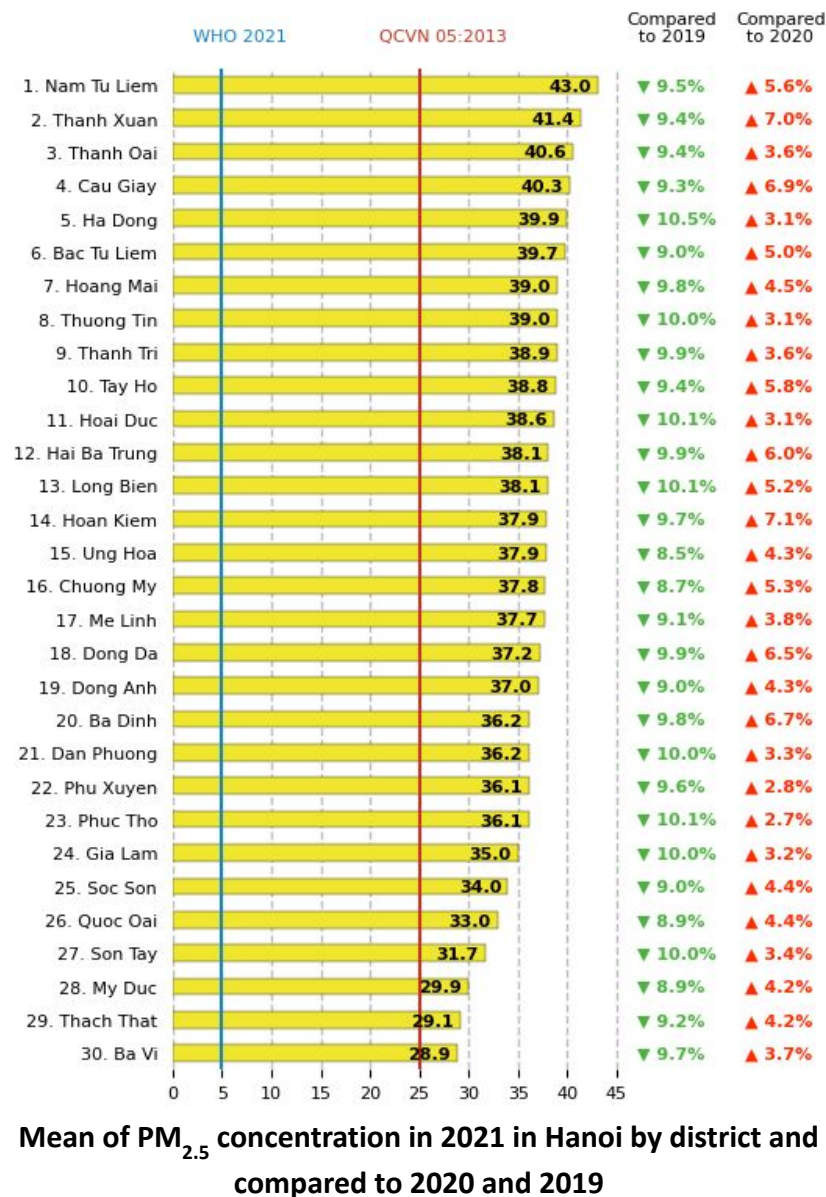
The Status of PM_{2.5} in Hanoi

- PM_{2.5} concentration in Hanoi was shown to be higher in the inner districts than some of the outer counterparts like Soc Son, My Duc, Thach That, Ba Vi.

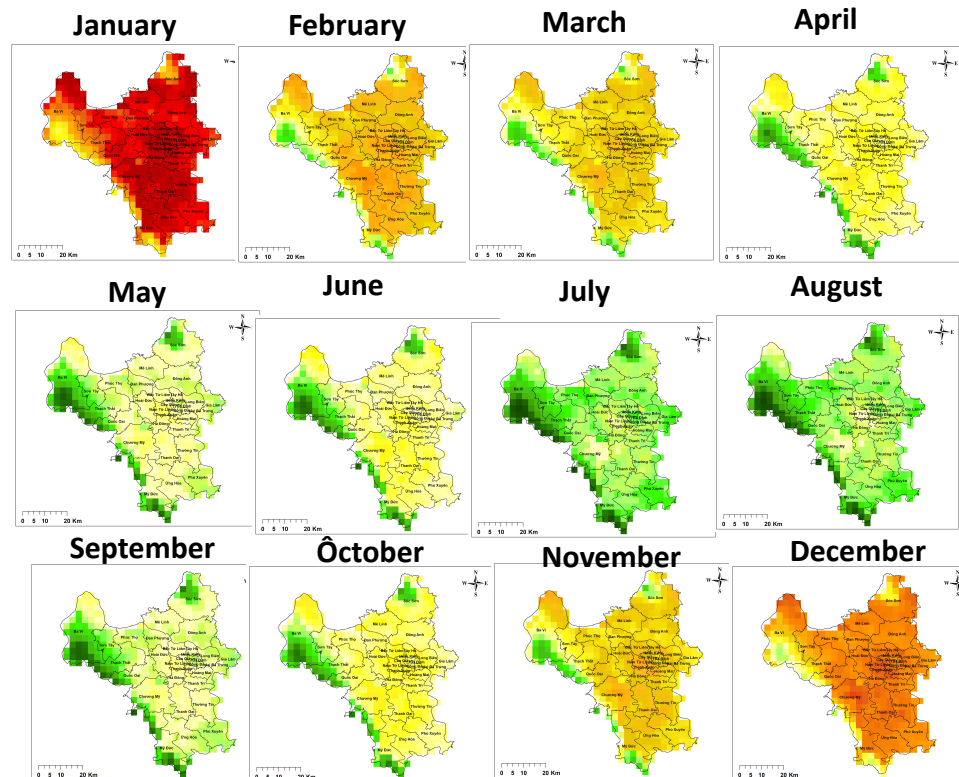


Annual mean PM_{2.5} concentration in 2021 in Hanoi

- In 2021, 100% of the districts in Hanoi had PM_{2.5} concentration exceeding the Vietnam standard (QCVN 05:2013/BTNMT) and the 2021 WHO recommendation.
- The annual mean PM_{2.5} values at district level varied from 28.9 µg/m³ to 43.0 µg/m³, which were 8.9% to 10.5% lower compared to 2019 and 3.1 to 7% higher compared to 2020



The Status of PM_{2.5} in Hanoi

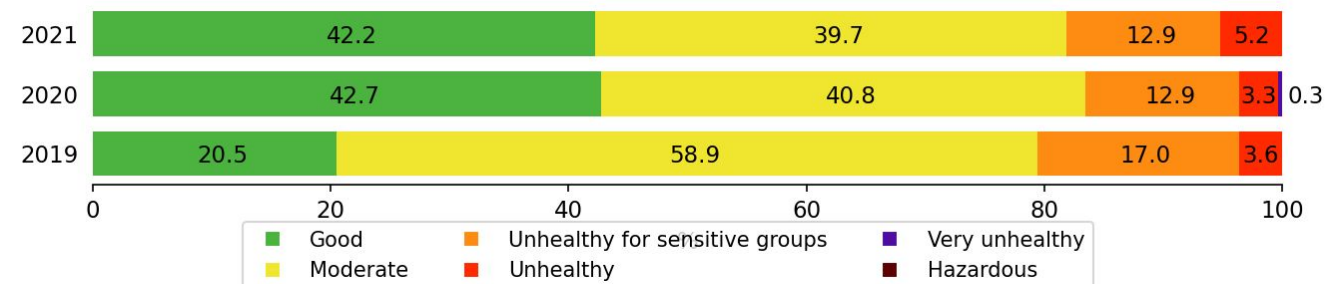


Monthly PM_{2.5} concentration in 2021

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
2021	80.9	41.8	37.1	28.0	23.2	25.6	19.5	19.7	22.5	27.2	37.6	55.9	34.9
2020	44.1	53.9	37.5	35.1	26.0	23.5	22.1	17.8	22.3	25.7	43.1	51.8	33.6
2019	50.2	35.9	40.3	31.7	32.1	24.2	22.5	28.6	40.6	41.2	54.8	60.2	38.5

Good
Moderate
Unhealthy for sensitive groups
Unhealthy
Very unhealthy
Hazardous

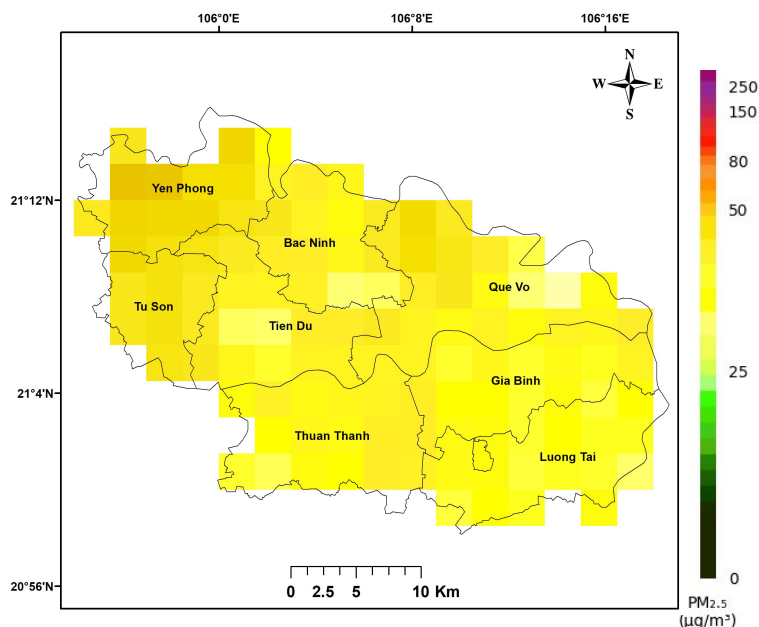
Monthly mean of PM_{2.5} concentration in Hanoi



Percentage of days at different levels of air quality in Hanoi

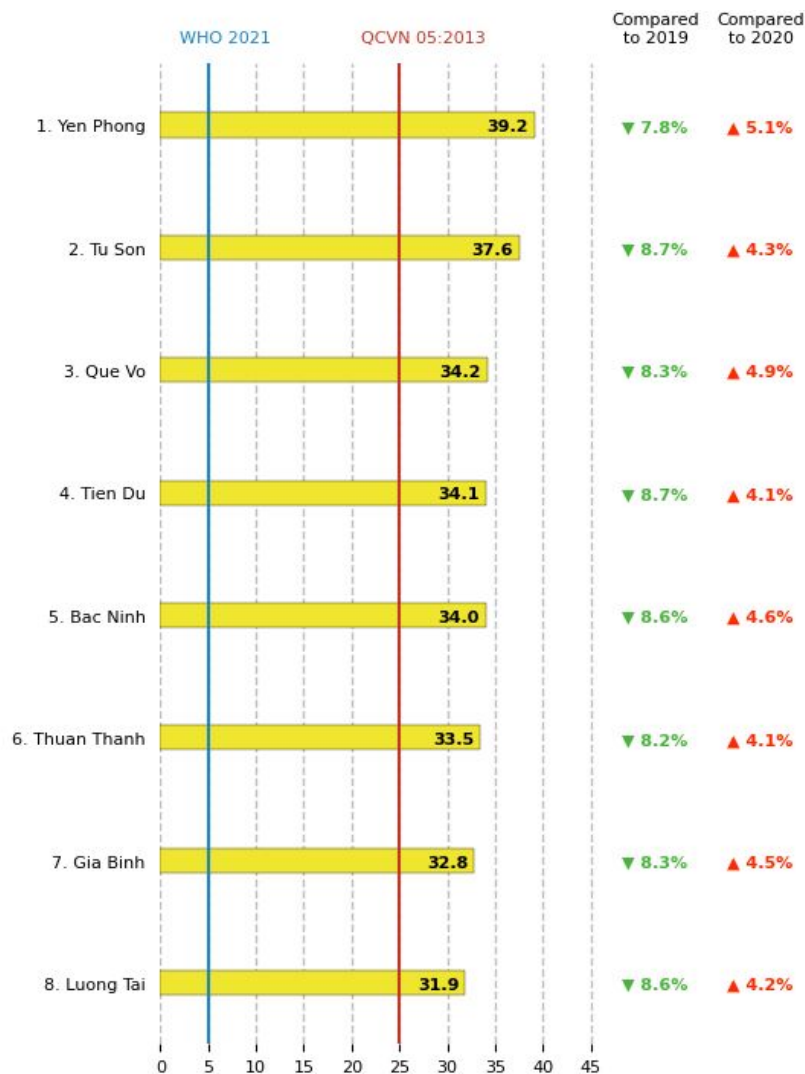
The Status of PM_{2.5} in Bac Ninh

- PM_{2.5} distribution in Bac Ninh showed little variation between districts



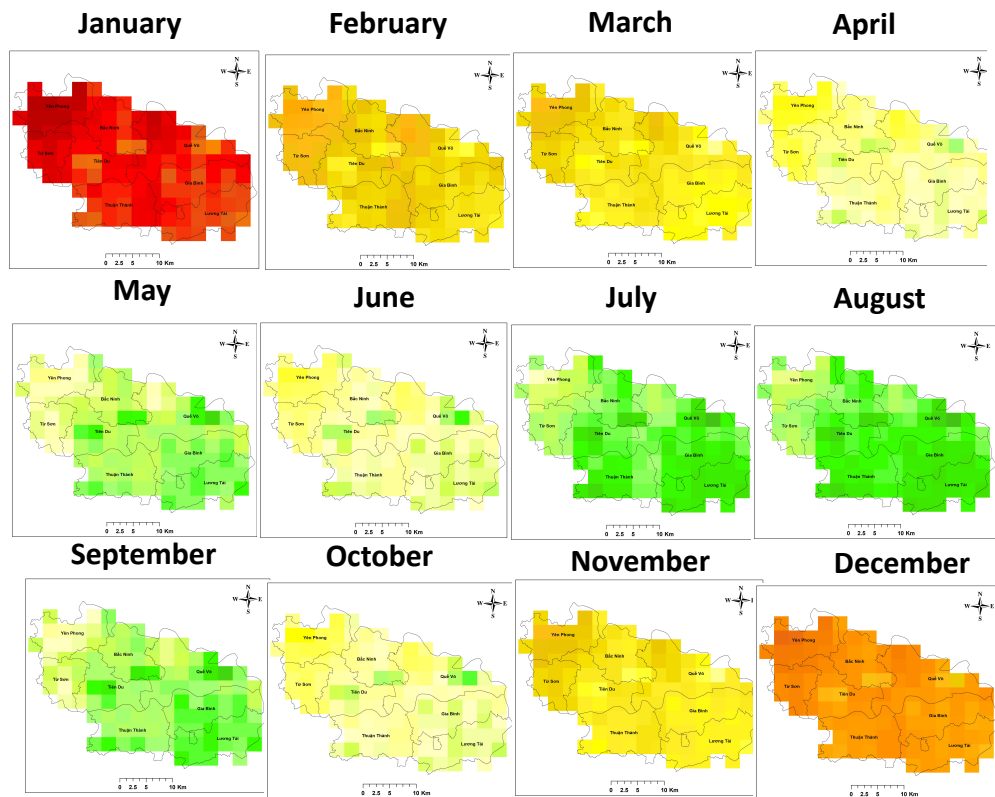
Annual mean PM_{2.5} concentration in 2021 in Bac Ninh

- In 2021, 100% of the districts in Bac Ninh having annual average PM_{2.5} concentrations exceeding the QCVN 05:2013/BTNMT and the 2021 WHO recommendation.
- Annual mean values at district level ranged from 31.9 µg/m³ to 39.2 µg/m³, 7.8% to 8.7% lower than 2019 and 4.1% to 5.1% higher than 2020



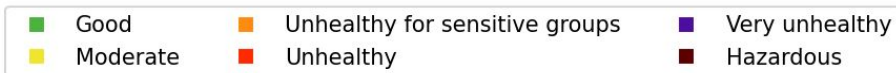
Mean of PM_{2.5} concentration in 2021 in Bac Ninh by district and compared to 2020 and 2019

The Status of PM_{2.5} in Bac Ninh

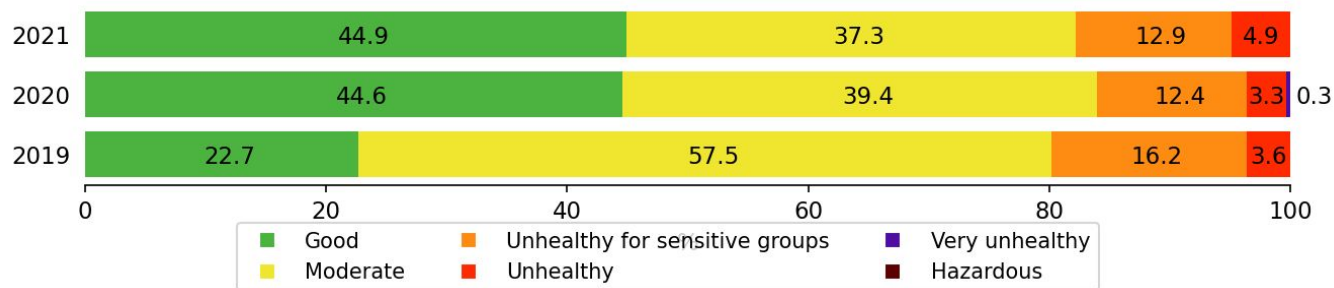


Monthly PM_{2.5} concentration in 2021 in Bac Ninh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
2021	80.9	41.2	36.8	27.2	22.3	25.8	19.8	19.3	21.4	26.3	36.8	55.3	34.4
2020	43.4	53.4	37.4	33.8	24.8	23.0	22.0	17.1	21.0	25.5	42.3	51.5	32.9
2019	49.2	36.1	39.7	30.9	31.2	23.8	21.6	27.5	38.0	40.1	53.7	58.9	37.6



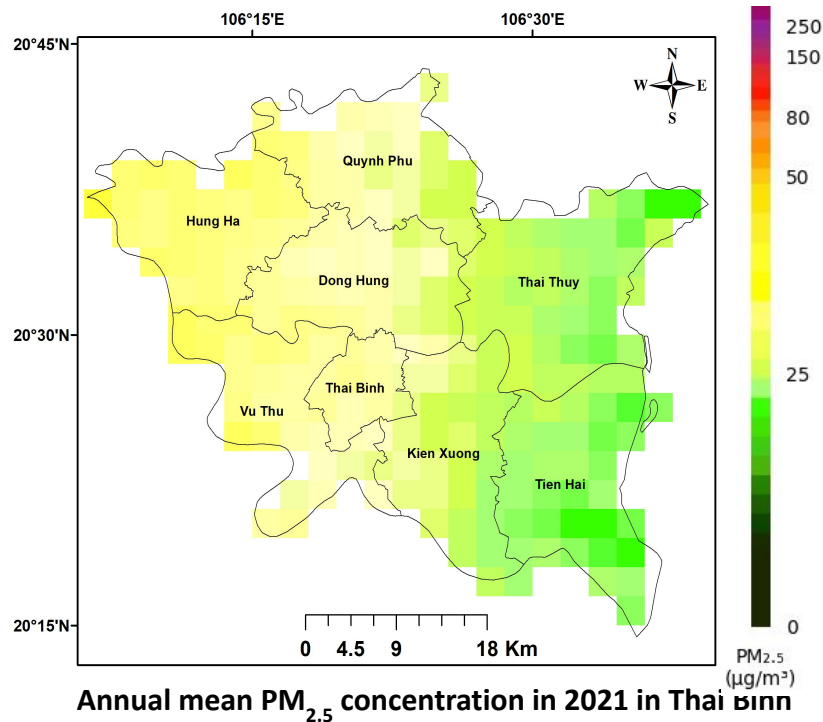
Monthly mean of PM_{2.5} concentration in Bac Ninh



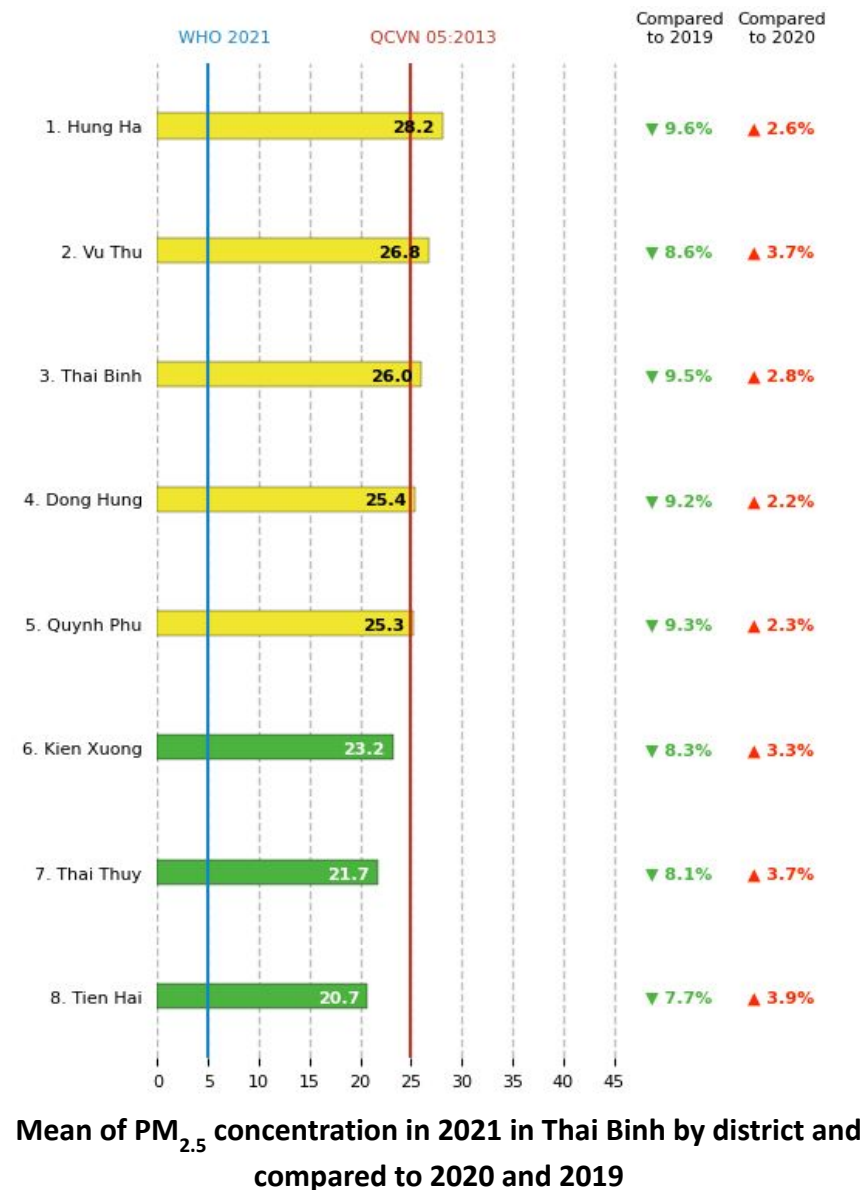
Percentage of days at different levels of air quality in Bac Ninh

The Status of PM_{2.5} in Thai Binh

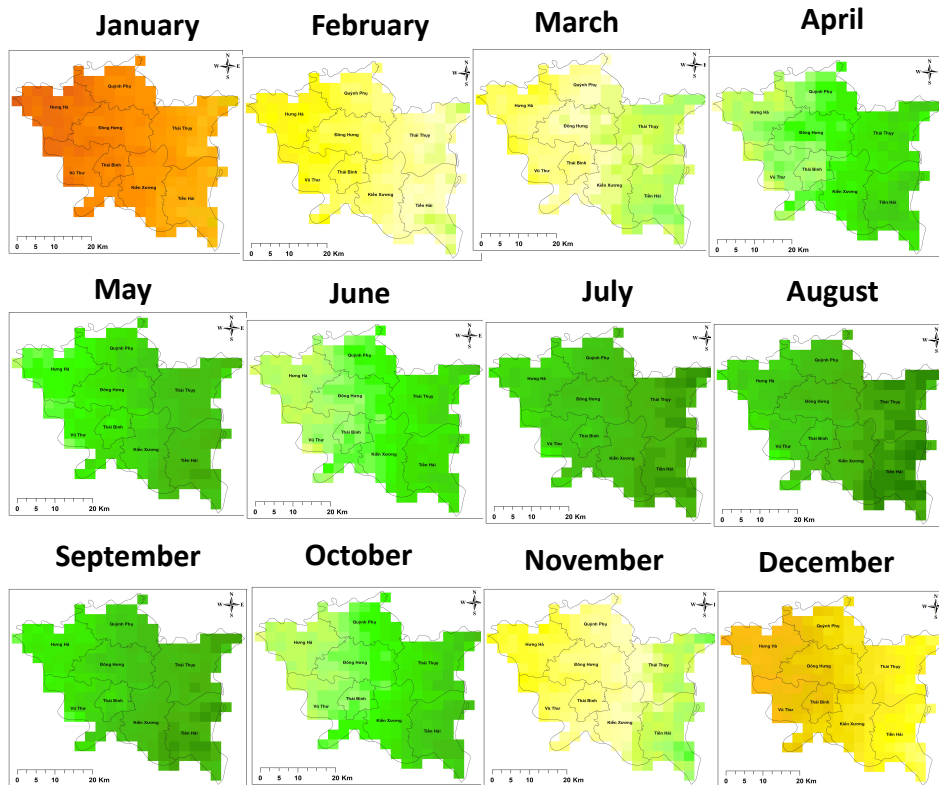
- PM_{2.5} in Thai Binh was high in western districts (Hung Ha, Quynh Phu, Vu Thu and Thai Binh city), low in eastern coastal districts (Thai Thuy, Kien Xuong, Tien Hai)



- In 2021, annual PM_{2.5} concentrations of 5/8 districts in Thai Binh exceeded Vietnam standards (QCVN 05:2013/BTNMT).
- The average PM_{2.5} in 2021 at the district level varied from 20.7 µg/m³ to 28.2 µg/m³, decreased from 7.7% to 9.6% compared to 2019 and increased from 2.2% to 5.1% compared to 2020

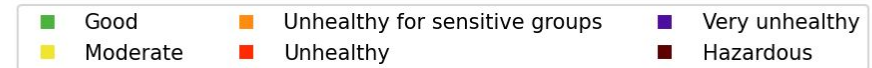


The Status of PM_{2.5} in Thai Binh

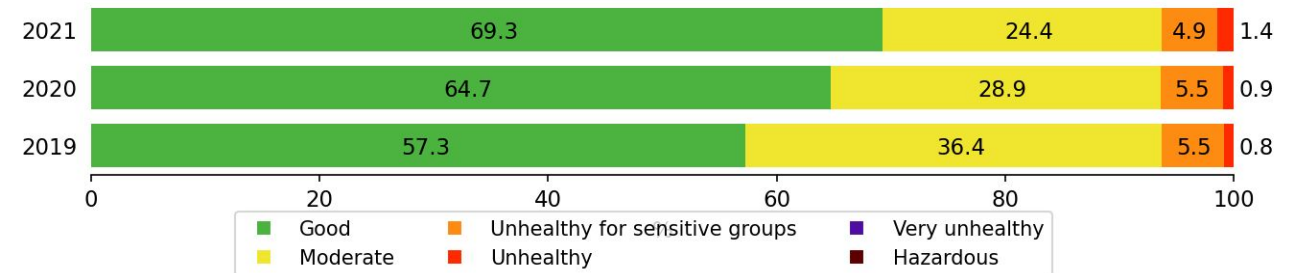


Monthly PM_{2.5} concentration in 2021 in Thai Binh

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
2021	56.8	28.8	25.3	19.1	16.3	19.3	14.2	13.7	15.0	18.7	26.4	38.8	24.4
2020	30.7	38.0	27.0	25.7	18.2	16.7	15.3	12.0	14.8	17.9	30.4	37.1	23.6
2019	35.7	25.8	27.0	22.7	22.6	17.8	15.5	19.1	26.7	28.4	38.0	41.3	26.7



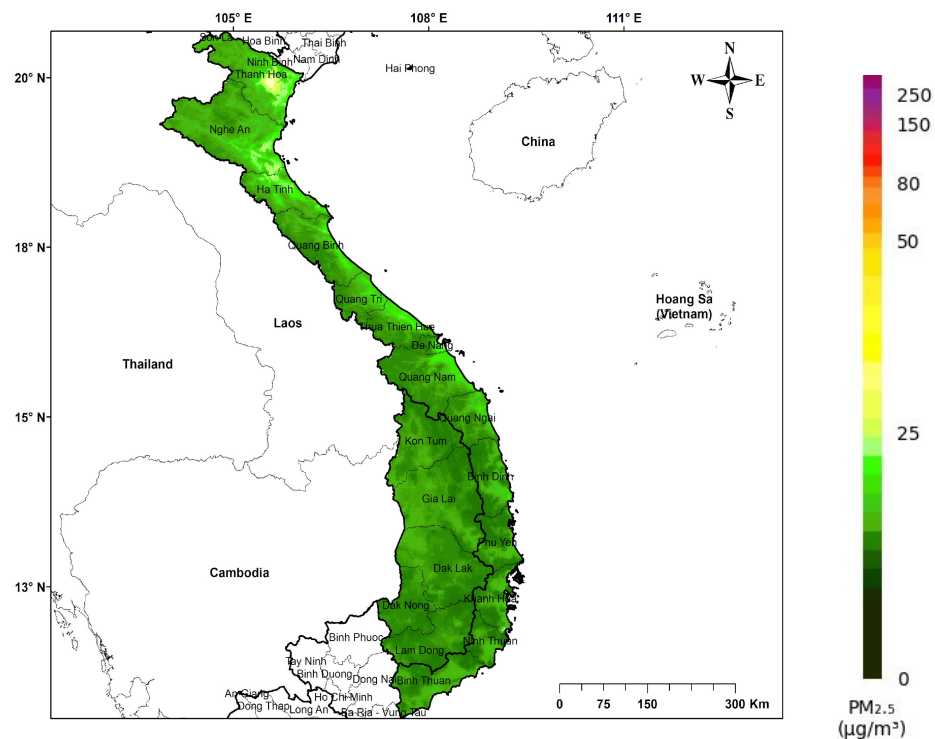
Monthly mean of PM_{2.5} concentration in Thai Binh



Percentage of days at different levels of air quality in Thai Binh

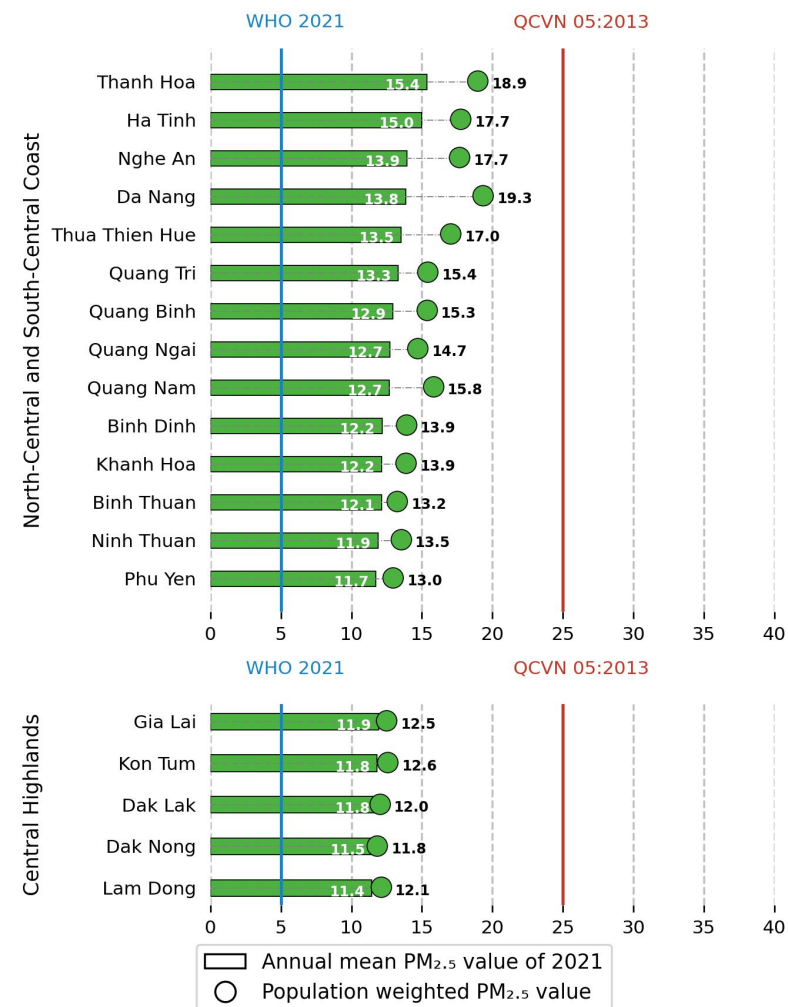
The Status of PM_{2.5} in the Central region

The Central region has 19 provinces and cities, divided into 2 regions including North Central and South-Central Coast (14 provinces) and Central Highlands (5 provinces).

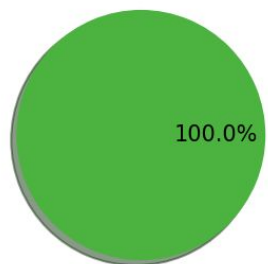


Annual mean PM_{2.5} concentrations in 2021 in the Central region

Annual mean PM_{2.5} concentration in 2021 at provincial level in the Central, compared to population-weighted PM_{2.5} concentration

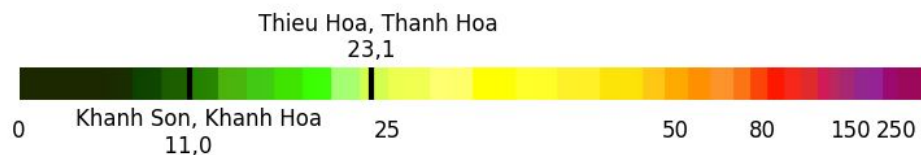


The Status of PM_{2.5} in the Central region



■ Provinces under the QCVN 05: 2013/BTNMT
■ Provinces over the QCVN 05:2013/BTNMT

100% of the provinces/cities in the Central met the Vietnam standards (QCVN 05:2013/BTNMT)



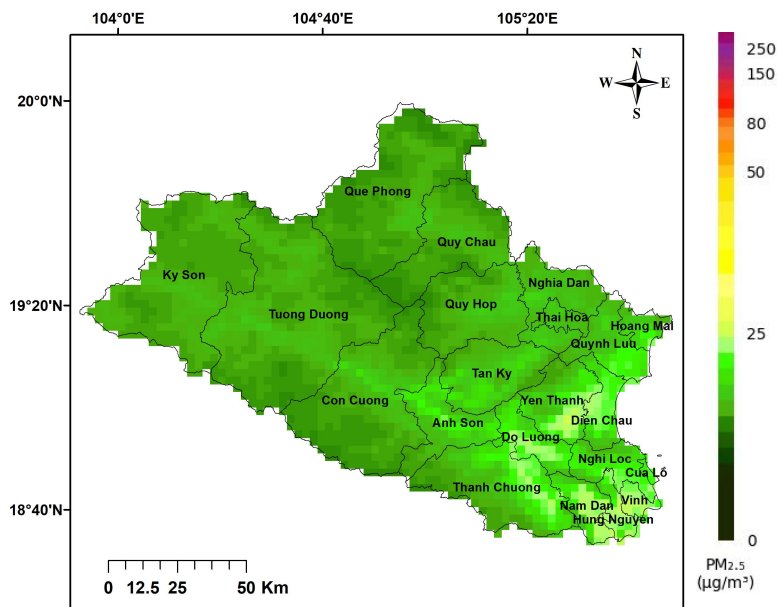
Value range of annual mean PM_{2.5} concentration in the Central districts

The most and least polluted districts in the Central in 2021 based on the annual mean PM_{2.5} concentration

Province/ city	District		Province/ city	District	
Thanh Hoa	Thieu Haa	23.1 µg/m ³	Khanh Hoa	Khanh Son	11.0 µg/m ³
Thanh Hoa	Yen Dinh		Gia Lai	KBang	
Thanh Hoa	Tho Xuan		Lam Dong	Lac Duong	
Thanh Hoa	Dong Son		Binh Dinh	Van Canh	
Nghe An	Vinh		Phu Yen	Đong Xuan	
Thanh Hoa	Trieu Son		Binh Dinh	Vinh Thanh	
Thanh Hoa	Thanh Hoa (city)		Gia Lai	Kong Chro	
Da Nang	Hai Chau		Dak Nong	Dak Glong	
Da Nang	Thanh Khe		Binh Dinh	An Lao	
Ha Tinh	Ha Tinh	20.3 µg/m ³	Lâm Dong	Bao Lam	11.2 µg/m ³

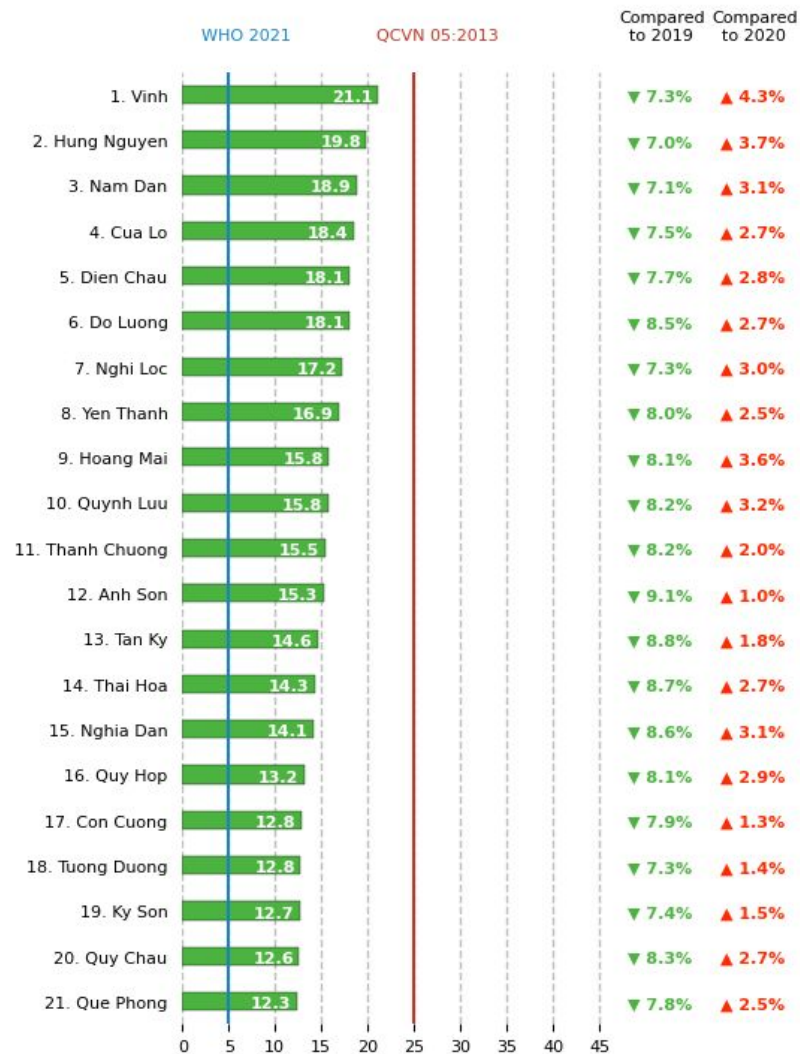
The Status of PM_{2.5} in Nghe An

- The annual PM_{2.5} in Nghe An was high in the Southeast districts (Hung Nguyen, Vinh, Cua Lo...), and low in the Northwest mountainous districts (Ky Son, Que Phong, Tuong Duong...)



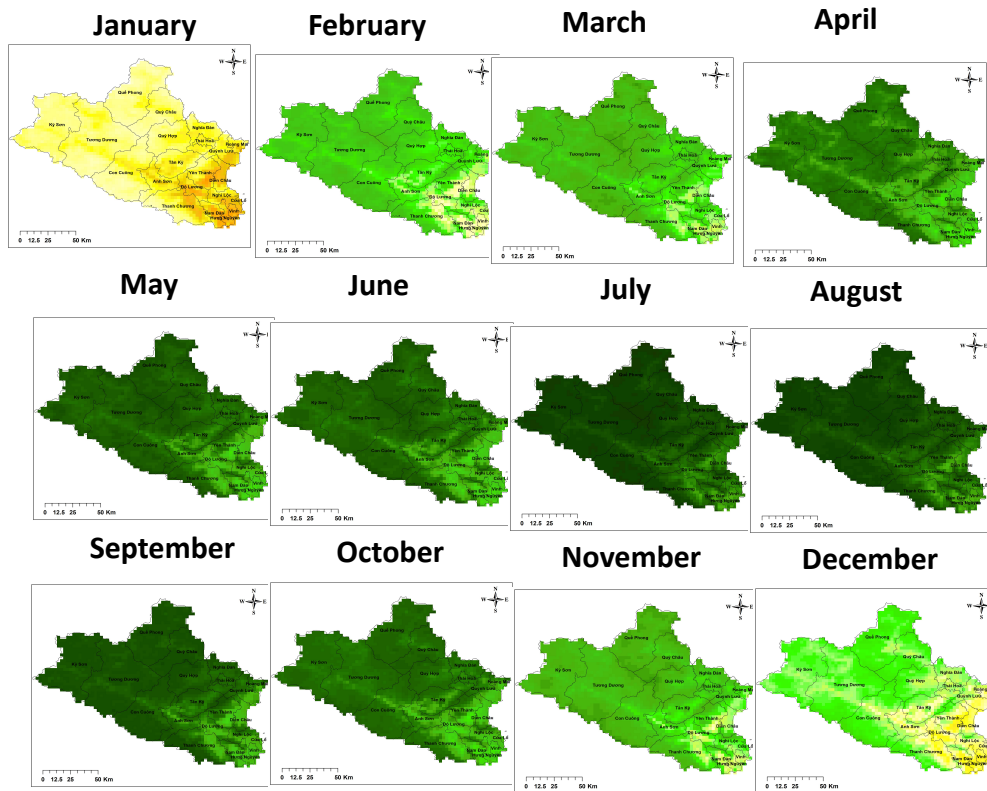
Annual mean PM_{2.5} concentration in 2021 in Nghe An

- In 2021, 100% of districts/cities in Nghe An met the Vietnam standard (QCVN 05:2013/BTNMT).
- The average PM_{2.5} in 2021 at district level varied from 12.3 $\mu\text{g}/\text{m}^3$ to 21.1 $\mu\text{g}/\text{m}^3$, decreased from 7.0% to 9.1% compared to 2019 and increased from 1% to 4.3% compared to 2020

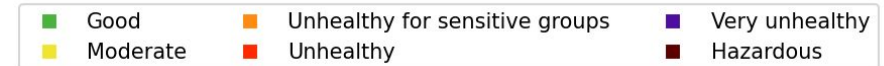


. Mean of PM_{2.5} concentration in 2021 in Nghe An by district and compared to 2020 and 2019

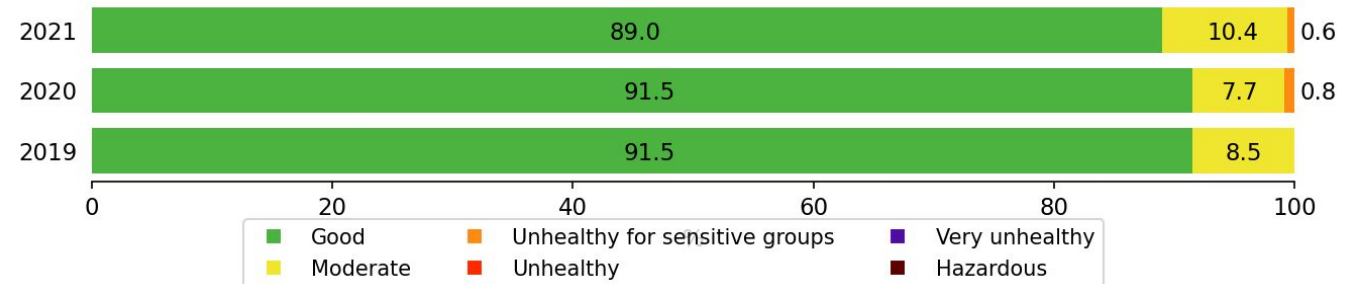
The Status of PM_{2.5} in Nghe An



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
2021	31.1	17.0	15.1	11.6	9.9	10.3	7.8	8.2	9.2	10.8	14.9	21.4	13.9
2020	17.2	20.7	14.8	14.8	10.8	9.7	9.4	7.5	9.3	10.2	17.5	22.1	13.7
2019	19.0	13.3	15.1	13.3	13.0	10.1	9.2	11.8	15.9	16.1	21.6	23.4	15.1



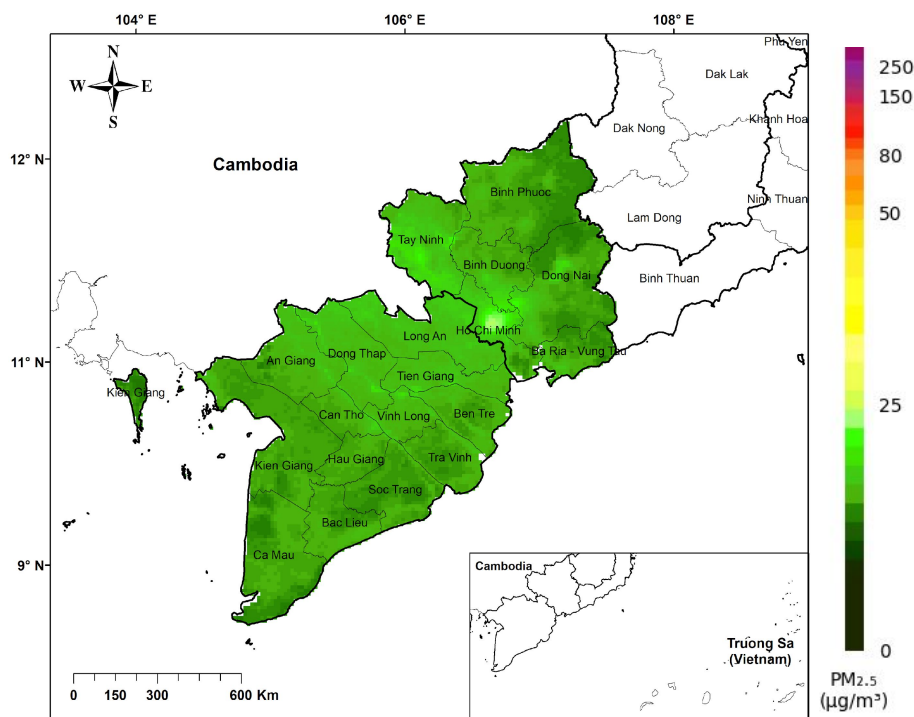
Monthly mean of PM_{2.5} concentration in Nghe An



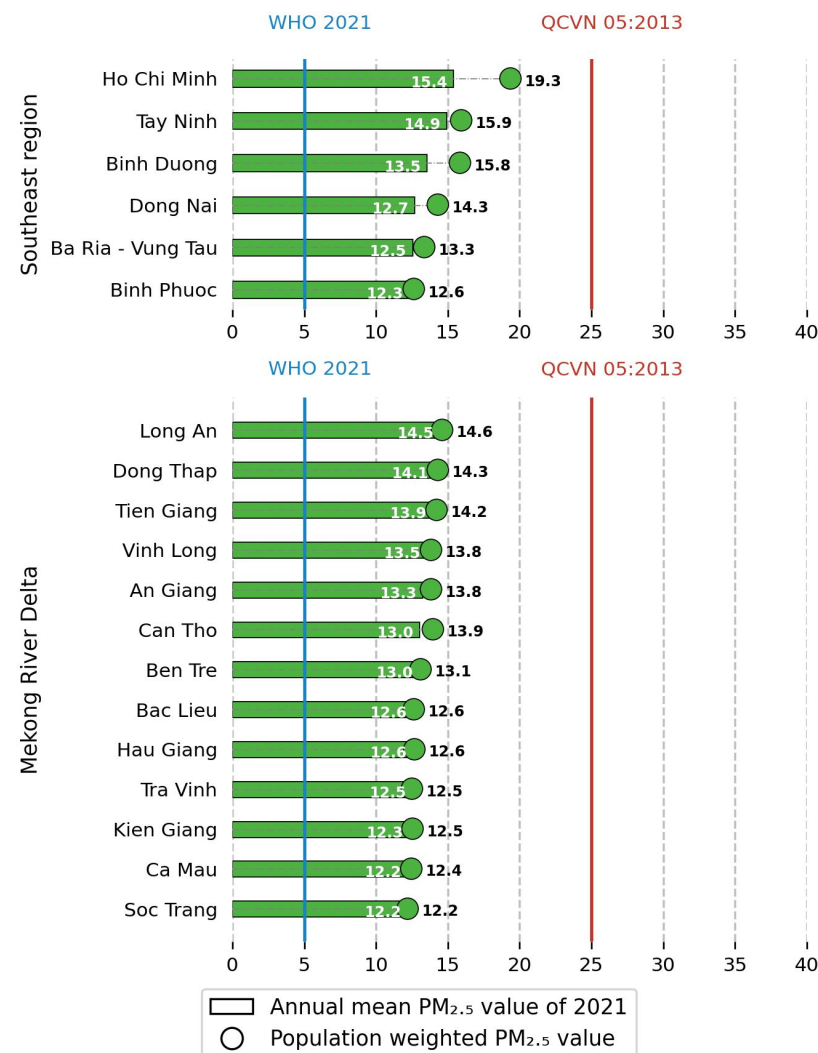
Percentage of days at different levels of air quality in Nghe An

The Status of PM_{2.5} in the Southern region

- The South has 19 provinces and cities, divided into 2 regions, including the Southeast (6 provinces/cities) and the Mekong River Delta (13 provinces/cities)

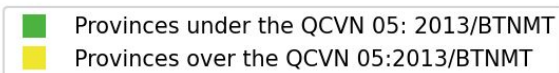
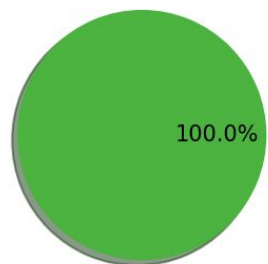


- Annual mean PM_{2.5} concentration in 2021 at provincial level in the South, compared to population-weighted PM_{2.5} concentration

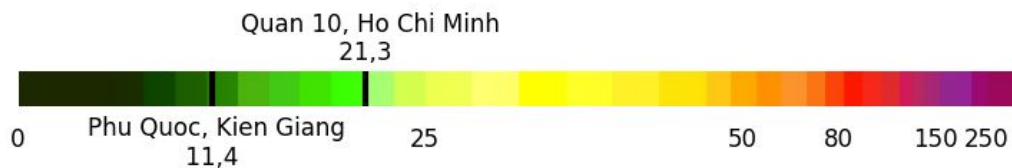


Annual mean PM_{2.5} concentrations in 2021 in the Southern region

The Status of PM_{2.5} in the Southern region



100% of the provinces/cities in the South met the Vietnam standards (QCVN 05:2013/BTNMT)



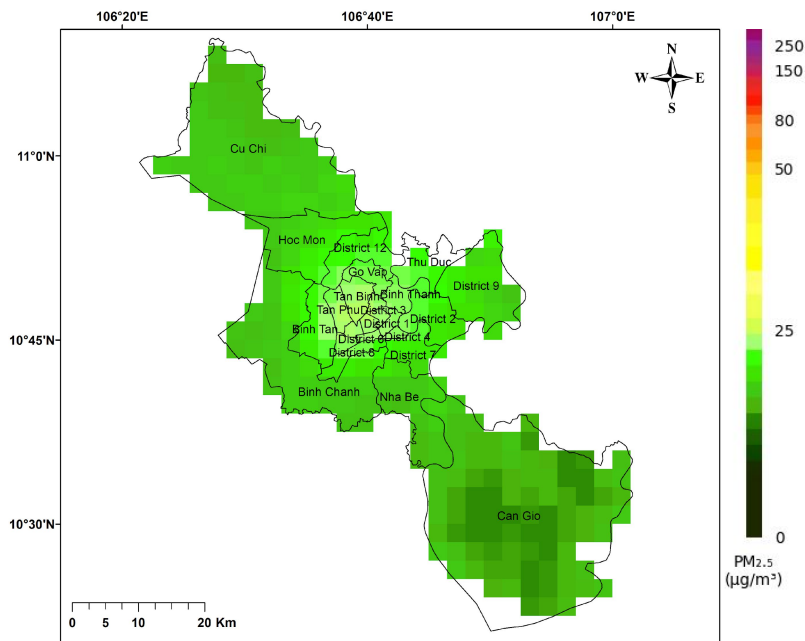
Value range of annual mean PM_{2.5} concentration in the Southern districts

The most and least polluted districts in the South in 2021 based on the annual mean

Province/ city	District		Province/ city	District	
Ho Chi Minh	District 10	21.3 µg/m³	Kien Giang	Phu Quoc	11.4 µg/m³
Ho Chi Minh	Tan Binh		Ca Mau	Ngoc Hien	
Ho Chi Minh	District 11		Binh Phuoc	Bu Dang	
Ho Chi Minh	District 3		Soc Trang	Thanh Tri	
Ho Chi Minh	Phu Nhuan		Ca Mau	U Minh	
Ho Chi Minh	Tan Phu		Dong Nai	Cam My	
Ho Chi Minh	District 5		Kien Giang	Kien Hai	
Ho Chi Minh	District 1		Bac Lieu	Vinh Loi	
Ho Chi Minh	District 6		Binh Phuoc	Bu Gia Map	
Ho Chi Minh	District 4		Ba Ria - Vung Tau	Xuyen Moc	
		20.5 µg/m³			12.0 µg/m³

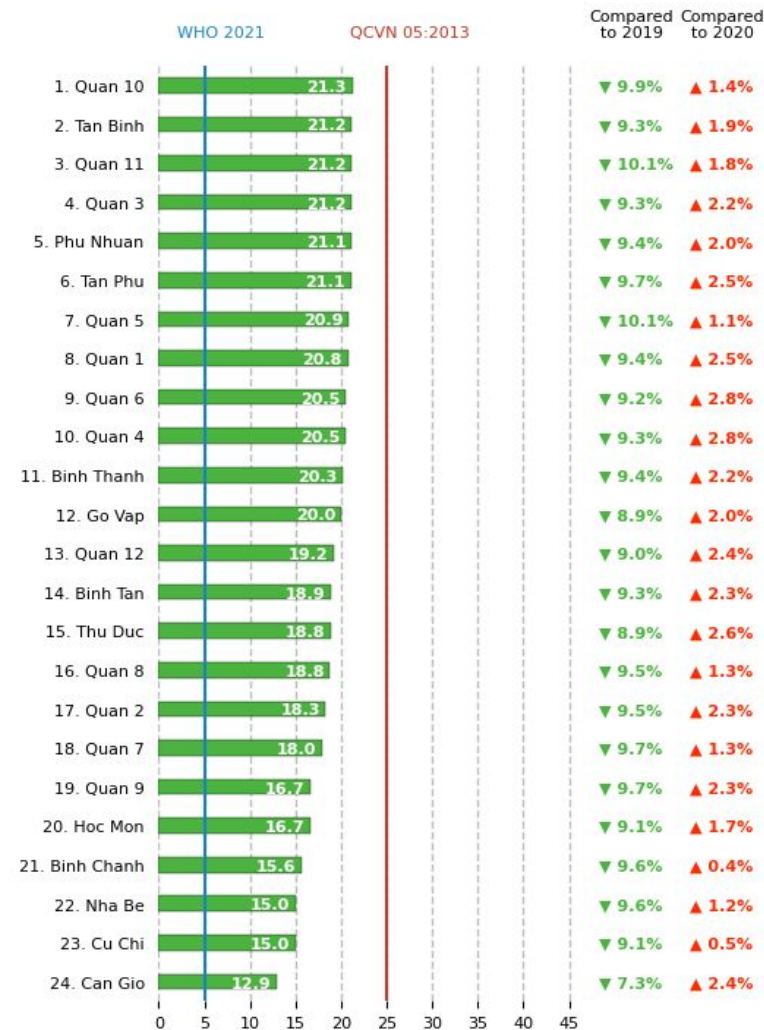
The Status of PM_{2.5} in Ho Chi Minh city

- Average concentration in 2021 was high in central districts and low in the outer districts such as Cu Chi and Can Gio



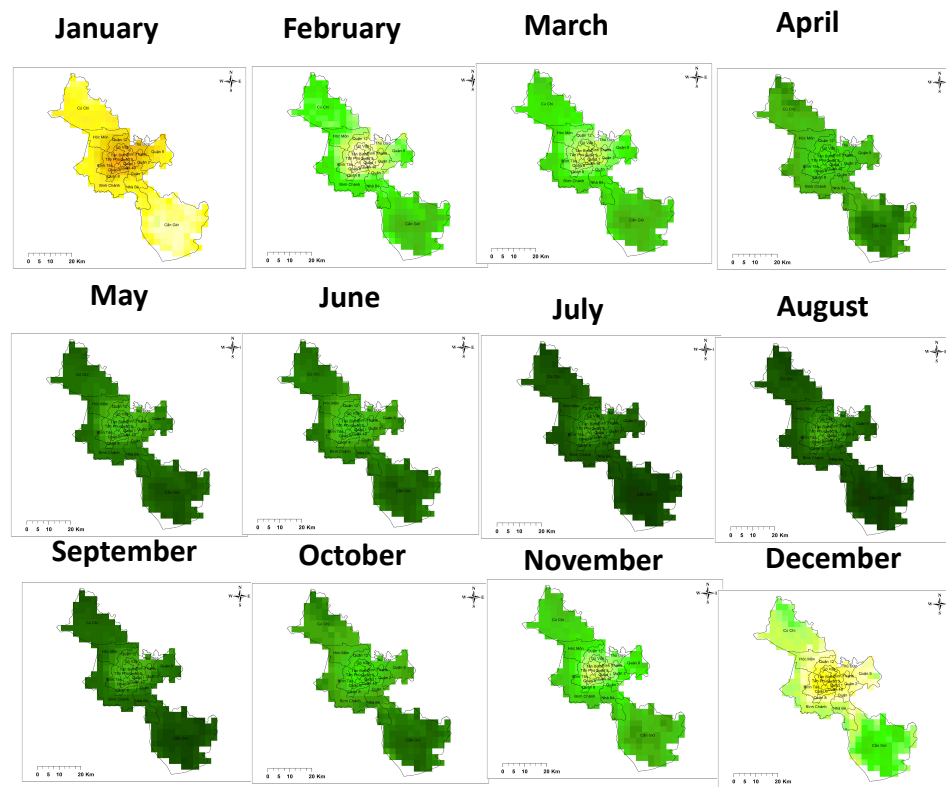
Annual mean PM_{2.5} concentration in 2021 in Ho Chi Minh city

- In 2021, PM_{2.5} concentrations of 100% of districts of Ho Chi Minh City were below of Vietnam standard (QCVN 05:2013/BTNMT).
- The average concentration at district level varied from 12.9 µg/m³ to 21.3 µg/m³, decreased from 7.3% to 10.1% compared to 2019 and increased from 0.5% to 2.8% compared to 2020



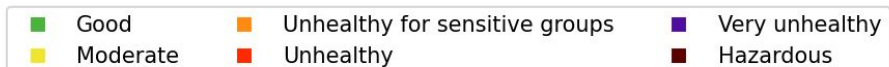
Mean of PM_{2.5} concentration in 2021 in Ho Chi Minh City by district and compared to 2020 and 2019

The Status of PM_{2.5} in Ho Chi Minh city

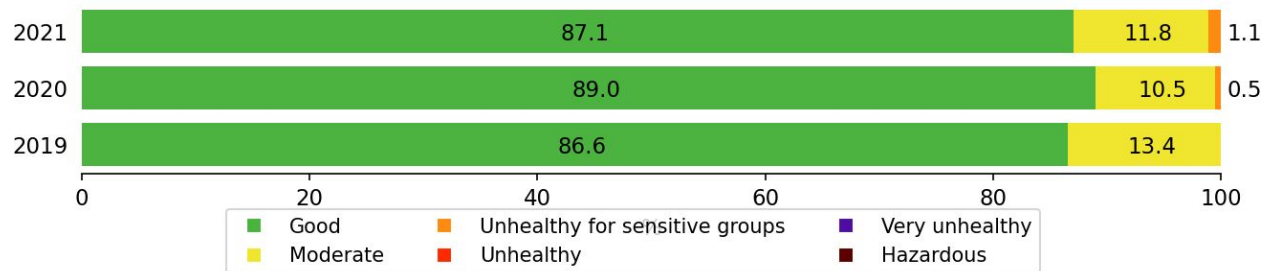


Monthly PM_{2.5} concentration in 2021 in Ho Chi Minh city

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVG
2021	33.9	18.9	17.4	13.3	10.6	11.3	8.7	8.8	9.9	12.4	16.3	23.2	15.4
2020	18.5	23.0	17.1	17.1	12.5	11.1	10.5	8.6	10.5	11.5	19.0	22.4	15.2
2019	21.1	14.8	16.7	14.6	14.6	11.3	10.8	12.9	18.1	18.6	24.1	25.0	16.9

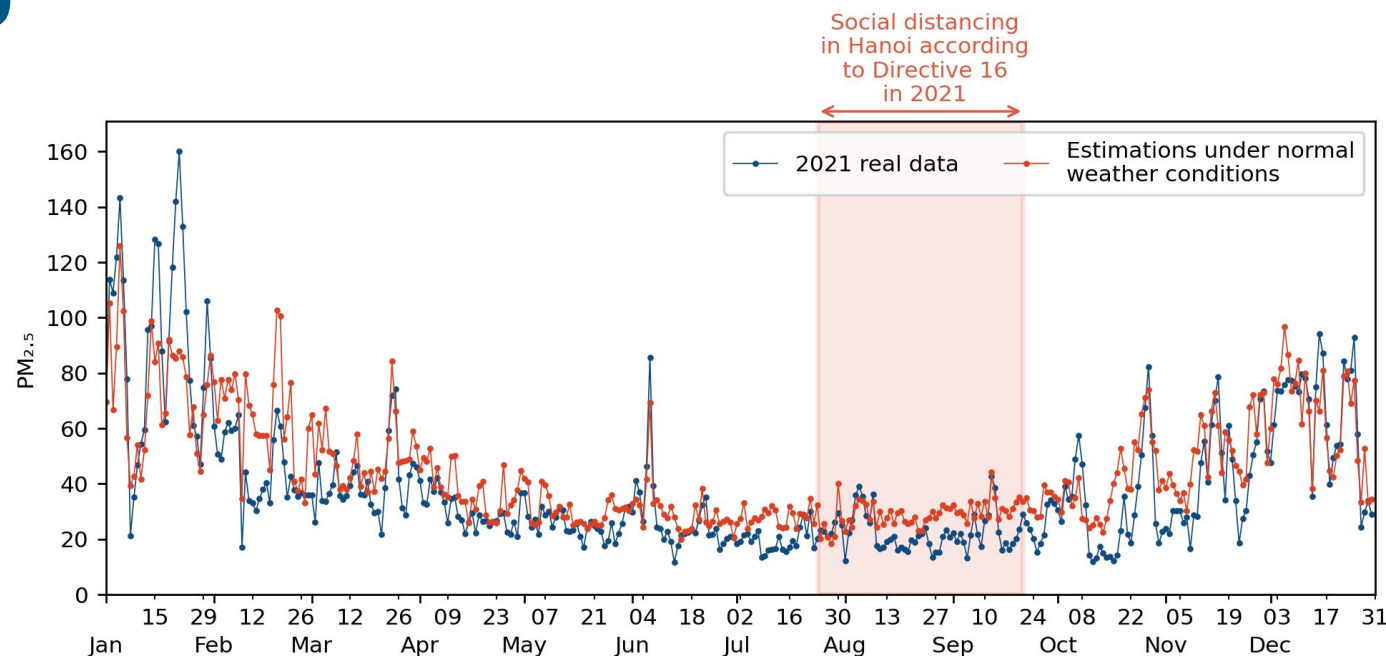


Monthly mean of PM_{2.5} concentration in Ho Chi Minh city



Percentage of days at different levels of air quality in Ho Chi Minh city

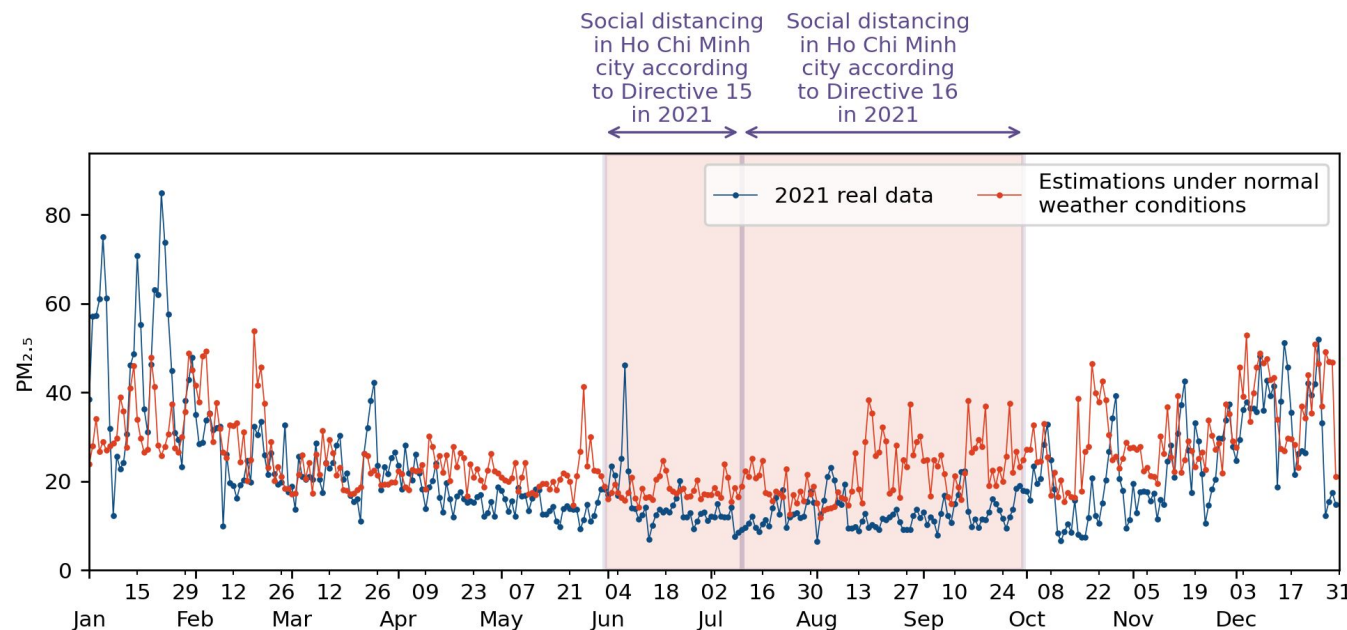
PM_{2.5} concentration during social distancing period due to COVID-19



Daily PM_{2.5} concentration measured and estimated under normal conditions in 2021 at the UWYO meteorological station on Nguyen Khang street, Hanoi.

- **In Hanoi**, during social distancing according to Directive 16, real PM_{2.5} values were observed to be lower than the normal-condition-estimated counterpart (22.8%). Shortly before and after social distancing, PM_{2.5} concentration also exhibited some decline compared to estimations.

PM_{2.5} concentration during COVID-19



Daily PM_{2.5} concentration measured and estimated under normal conditions in 2021 at the UWYO meteorological station at Tan Son Nhat airport in Ho Chi Minh city

- **In Ho Chi Minh city**, during social distancing according to Directive 16, real PM_{2.5} values were substantially lower (by 41.4%) compared to those of normal-condition (excluding the effects of social distancing) estimations. Shortly before and after social distancing by Directive 16, PM_{2.5} concentration also showed similar trends, being lower than estimations by 27,3% and 25,7%, respectively.

Thank you for listening!
