



MINISTRY OF NATURE RESOURCES AND ENVIRONMENTS
NATIONAL REMOTE SENSING DEPARTMENT

APPLICATION OF BIG DATA-REMOTE SENSING PROCESSING SOLUTIONS FOR AIR POLLUTION MONITORING IN HANOI

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INTRODUCTION

- In Hanoi, Air pollution in general is directly related to particulate matter (like PM10 and PM2.5) and toxic chemical components in the form of gases in the air such as CO, SO₂, NO₂, CH₄,....
- Air quality monitoring is currently being carried out in many different methods such as direct monitoring: through in-situs network; and indirect monitoring: via satellite data, UAV,
- However, each method has its advantages and disadvantages:

Direct monitoring methods often have high reliability, but it's local and representing a small area;

While indirect methods such as using remote sensing data have the advantage of large coverage, showing relatively clear trends in spatial distribution of air quality, but it has the limitation of the frequency of monitoring and reliability.

INTRODUCTION

- Therefore, it is necessary to develop a new solution by combining direct and indirect monitoring data with many advantages than technical separates for large-scale but high-frequency monitoring. However, this combination is currently facing difficulties in data processing, especially the spatial and temporal synchronization of the two data sources.
- To solve this problem, we have developed a solution to handle bigdata-remote sensing in monitoring some gas components in the air; on that basis, develop algorithms and tools on GoogleEarth Engine platform to build AQI24h index map of Hanoi.
- This solution will provide new technical that can monitor air quality on a large area, with near-real-time frequency and ensure reliability for monitoring at the city scale.

GOALS

- Establishing a scientific basis and methodology for Big data- remote sensing application in monitoring air pollution;
- Developing the process of Big data - remote sensing technology application for monitoring air pollution from waste treatment areas;

RESEARCH CONTENTS

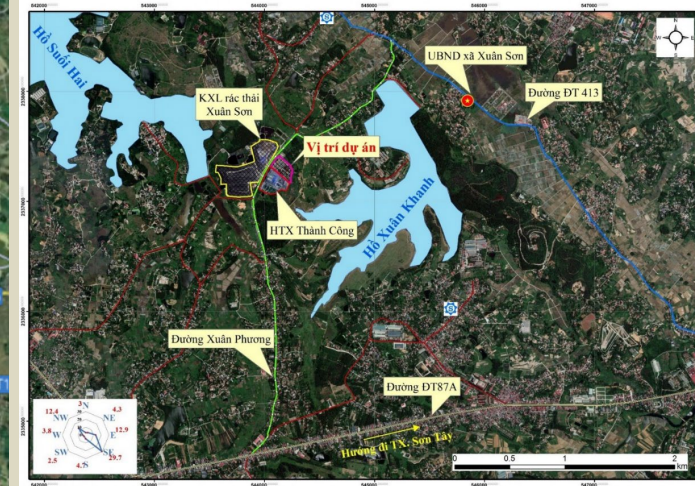
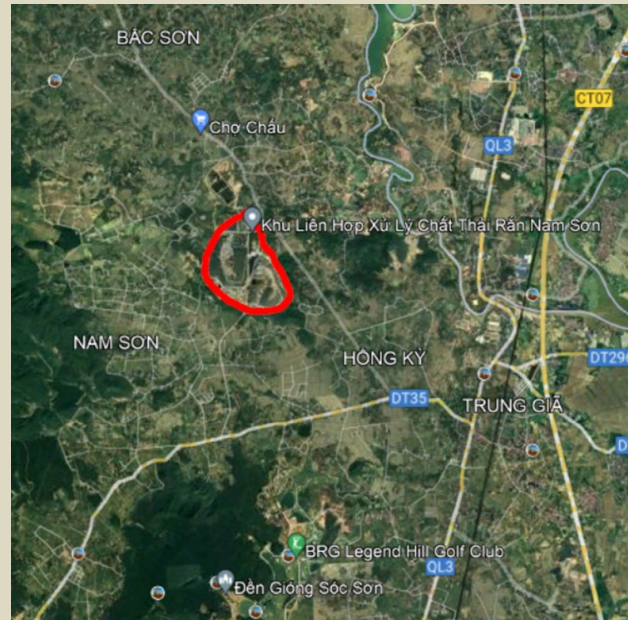
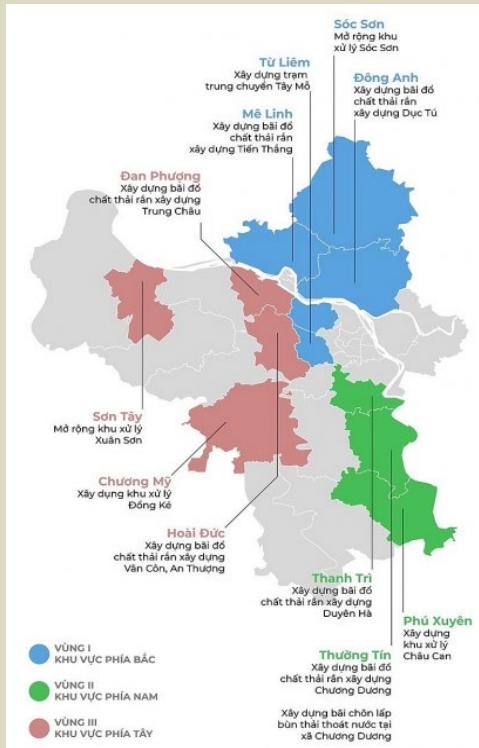
Research subjects

Monitoring air pollution components such as dust (PM2.5, PM10) and some toxic chemicals such as SO₂, NO₂, CO, O₃ and air quality index AQI 24h.

Area

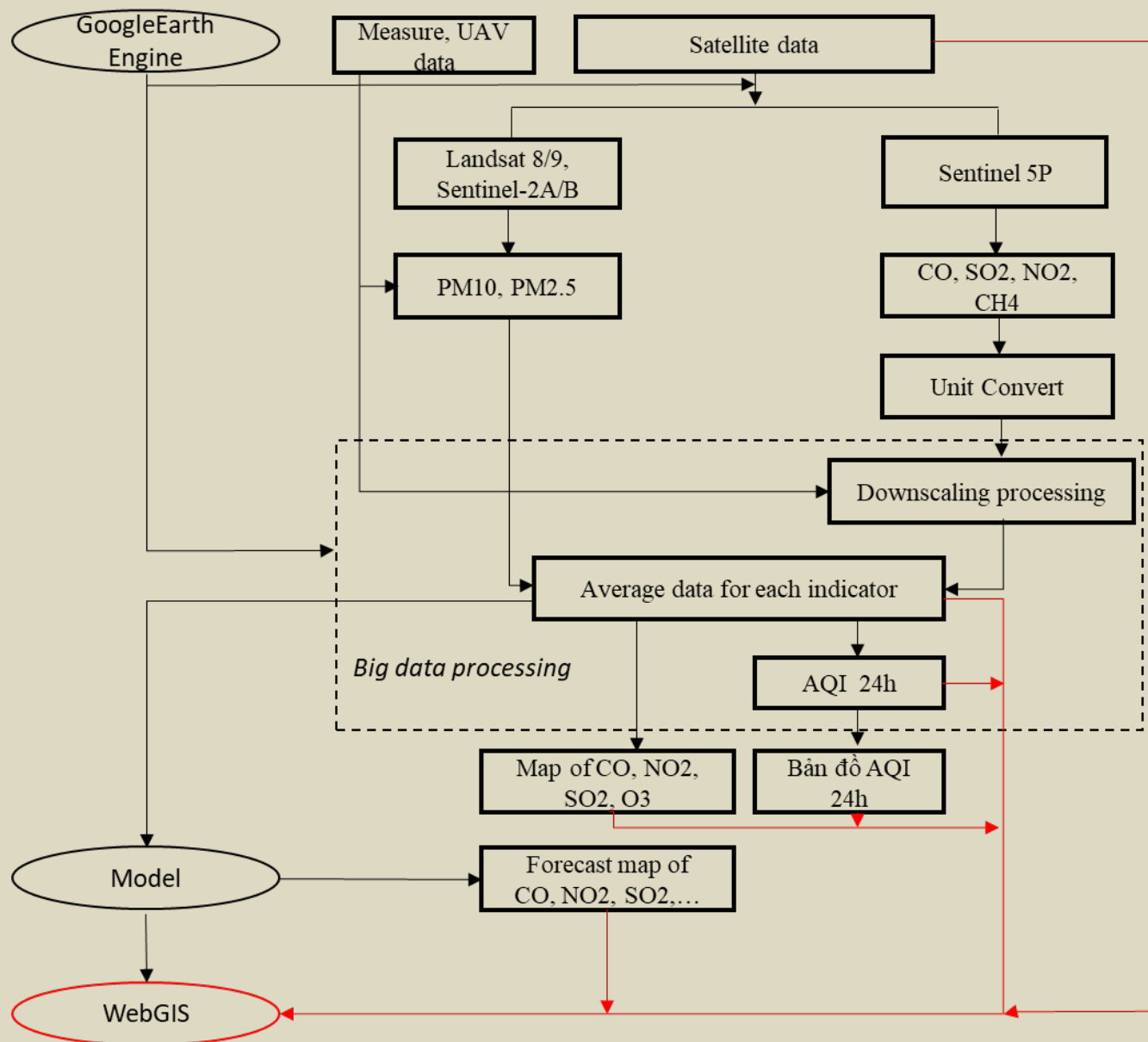
1) Large scale: covering the Ha Noi city

2) Detailed scale: Nam Son and Xuan Son solid waste treatment zones

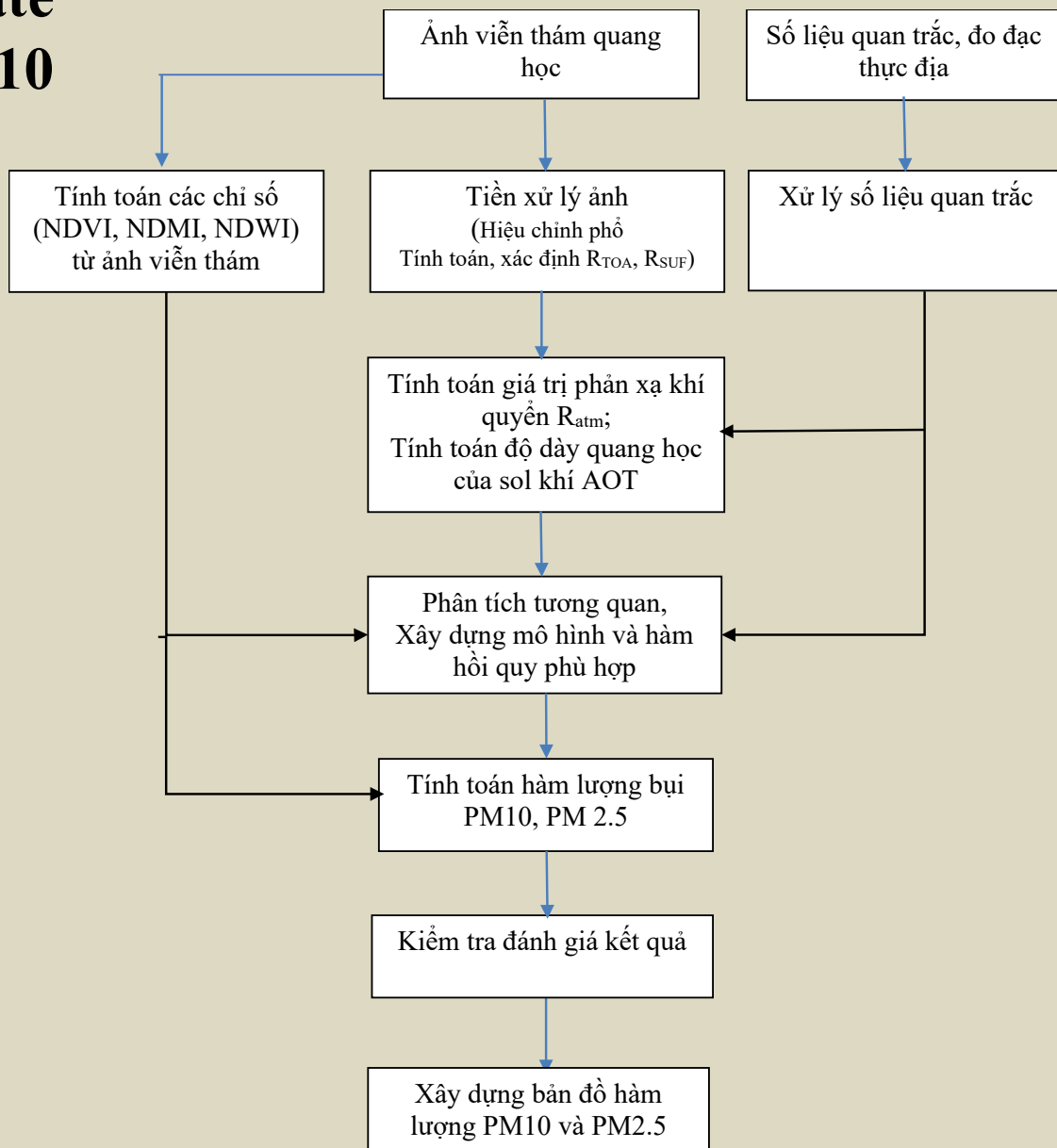


METHODOLOGIE

Process of Big data-remote sensing technology for monitoring air pollution



Monitoring particulate matter PM2.5 and PM10 using remote sensing data



Technical solutions for processing Bigdata-remote sensing for monitoring some air components in Hanoi area

★ Convert data units to $\mu\text{g}/\text{m}^3$

Conversion formula:

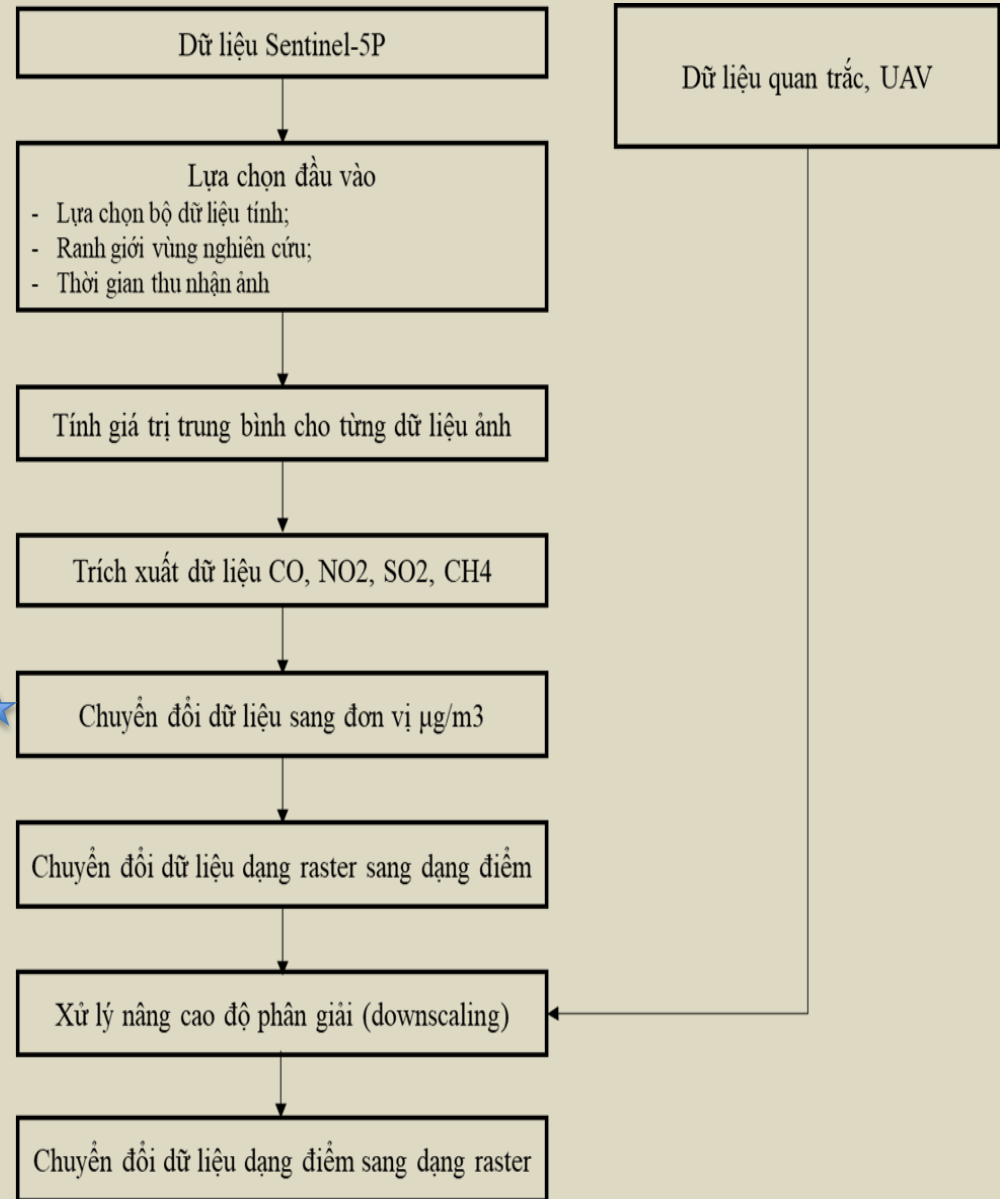
$$P_s = P_t * A$$

where, P_s and P_t represents data with units of $\mu\text{g}/\text{m}^3$ and mol/m^2 respectively.

A is the transfer constant of each gas, shown in the table

Hệ số chuyển đổi đơn vị tính từ mol/m^2 sang đơn vị $\mu\text{g}/\text{m}^3$

No	Gas	A
1	CO	280 000
2	SO2	640 000
3	NO2	460 000
4	CH4	160 000
5	O3	480 000



Technical solutions for processing Big data-remote sensing in mapping the AQI24h air quality index

Daily AQI values of parameters SO₂, CO, NO₂, O₃, PM10, PM2.5 are calculated according to the following formula:

$$AQI_x = \frac{I_{i+1} - I_i}{BP_{i+1} - BP_i} (C_x - BP_i) + I_i$$

Lookup table of AQI value (µg/m³)

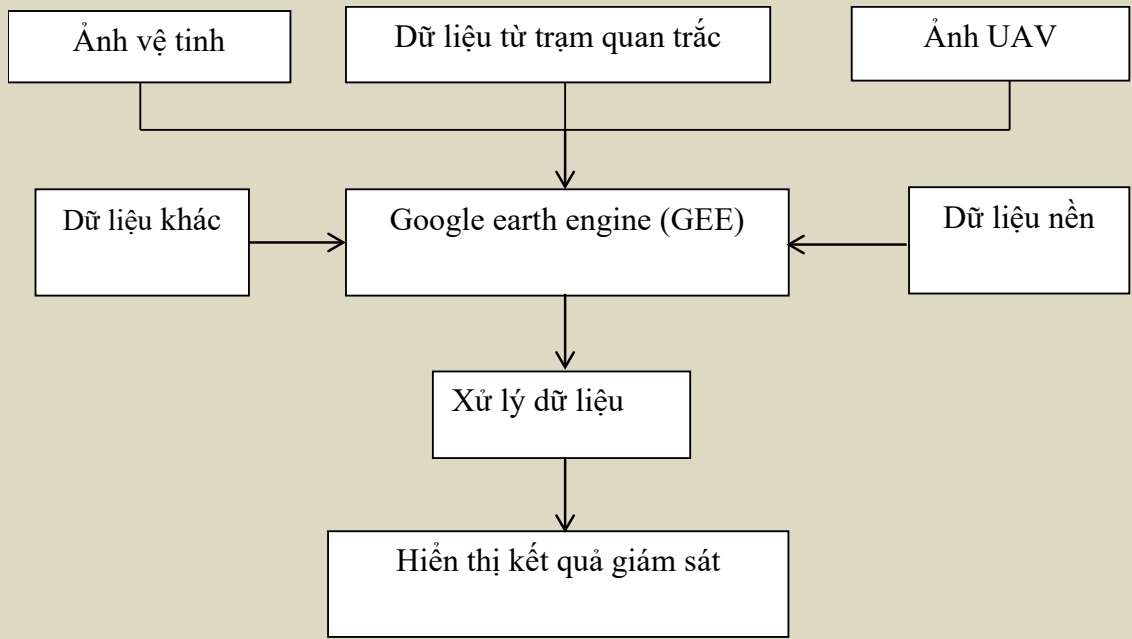
where:

- BP_i and I_i: from the lookup table;
- AQI_x: value AQI day of parameter x;
- BP_i: Concentration of lower limit;
- BP_{i+1}: Concentrations of the upper limit;
- I_i : The AQI value at level i given in the table corresponds to the value of BP_{i+1}.

AQI	PM10 24-hr	PM2.5 24-hr	NO ₂ 24-hr	O ₃ 8-hr	CO 8-hr (mg/ m ³)	SO ₂ 24-hr
Good (0-50)	0-50	0-30	0-40	0-50	0-1.0	0-40
Satisfactory (51-100)	51-100	31-60	41-80	51-100	1.1-2.0	41-80
Moderate (101-200)	101-250	61-90	81-180	101-168	2.1-10	81-380
Poor (201-300)	251-350	91-120	181-280	169-208	10.1-17	381-800
Very poor (301-400)	351-430	121-250	281-400	209-748*	17.1-34	801-1600
Severe (401-500)	430+	250+	400+	748+*	34+	1600+

DEVELOPING A BIGDATA-REMOTE SENSING PROCESSING MODULE FOR AIR POLLUTION MONITORING

- Using Google Earth Engine (GEE) solution in storing and processing air monitoring data;
- GEE is an open source platform that supports storing and processing Big data-remote sensing;
- GEE links to a diverse repository of remote sensing data;
- Allows users to integrate other data sources outside of the GEE platform



DATA USED

1) **Satellite data:** Sentinel 2A/2B, Landsat 8/9 (to retrieve PM10 and PM2.5); Sentinel-5P (to retrieve: CO, NO₂, SO₂, O₃)

2) **Ground observation data:** air quality (35 stations) and meteorology data from in-situs;



STT	Tên trạm	STT	Tên trạm
1	Chi cục BVMT Hà Nội	1	Đông Kinh Nghĩa Thục
2	Minh Khai - Bắc Từ Liêm	2	Đào Duy Từ
3	Đại Sứ Quán Pháp	3	Lý Thái Tổ - Cung thiếu nhi
4	Hoàn Kiếm	4	Đàm Trấu
5	Hàng Đậu	5	Lê Trực
6	Kim Liên	6	Tứ Liên
7	Thành Công	7	Khuong Trung
8	Tân Mai	8	Cầu Diễn
9	Mỹ Đình	9	KĐT.Tây Hồ Tây
10	Phạm Văn Đồng	10	KĐT.Pháp Vân
11	Tây Mỗ	11	Văn Quán
		12	An Khánh
		13	Kim Bài
		14	Võng La
		15	Vân Hà
		16	Liên quan
		17	Xuân Mai
		18	Chúc Sơn
		19	Sóc Sơn
		20	Thanh Xuân Sóc Sơn
		21	Sài Sơn
		22	Vân Đình
		23	Quảng Phú cầu
		24	Đội Bình

3) UAV data: measure the concentration of gases such as PM10, PM2.5, CO, NO, NO2, SO2



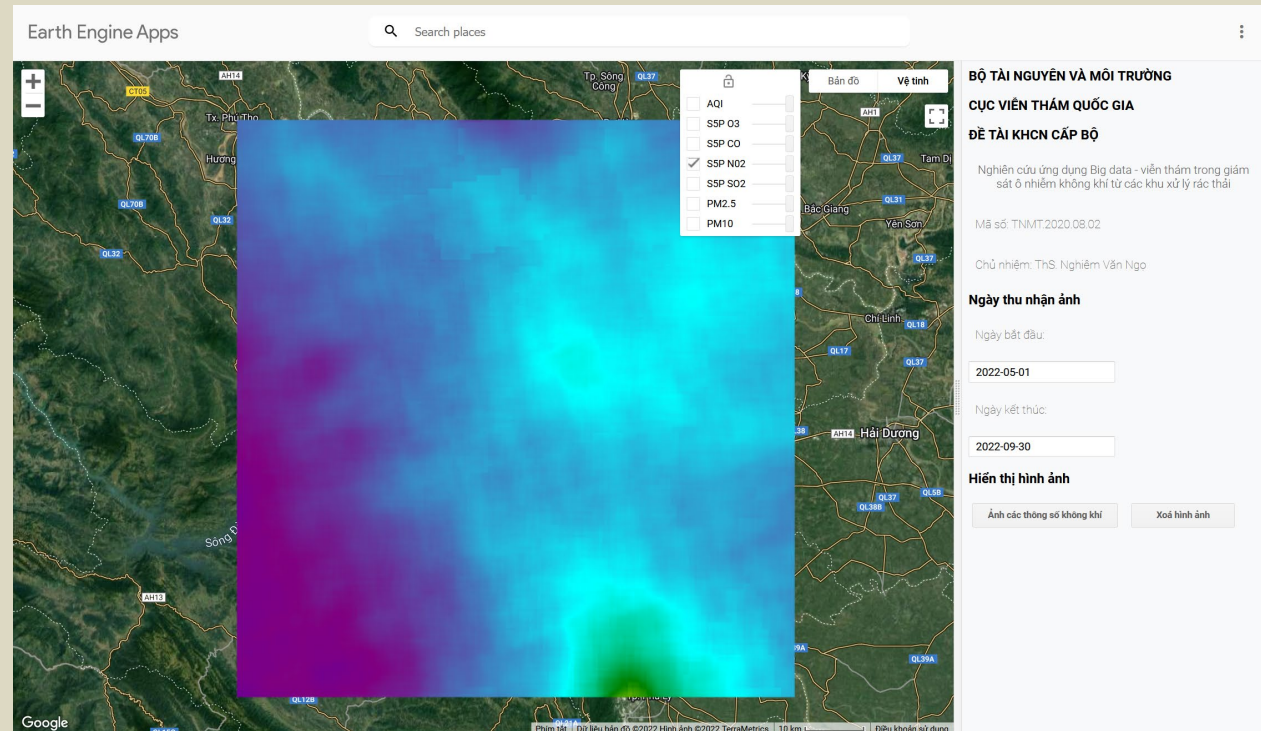
STT	Long	Lat	H	CO	NO	NO2	SO2	CO2	VOC	PM1.0	PM2.5	PM10
1	105.8374	21.34044	15.14336	5.11	0.23	0	0.28	434	1.3	40	60	68
2	105.8367	21.34027	15.2048	5.03	0.21	0	0.3	434	1.3	40	60	67
3	105.8391	21.33635	15.47104	4.97	0.1	16.66	0.31	434	1.3	40	60	67
4	105.8391	21.3364	15.79872	5.07	0.19	18.34	0.3	434	1.3	38	58	62
5	105.8367	21.34098	16.06496	5.09	0.18	18.33	0.3	434	1.3	40	59	62
6	105.8386	21.33611	16.26976	5.07	0.19	18.3	0.28	435	1.3	39	58	61
7	105.8387	21.33611	16.47456	5.07	0.18	18.34	0.26	435	1.3	42	63	67
8	105.8376	21.3399	16.61792	5.04	0.16	18.38	0.28	436	1.3	41	62	64
9	105.8377	21.33908	16.7408	5.08	0.17	18.33	0.23	436	1.3	41	63	66
10	105.8375	21.34021	16.7408	5.02	0.08	18.33	0.26	437	1.3	40	62	67

RESULTS

Tools for processing, managing and storing Big data-remote sensing

Functions:

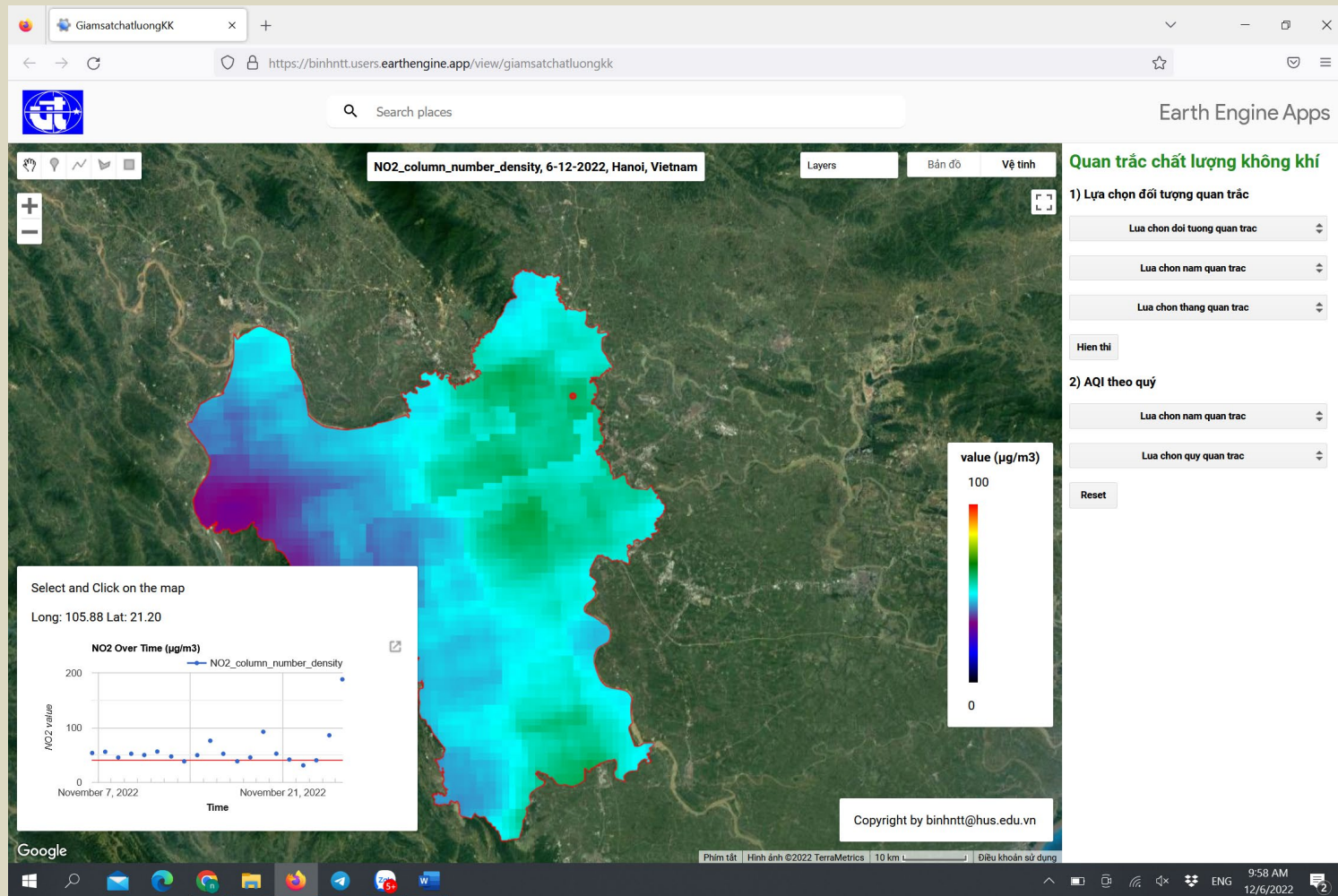
- *Storage and management of big data- remote sensing;*
- *Processing remote sensing data to extract PM10; PM2.5*
- *Processing data to extract CO; SO2; NO2; O3 from S-5P (enhanced data resolution by downscaling solution);*
- *Data processing, calculation of AQI24h air quality index;*



Electronic portal (WebGIS) providing air pollution information

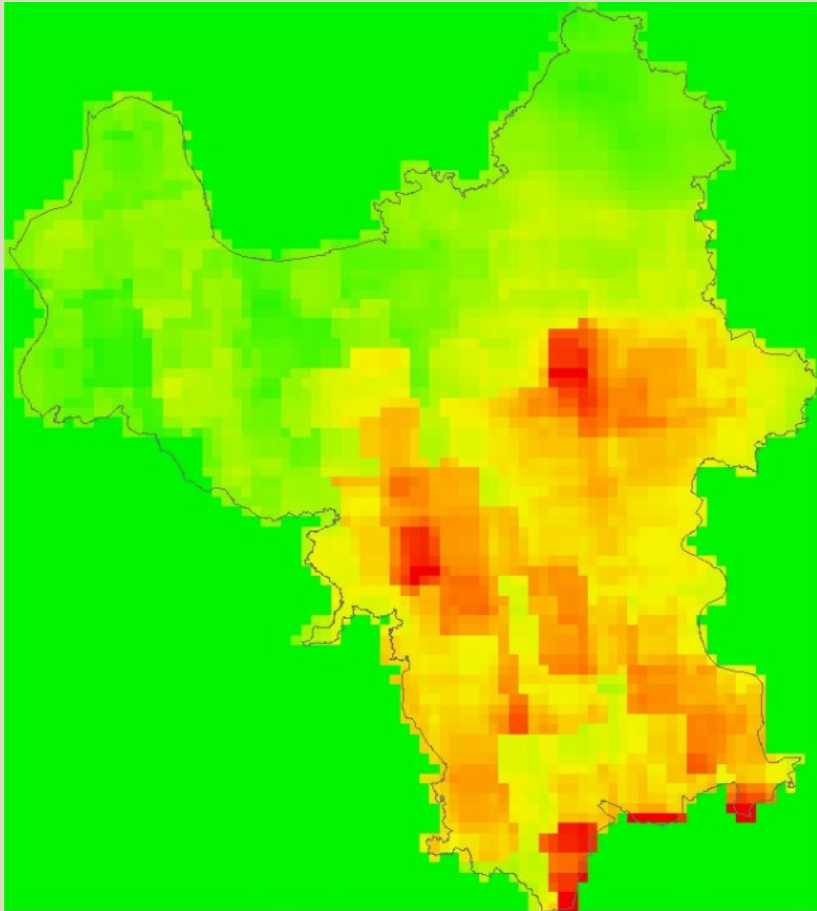
Functions:

- Allows displaying spatial distribution of air quality images on the whole of Hanoi;
- Allows to look up and extract specific parameters of each air quality component such as PM10, PM2.5; CO, SO2, NO2,...and AQI24h air quality index at any points

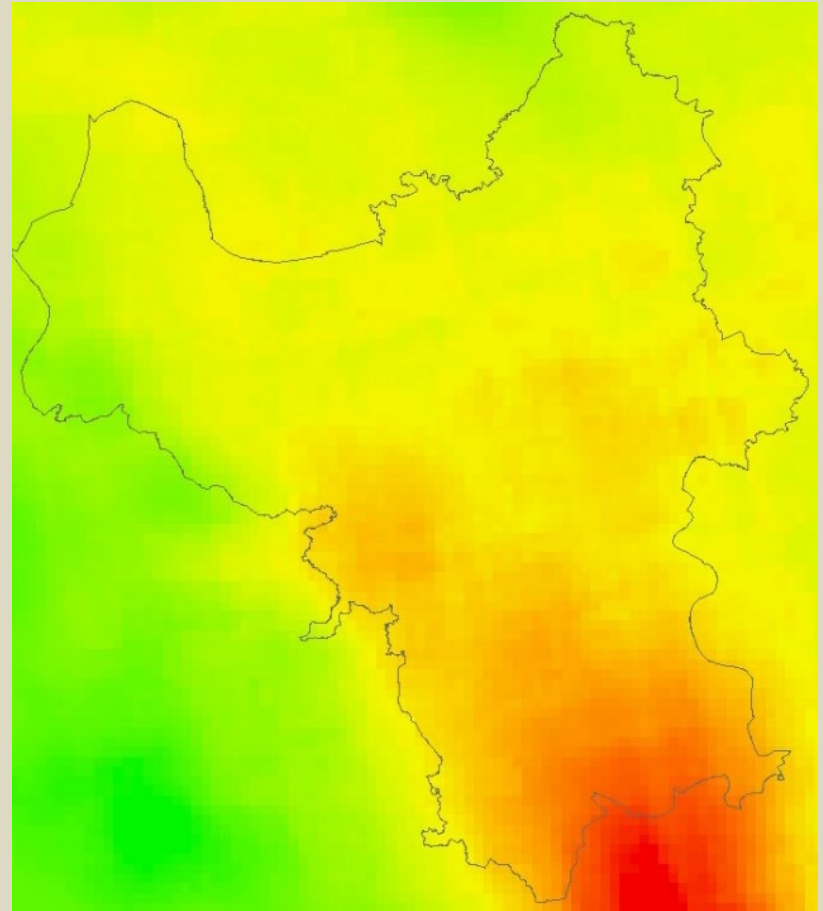


Processing enhanced data resolution

- Data used: Original data from S-5P (3.5 x 7km resolution) and data from in-situs
- Methodology: downscaling solution

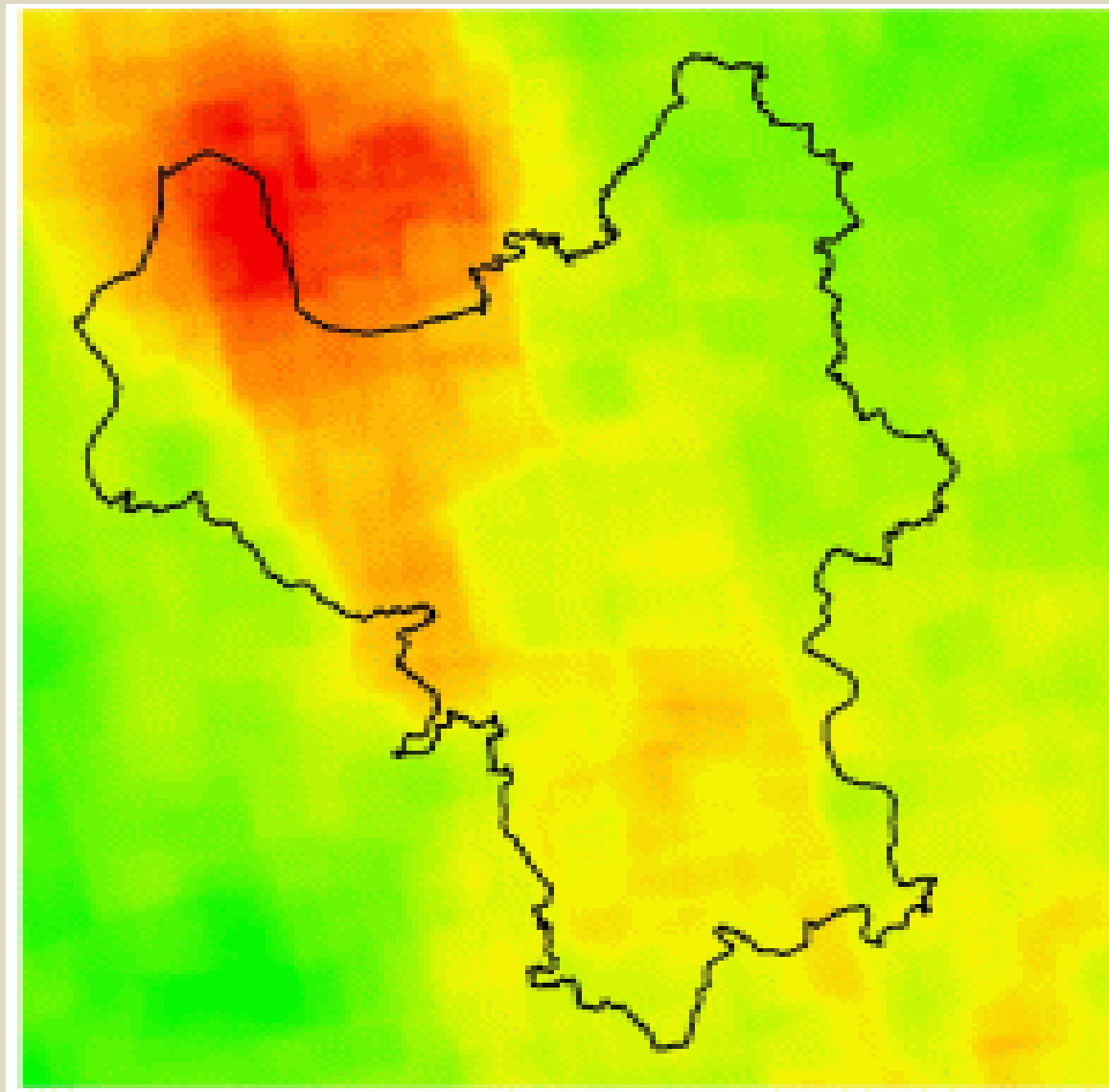


Original data



After processing (100m resolution)

Data time series

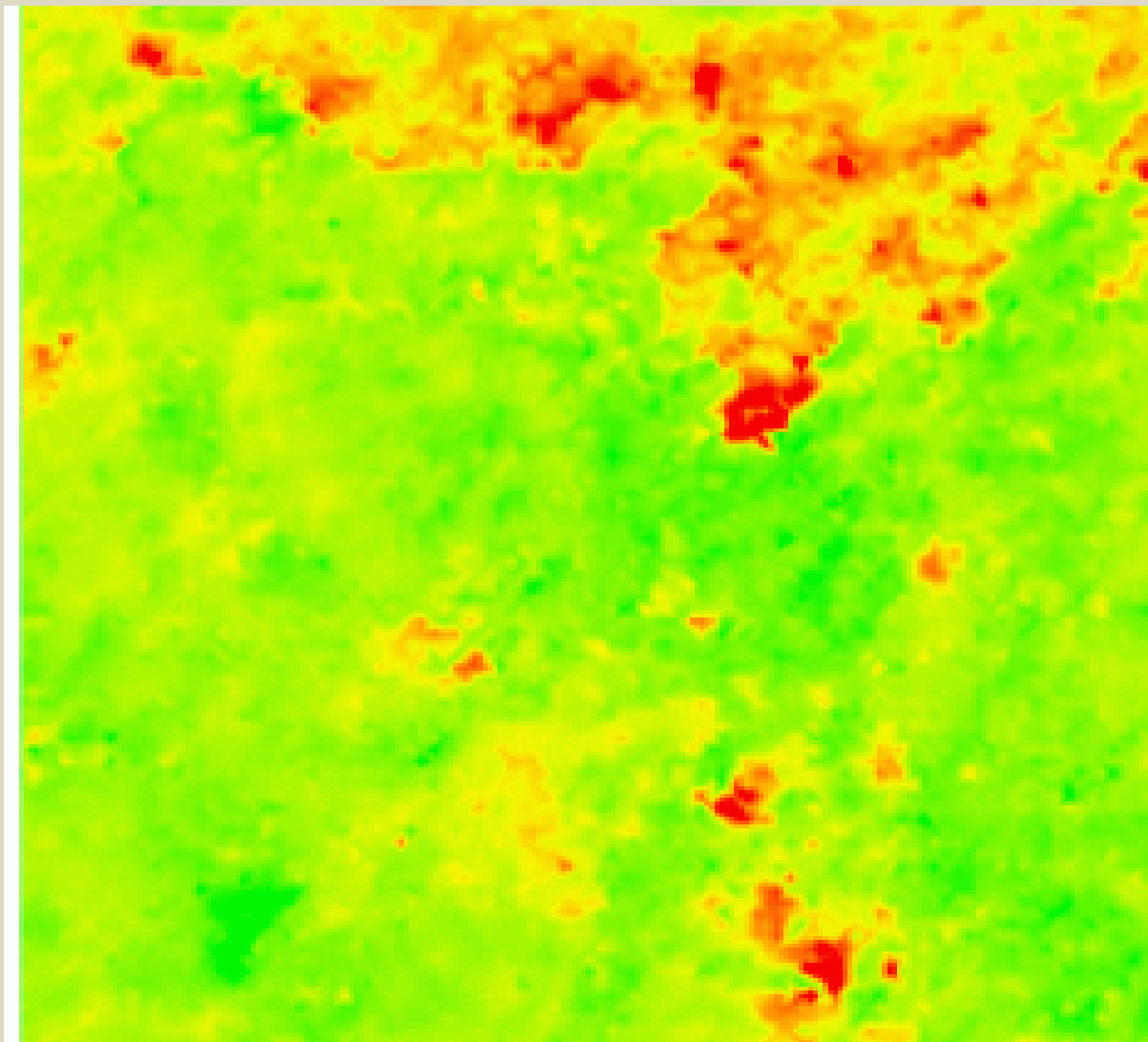


NO2 of 2022

Nghiêm Văn Tuấn

18/02/2023

AQI 24h



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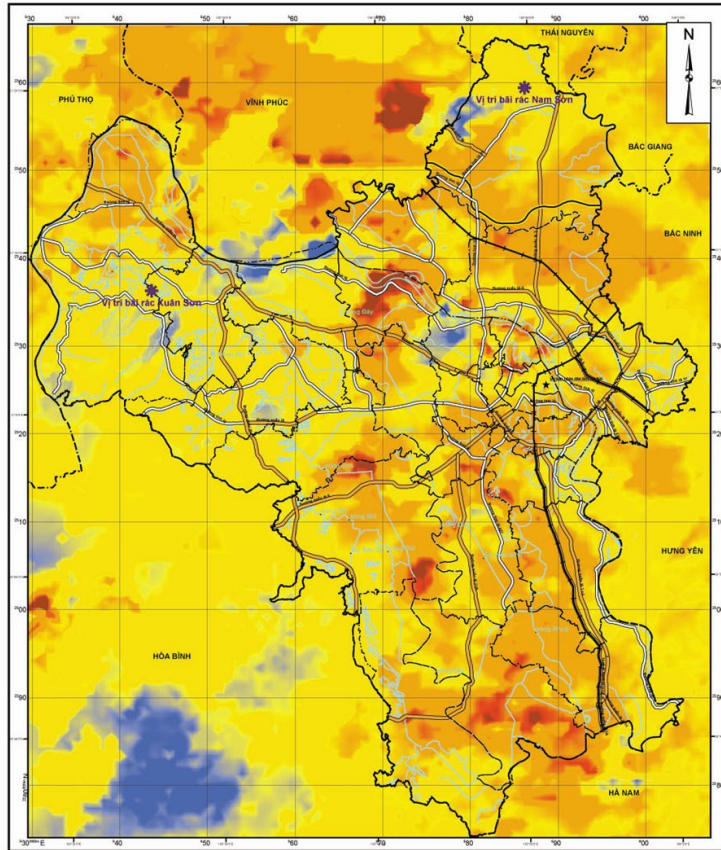
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18/02/2023

Ingillem van Iuan

Maps of AQI 24h

**BẢN ĐỒ CHỈ SỐ CHẤT LƯỢNG KHÔNG KHÍ AQI 24H
QUÝ I NĂM 2022 KHU VỰC HÀ NỘI**



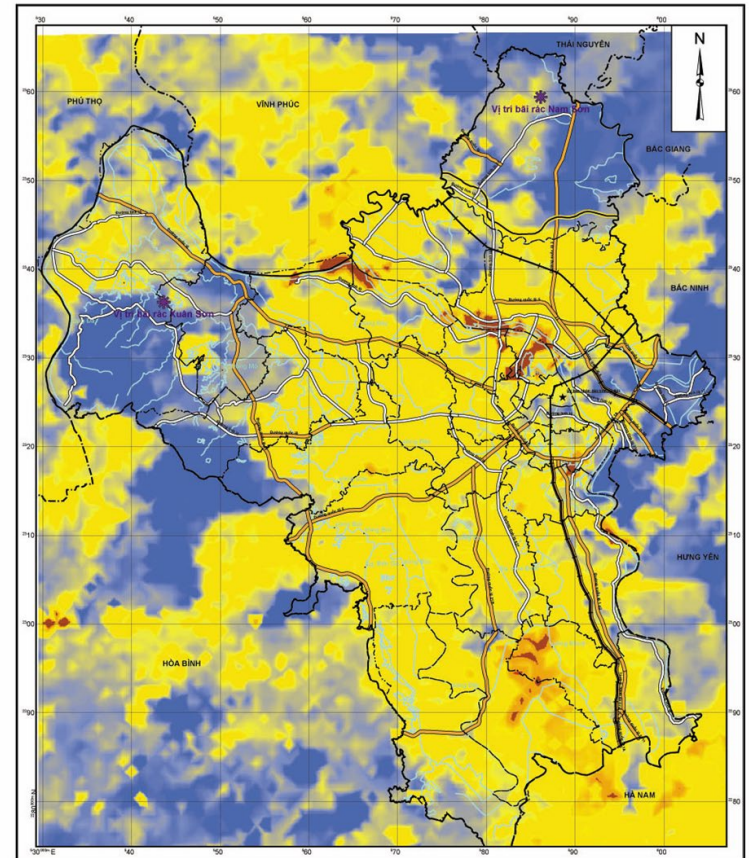
Tỷ lệ 1: 250 000

CHỮ GIẢI	Chỉ số AQI 24h
Blue	0-50
Light Blue	51-100
Yellow	101-200
Orange	201-300
Red	>300

CÁC YẾU TỐ NỘI DUNG BẢN ĐỒ	
●	Vị trí bãi rác
★	Khu chức năng
—	Địa giới hành chính cấp tỉnh
- - -	Địa giới hành chính cấp huyện
—	Đường bờ nước
—	Đoạn đường sắt
—	Đường Cao tốc
—	Đường Quốc lộ
—	Đường Tỉnh lộ

Q1

**BẢN ĐỒ CHỈ SỐ CHẤT LƯỢNG KHÔNG KHÍ AQI 24H
QUÝ II NĂM 2022 KHU VỰC HÀ NỘI**



Tỷ lệ 1: 250 000

CHỮ GIẢI	Chỉ số AQI 24h
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—	Đường Quốc lộ
—	Đường Tỉnh lộ

Q2

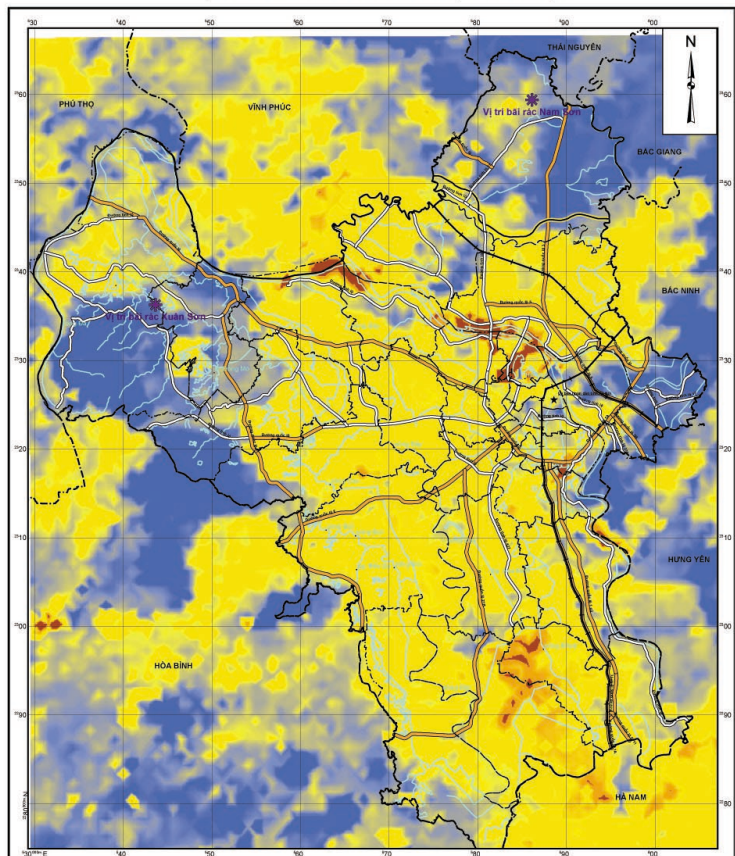
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Maps of AQI 24h

**BẢN ĐỒ CHỈ SỐ CHẤT LƯỢNG KHÔNG KHÍ AQI 24H
QUÝ II NĂM 2022 KHU VỰC HÀ NỘI**

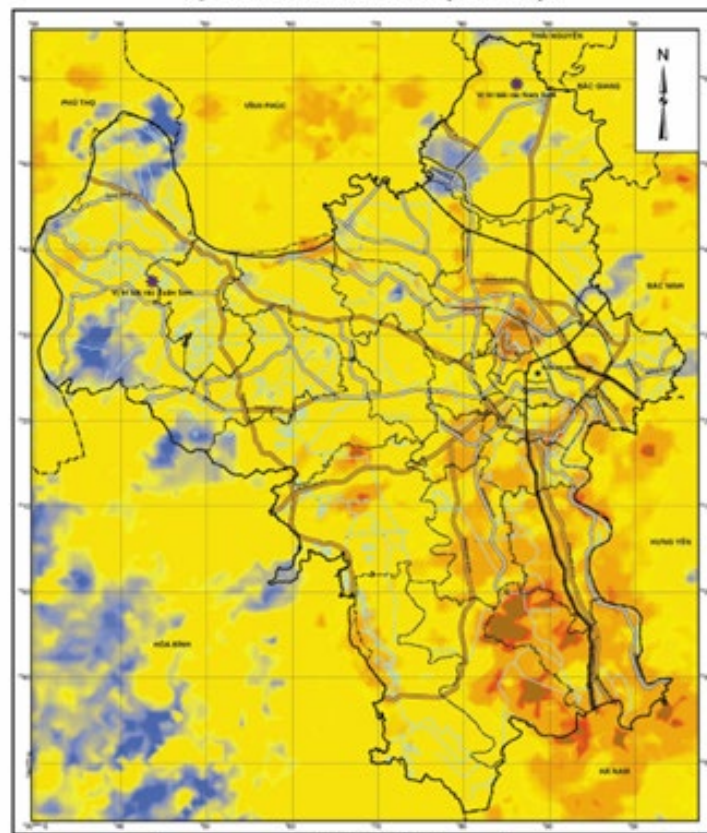


CHỈ SỐ	Đặc điểm
0-50	0-50
51-100	51-100
101-150	101-150
151-200	151-200
201-300	201-300
> 300	> 300

Tỷ lệ 1: 250 000

CÁC YẾU TỐ NỘI DUNG BẢN ĐỒ	
•	Vị trí bãi rác
•	Khu chức năng
—	Đa giới hành chính cấp tỉnh
—	Đa giới hành chính cấp huyện
—	Đường bộ nước
—	Đoạn đường sắt
—	Đường Cao tốc
—	Đường Quốc lộ
—	Đường Tỉnh lộ

**BẢN ĐỒ CHỈ SỐ CHẤT LƯỢNG KHÔNG KHÍ AQI 24H
QUÝ IV NĂM 2022 KHU VỰC HÀ NỘI**

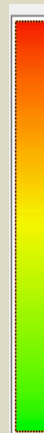


CHỈ SỐ	Đặc điểm
0-50	0-50
51-100	51-100
101-150	101-150
151-200	151-200
201-300	201-300
> 300	> 300

Tỷ lệ 1: 250 000

CÁC YẾU TỐ NỘI DUNG BẢN ĐỒ	
•	Vị trí bãi rác
•	Khu chức năng
—	Đa giới hành chính cấp tỉnh
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—	Đường Quốc lộ
—	Đường Tỉnh lộ

400



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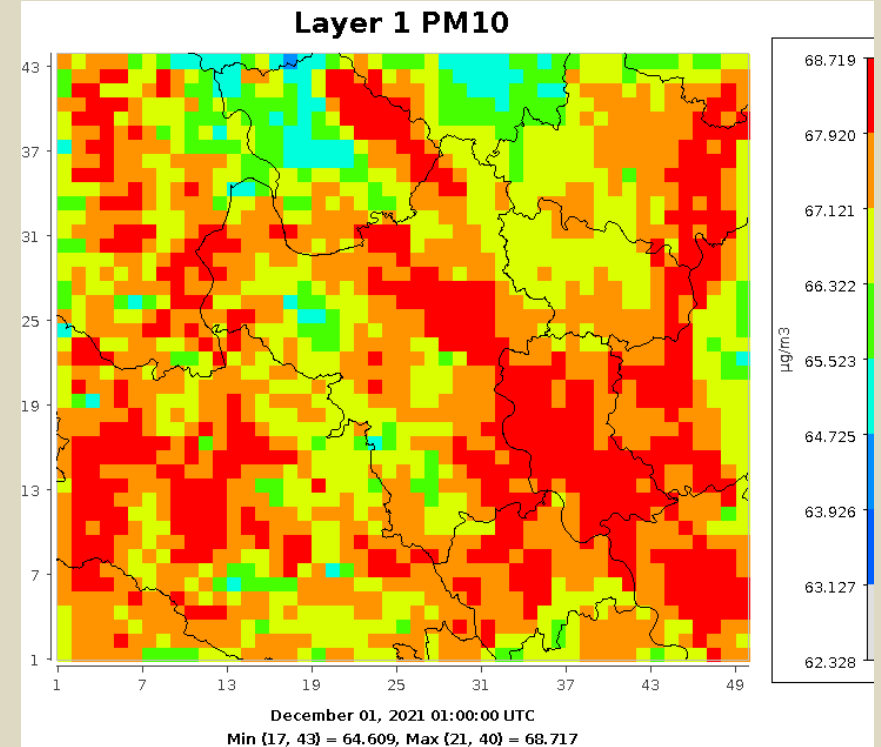
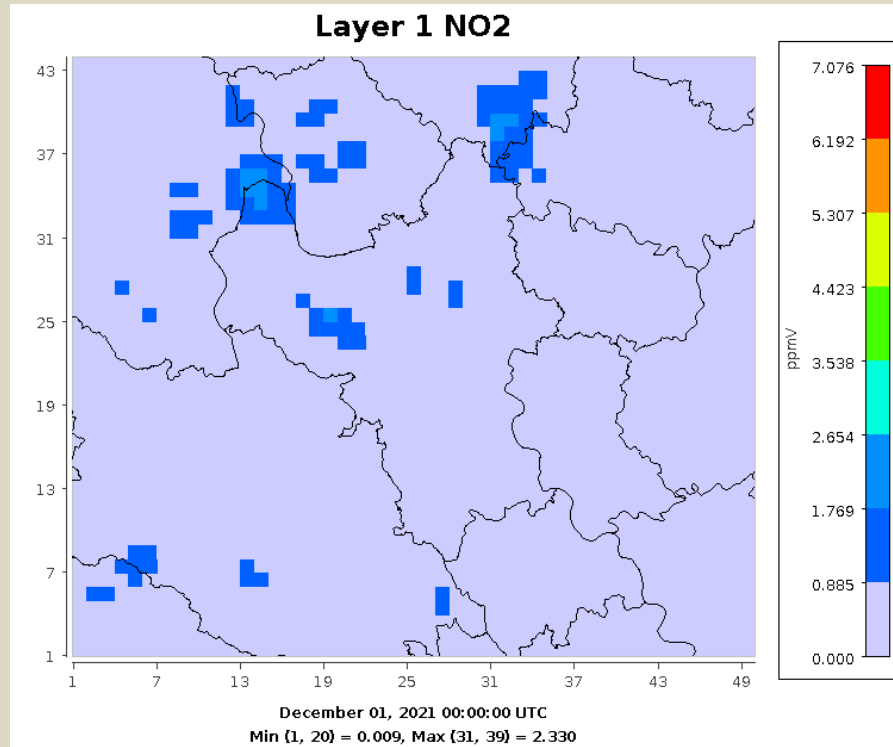
Q3

Q4

AIR POLLUTION MODELLING

Modelling the spread of air pollution in Hanoi area

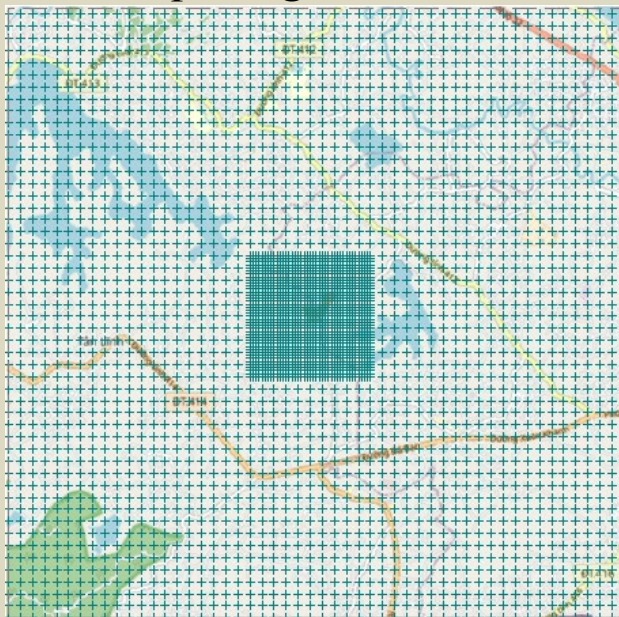
Using the WRF-Chem model



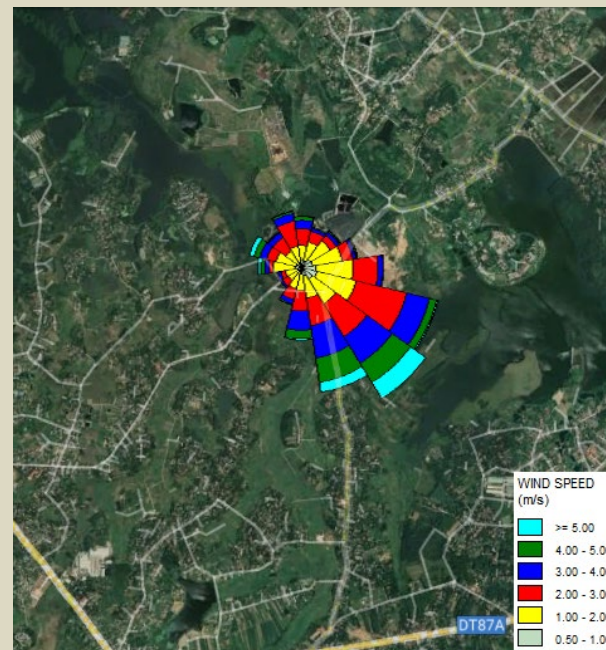
Modelling the air pollution dispersion from waste disposal areas

Using the AERMOD model

Set up the grid domain

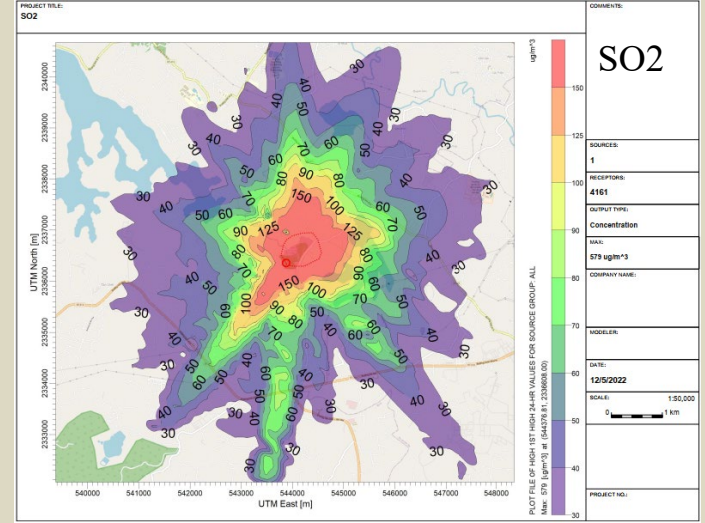
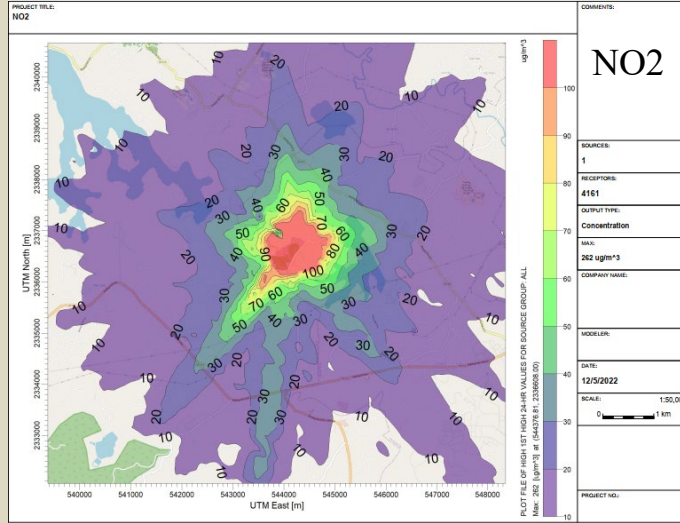


Meteorological data setting

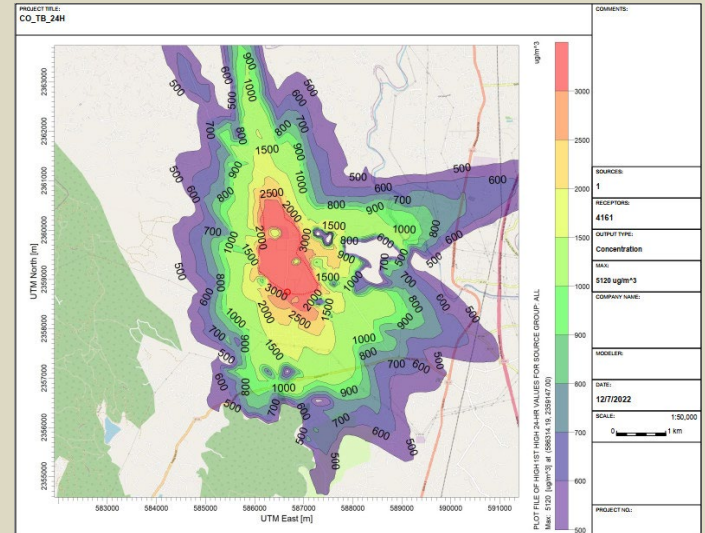
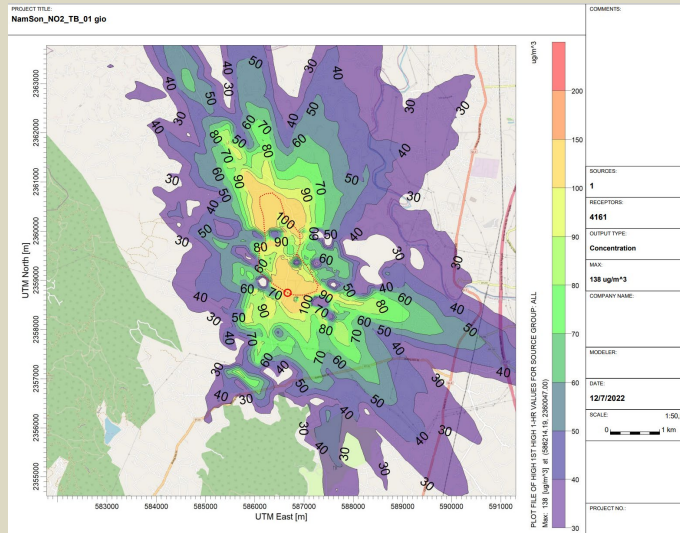


Establishing emission factors: using UAV monitoring data at 02 landfills

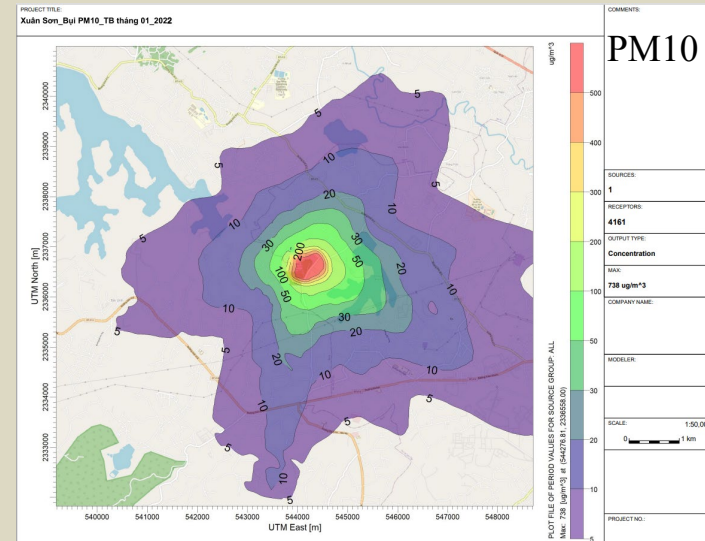
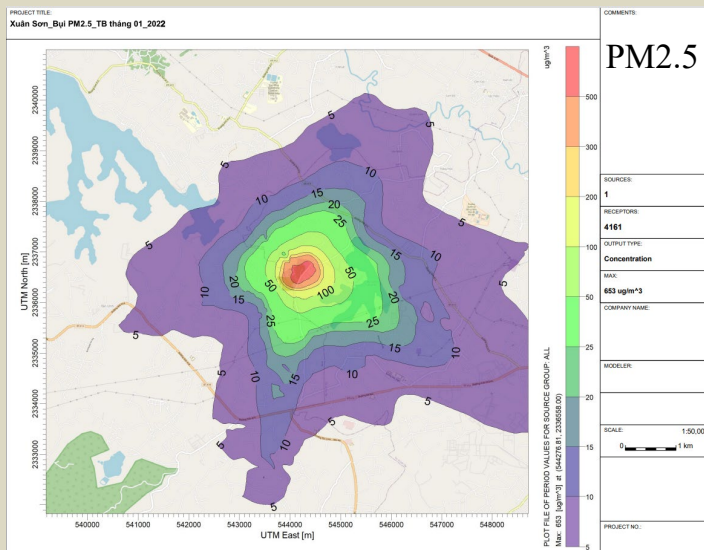
Average 24h spreading NO2 and SO2 of Xuan Son landfill



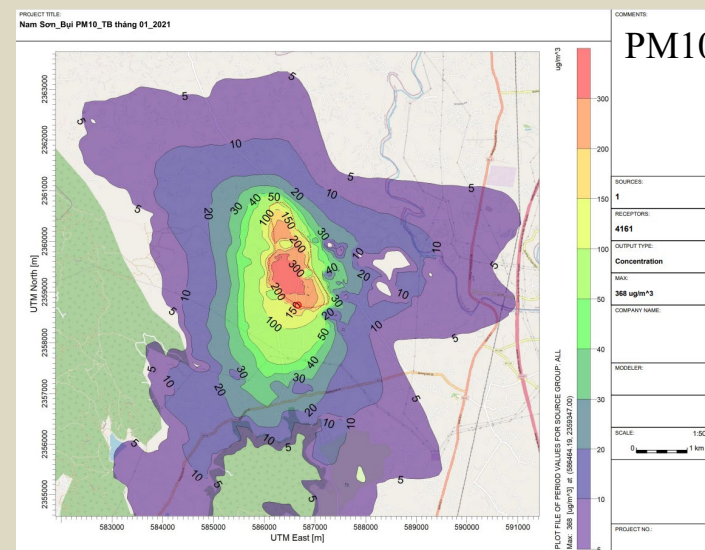
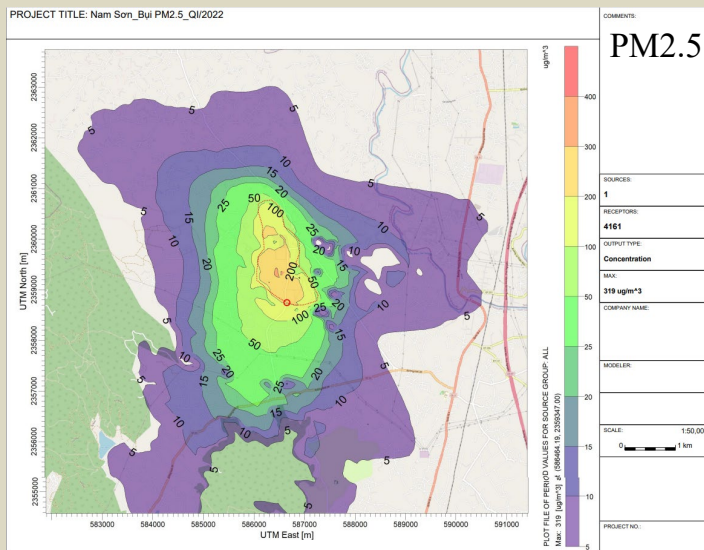
Average 24h spreading NO2 and SO2 of Nam Son landfill



Average 24h spreading PM2.5 and PM10 of Xuan Son landfill



Average 24h spreading PM2.5 and PM10 of Nam Son landfill



CONCLUSIONS AND RECOMMENDATIONS

Conclusions

- Results have shown that using remote sensing technology can meet air quality monitoring on a large scale.
- The research also shows that the application of Bigdata-remote sensing management and processing solutions in collecting, analyzing and processing remote sensing data has brought high efficiency.
- With Bigdata and Bigdata-remote sensing technology solutions, it allows processing remote sensing data in large volumes to extract daily air quality parameters.
- This technological solution also allows the combination of air quality data extracted from remote sensing with the one from the network of monitoring stations; allowing the resolution enhanced to be able to monitor detailed in small areas, but with common air pollution such as concentrated waste treatment areas, industrial parks, craft villages, etc.

Recommendation

In order for this solution to be effective and applicable in practice, it is necessary to continue researching, developing and building an Automatic air quality monitoring system; in which automatically from the processing of remote sensing data and directly linked to the network of monitoring stations to improve the quality and accuracy of air quality data.

Thanks for your attention!