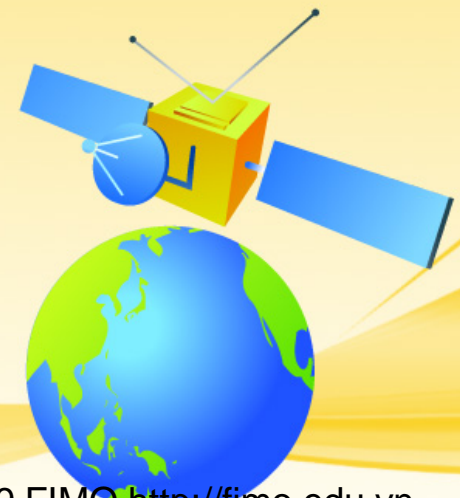


4th International Forum on Sustainable Future in Asia 4th NIES International Forum

SEAP: a Spatial data Exploration and Analysis Platform for Monitoring Environment Change

Center of Multidisciplinary Integrated Technology for Field Monitoring,
University of Engineering and Technology, Vietnam National University



Hanoi, January 23-24, 2019

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OUTLINE

- ❑ Introduction
- ❑ Urban classification in Vietnam
- ❑ Satellite air quality(PM2.5) estimation algorithm over Hanoi
- ❑ Impacts of urban expansion on air pollution
- ❑ SEAP: a Spatial data Exploration and Analysis Platform for Monitoring Environment Change



INTRODUCTION



RESEARCH OBJECTIVES

- Estimating the urban expansion of Vietnam from 2004 to 2015
- Analyzing the air pollution of Vietnam from 2004 to 2015
- Understanding the impacts of urban expansion on air pollution in Vietnam from 2004 to 2015.
- Building a platform for spatial and environmental data analysis and storage.



RESEARCH CONTRIBUTIONS

- Proposing an optimized urban classification method in Vietnam and a time-series of urban map from 2004 to 2015.
- Building an appropriate model to estimating air quality index in Vietnam.
- Evaluating the correlation between urban expansion and air pollution in Vietnam from 2004 to 2015.
- A spatial data exploration and analysis platform for monitoring environment change

URBAN CLASSIFICATION



DATA COLLECTION

For urban-mapping

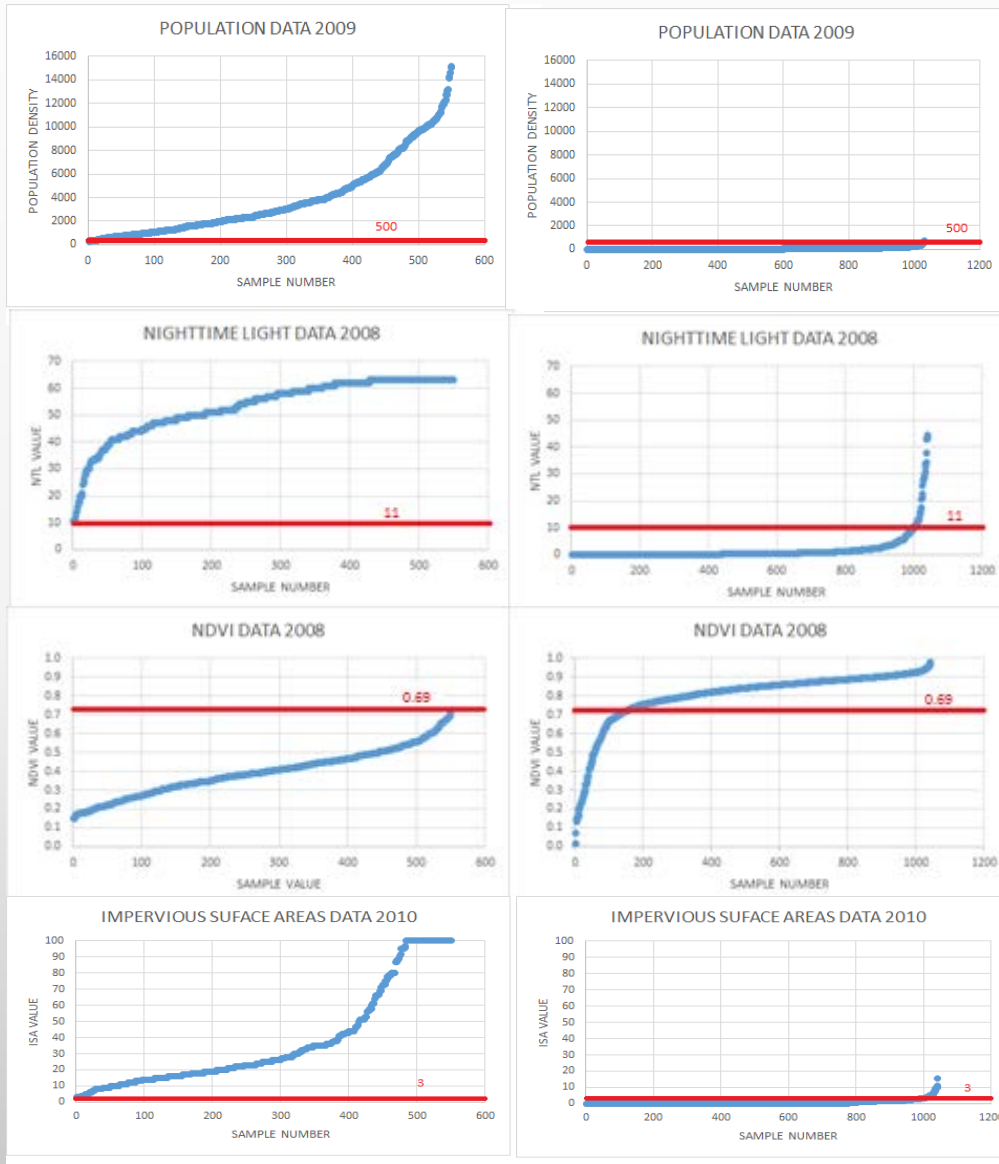
Data type	Population density	Nighttime light		Vegetation Indices	Impervious surface	Inland water
Abbr	GPWv4	DMSP-OLS	NPP-VIIRS	MOD13Q1	EstISA	MOD44W
Spatial Resolution	1 km	1km	500m	250m	1km	250m
Time	2004, 2008, 2012, 2015	2004, 2008, 2012	2015	2004, 2008, 2012, 2015	2010	2004, 2008, 2012, 2015



Sampling and threshold calculation

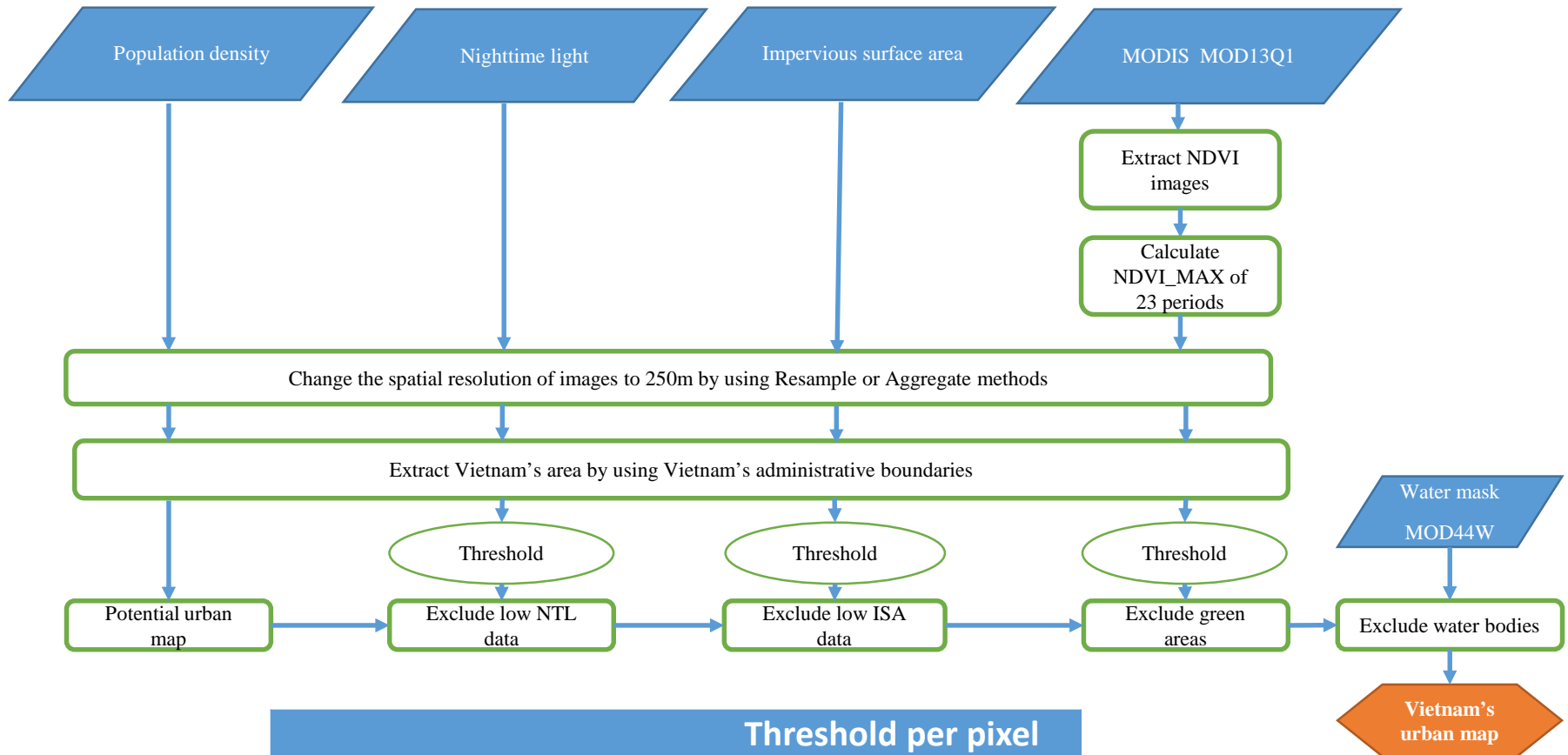
URBAN SAMPLES

NON-URBAN SAMPLES



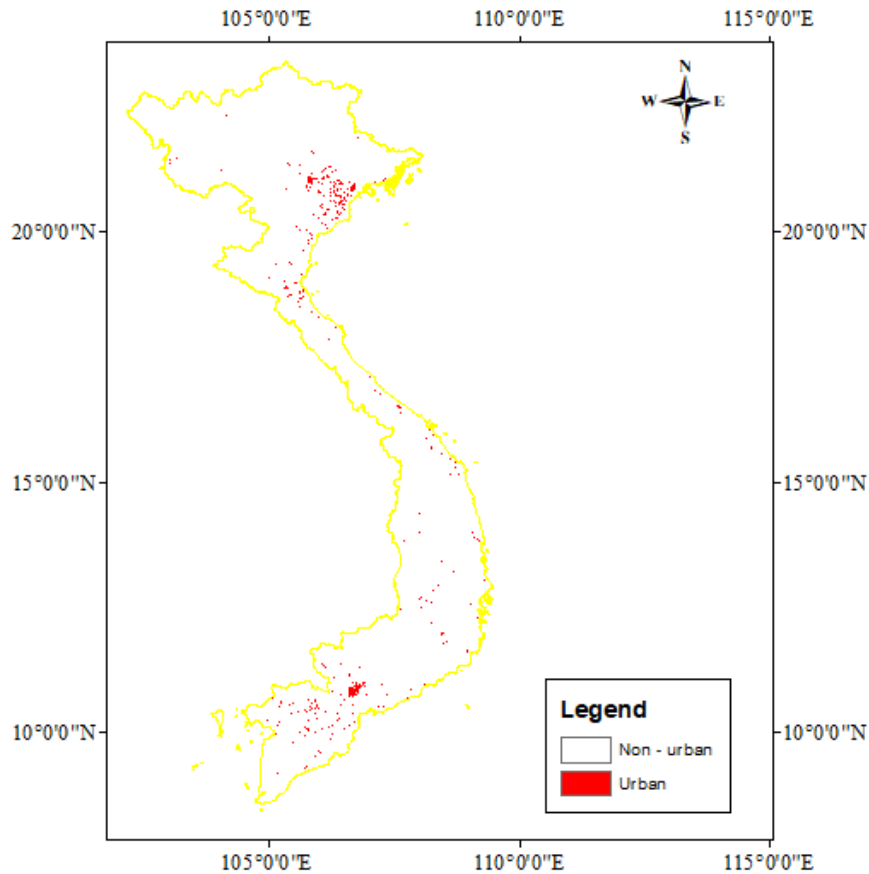
	Threshold per pixel
Population density (using Vietnam standard)	500
Nighttime light	11
NDVI_MAX	0.69
Impervious surface areas	3

Flowchart of urban-mapping

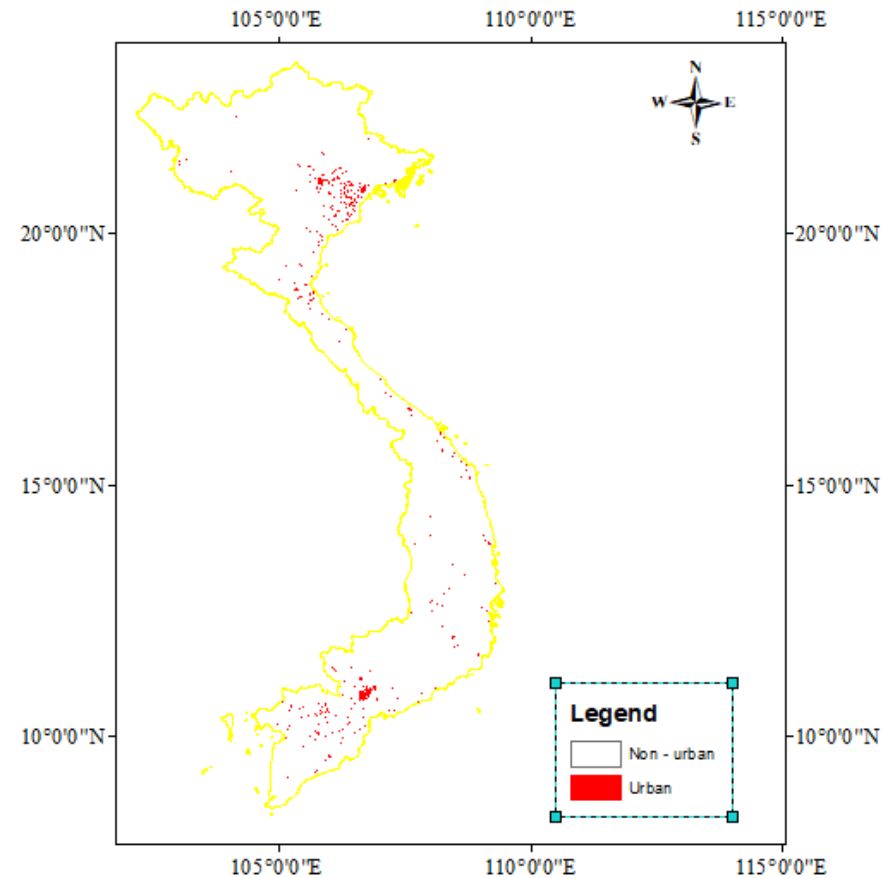


Threshold per pixel	
Population density	500
Nighttime light	11
NDVI_MAX	0.69
Impervious surface areas	3

Urban classification: Results

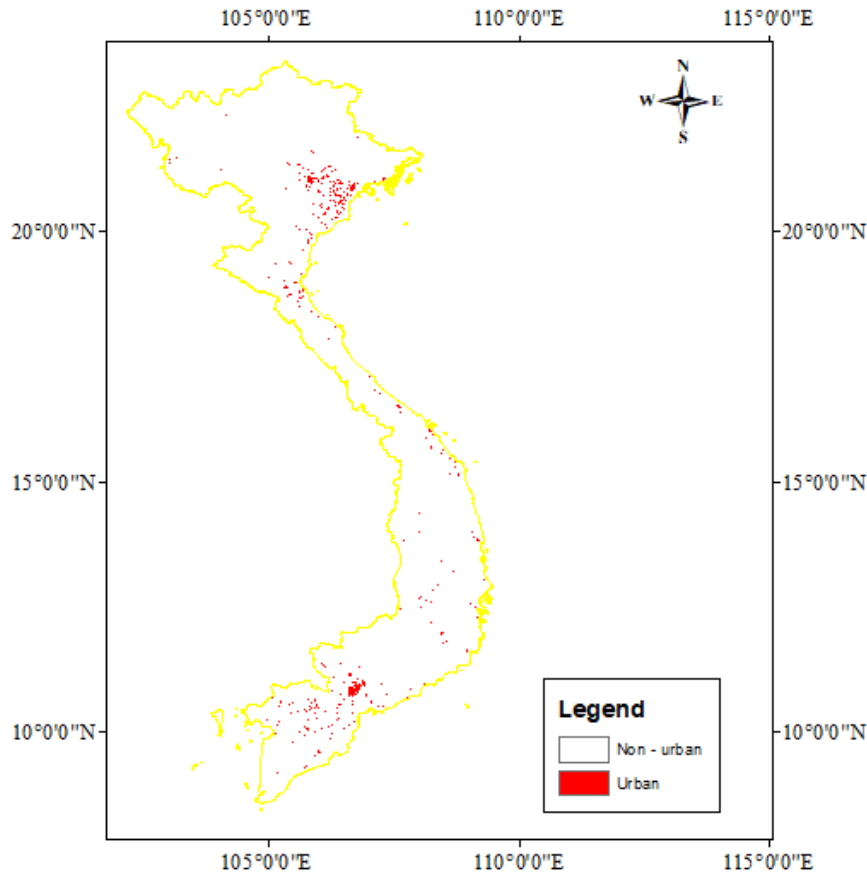


**Vietnam's urban map
2004: 4623 km²**

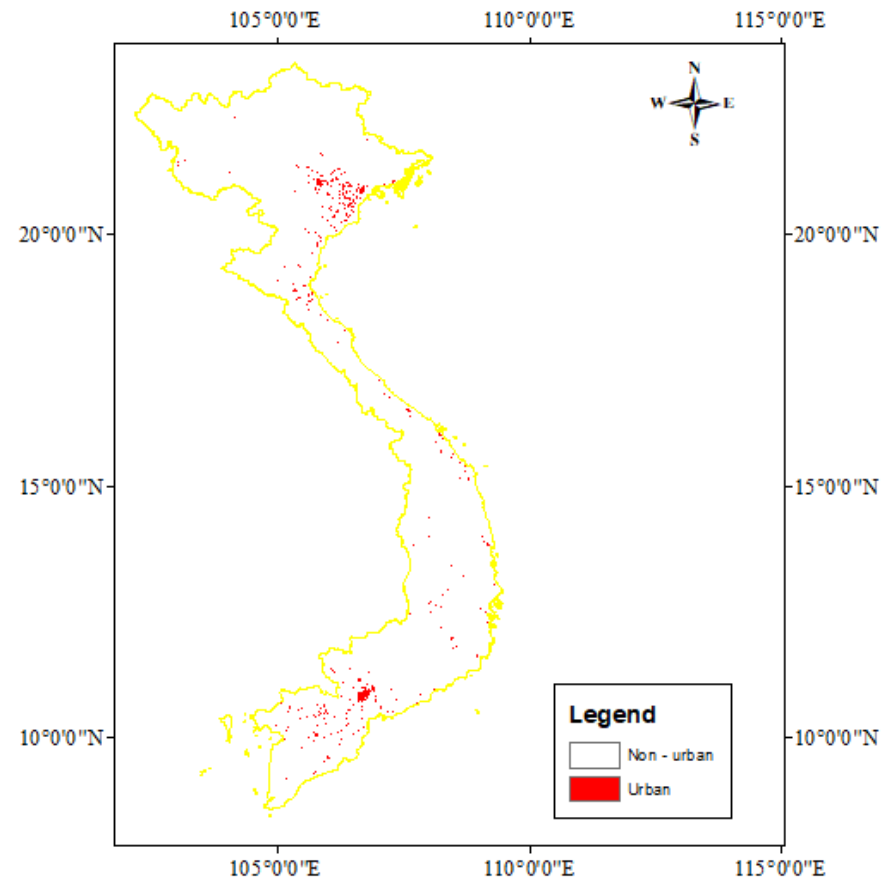


**Vietnam's urban map
2008: 4860 km²**

Urban classification: Results

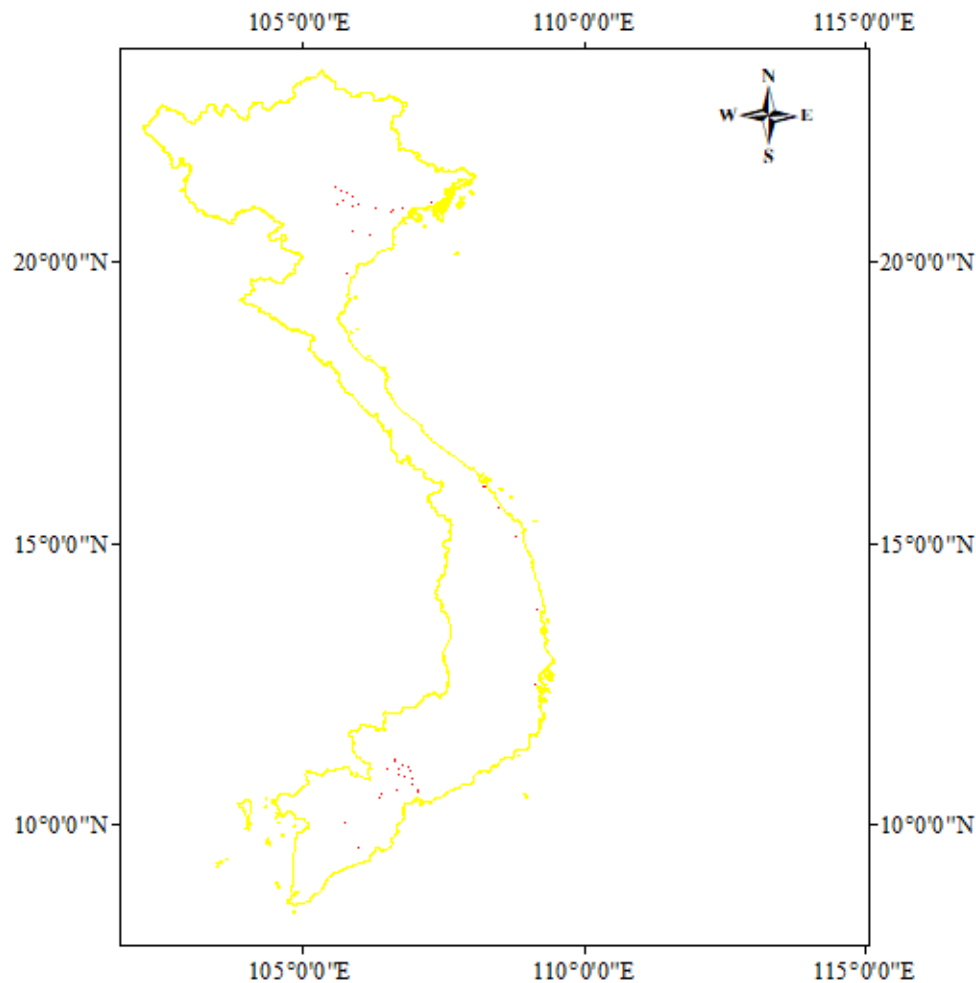


**Vietnam's urban map
2012: 5041 km²**




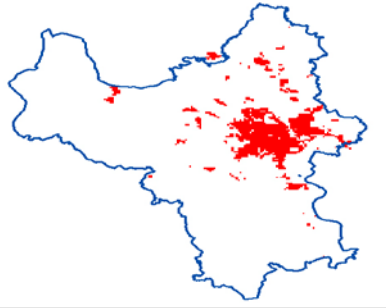
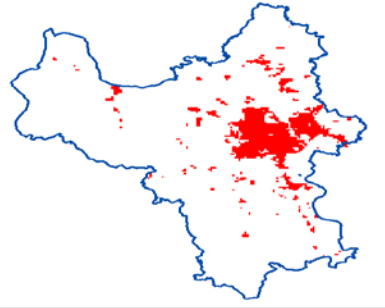
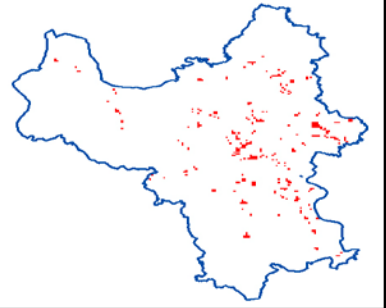




**Vietnam's urban map
2015: 5094 km²**

Urban classification: Results

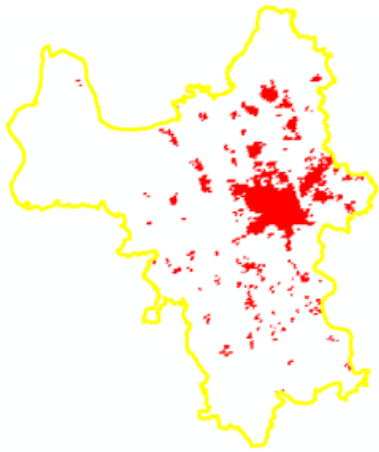


**Vietnam's urban expansion
2004-2015: 471 km²**

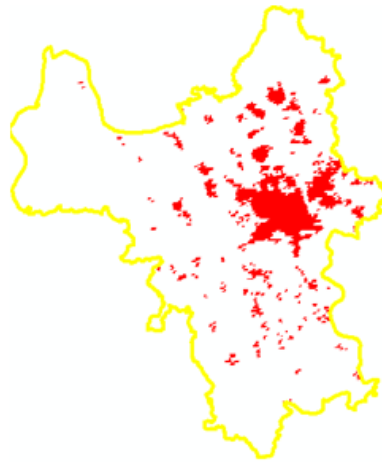
Urban classification: Results

	Google Earth images	Urban map 2004	Urban map 2015	Urban expansion 2004-2015
Hanoi				
Hochiminh city				

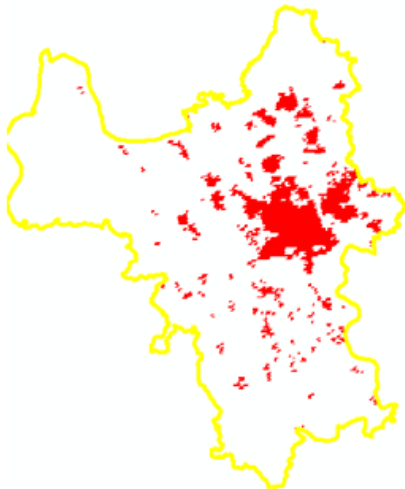
Urban map over Hanoi



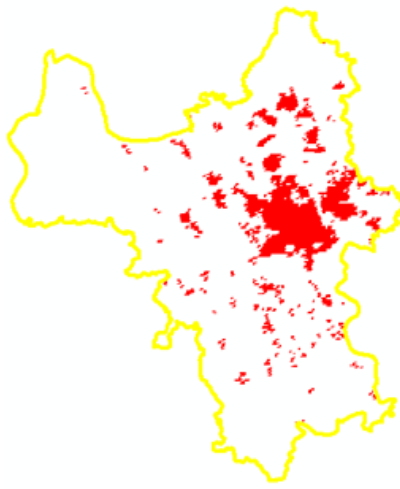
Năm 2004



Năm 2008



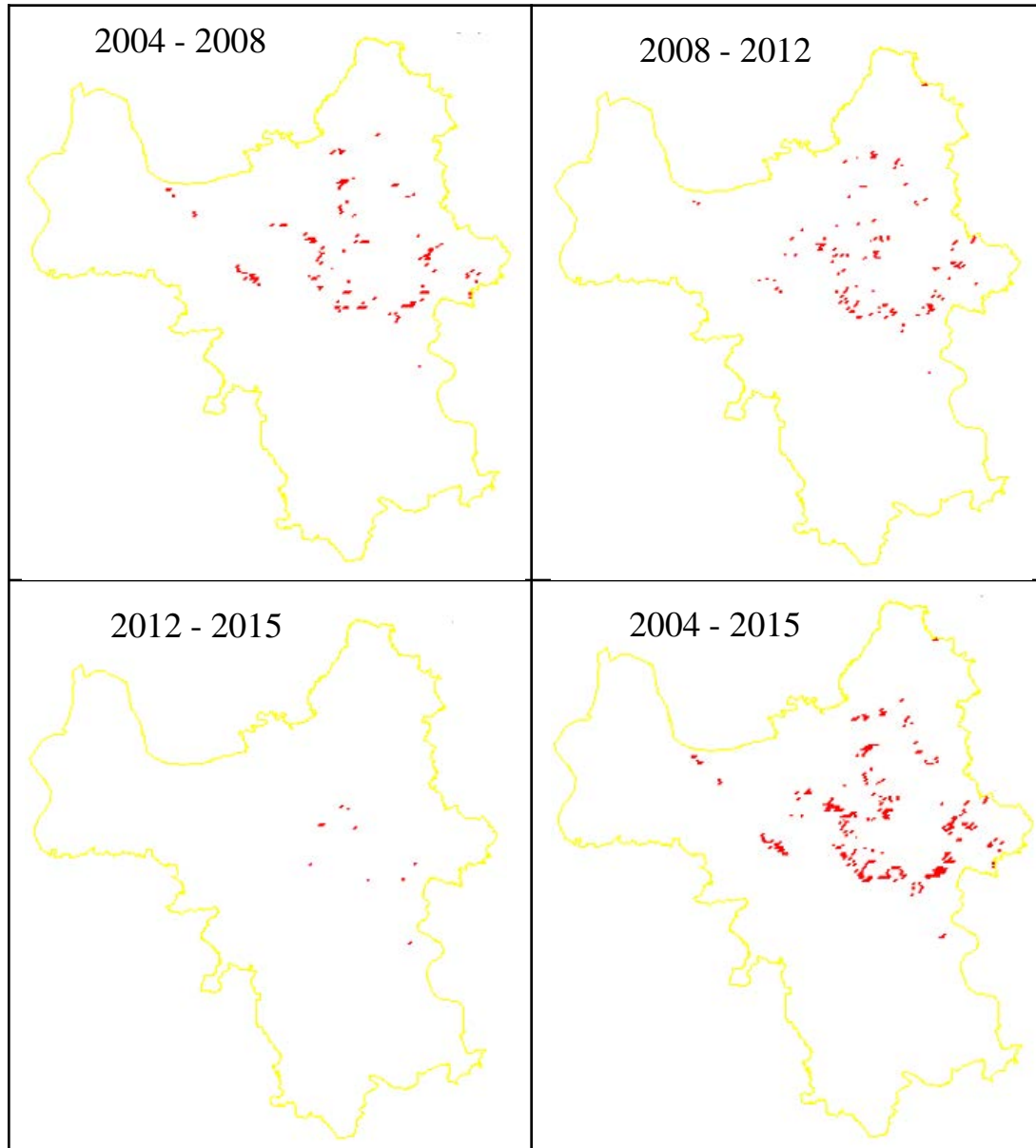
Năm 2012



Năm 2015

Year	Urban area
2004	288,9 km ²
2008	307,2 km ²
2012	334,4 km ²
2015	344,1 km ²

Urban expansion map over Hanoi(2004 – 2015)



SATELLITE AIR QUALITY (PM_{2.5}) ESTIMATION ALGORITHM OVER HANOI



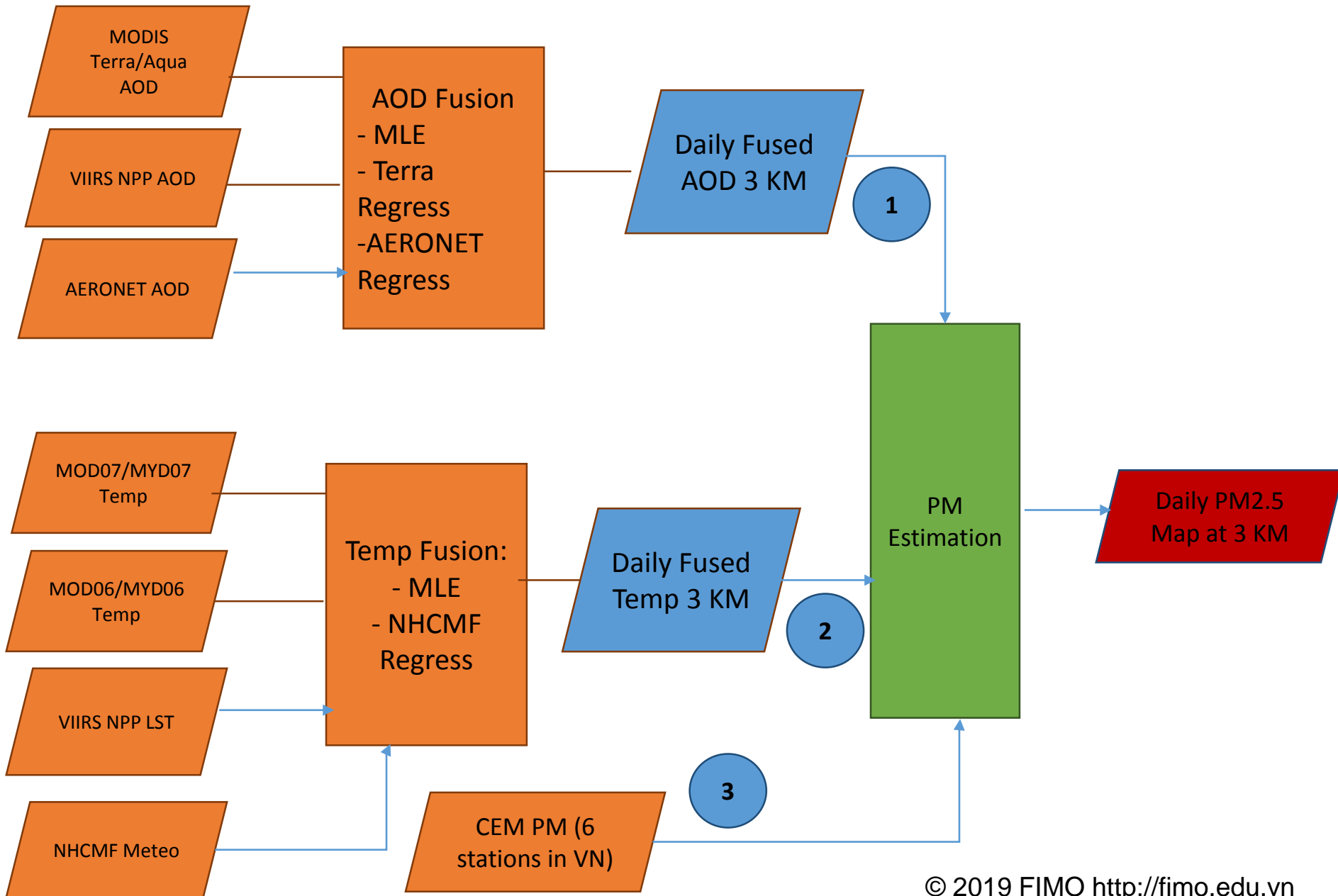
DATA COLLECTION

For air quality index estimation

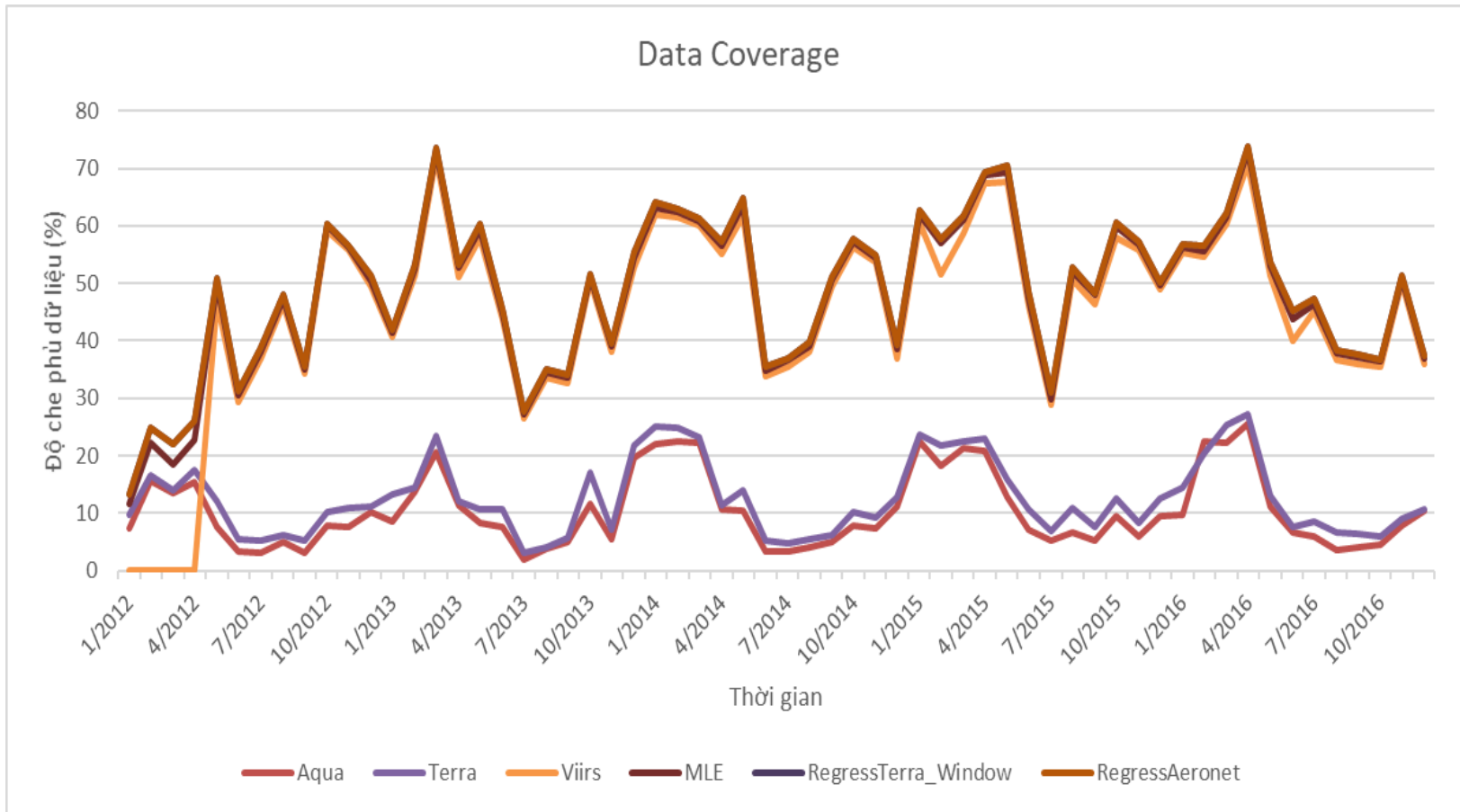
Data type	Aerosol Product	Satellite temperature		Aerosol Optical Depth	Ground - measurements PM2.5
Abbr	MOD04 3K	MOD06, MOD07	VIIRS LST	AERONET AOD	CEM PM2.5
Spatial Resolution	3 km	5 km	1 km	-	-
Time	2004, 2008, 2012, 2015	2004, 2008, 2012	2012, 2015	2012, 2015	2012, 2015



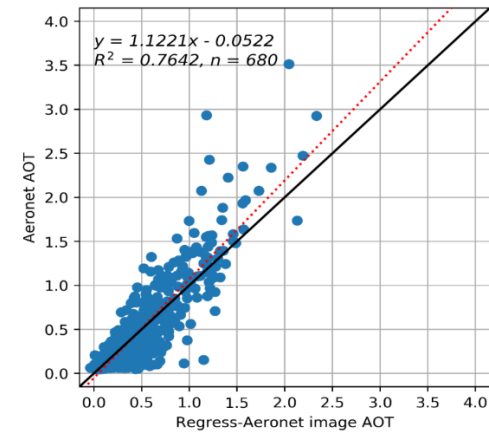
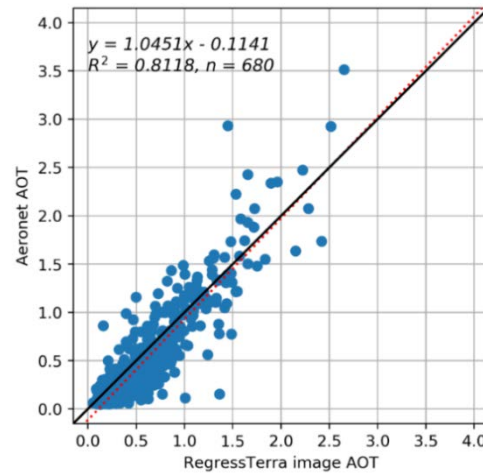
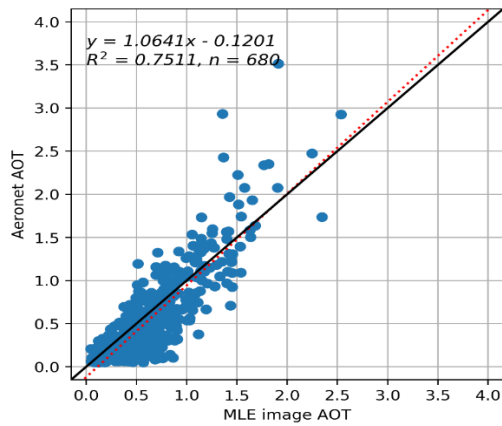
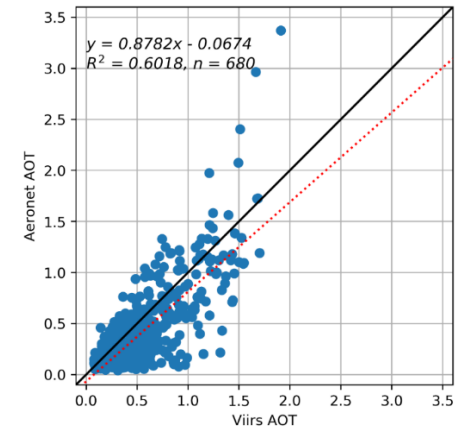
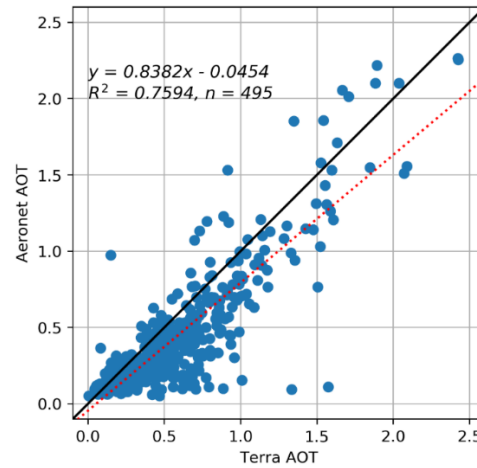
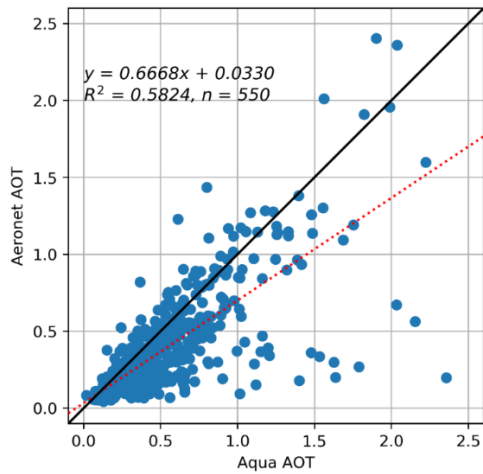
Flowchart of AQI estimation algorithm



Data coverage of original and fused AOD data



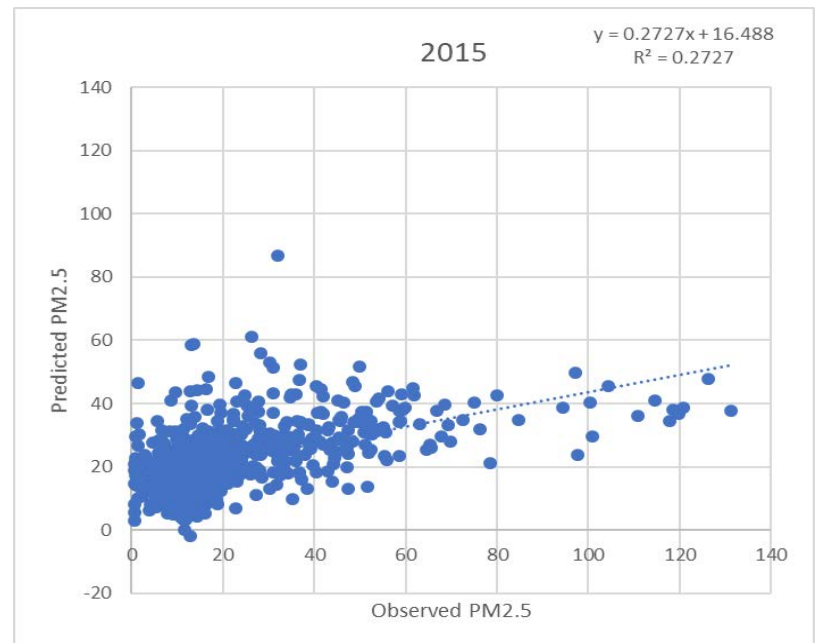
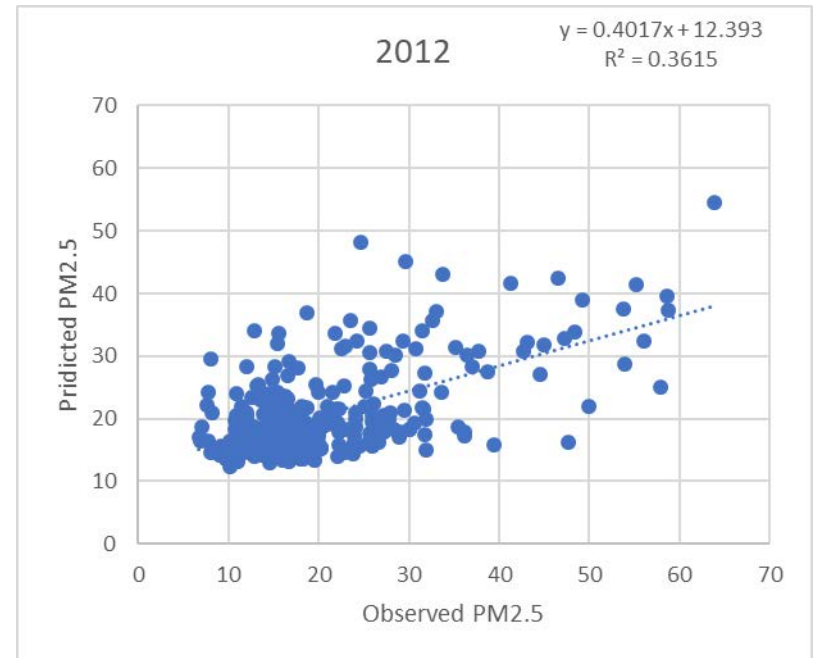
Quality of original and fused AOD data



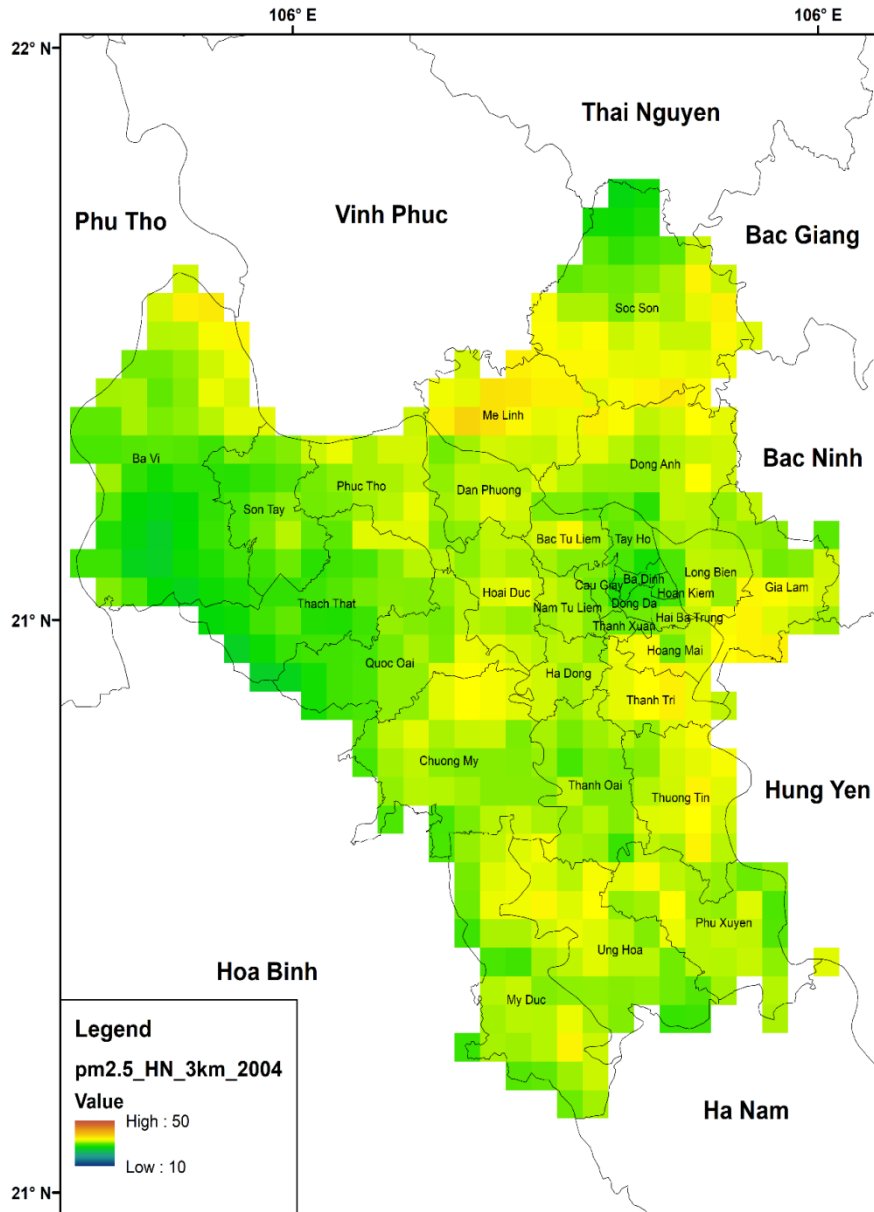
PM Regression model

Model: $PM_{2.5} = f(AOD, Temp)$

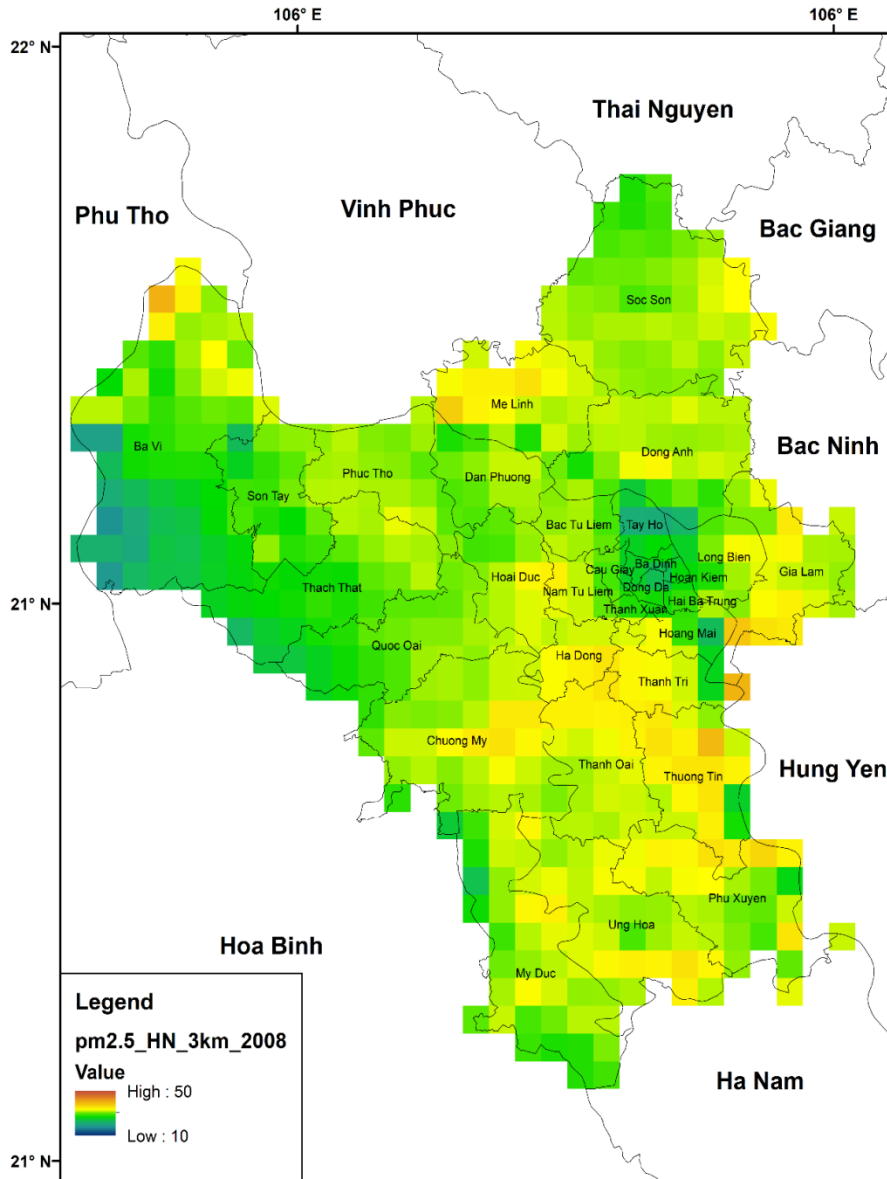
	2012	2015
Samples	300	670
R	0.603	0.522
R ²	0.363	0.272



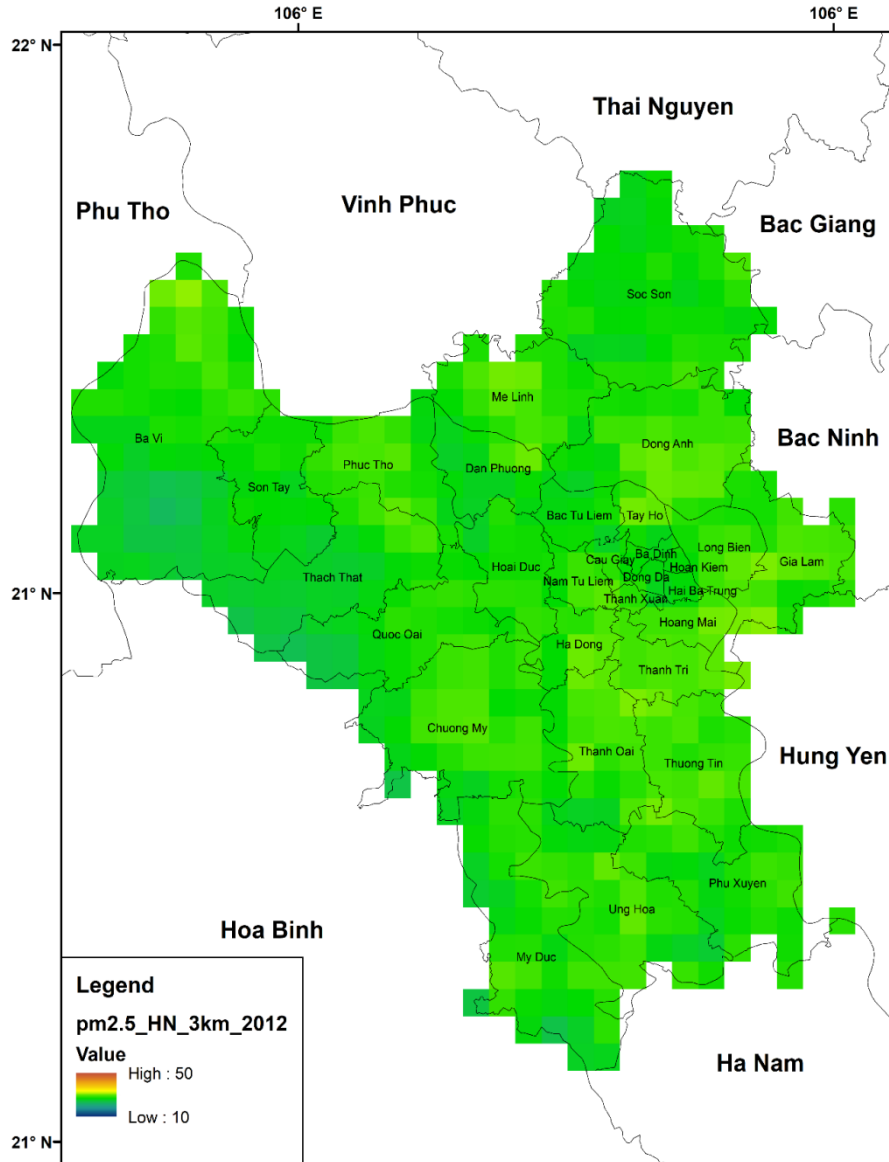
Annual PM2.5 over Hanoi (2004)



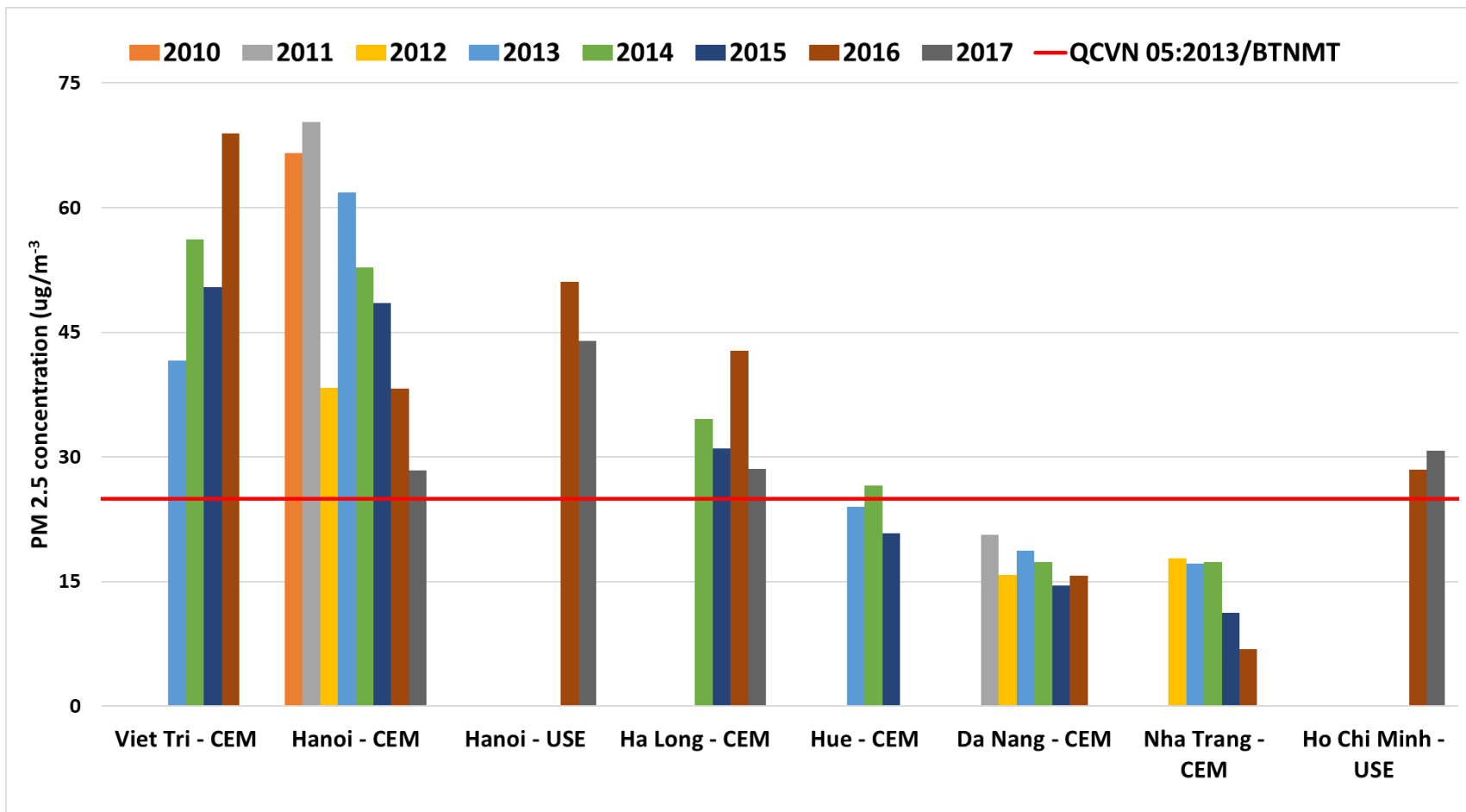
Annual PM2.5 over Hanoi (2008)



Annual PM2.5 over Hanoi (2012)

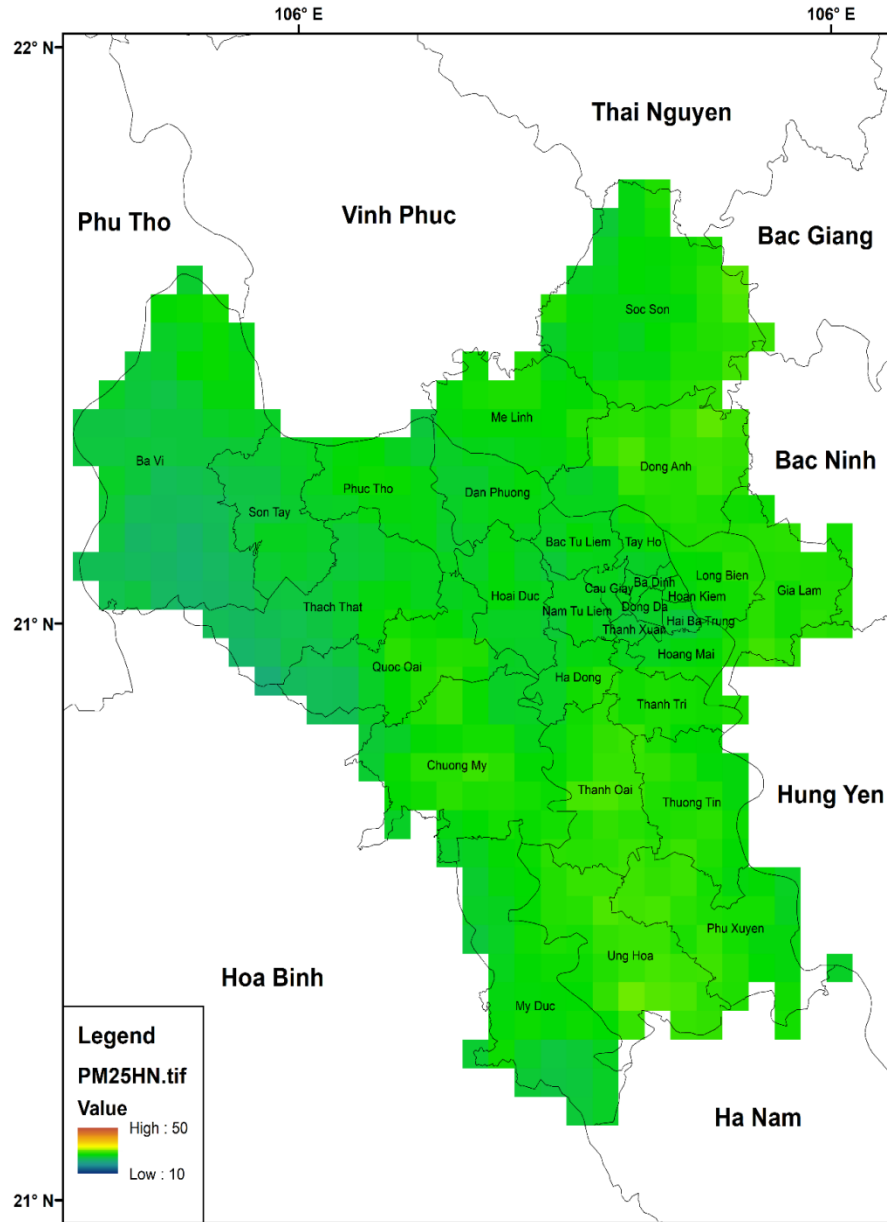


Annual PM2.5 over Hanoi (2012)

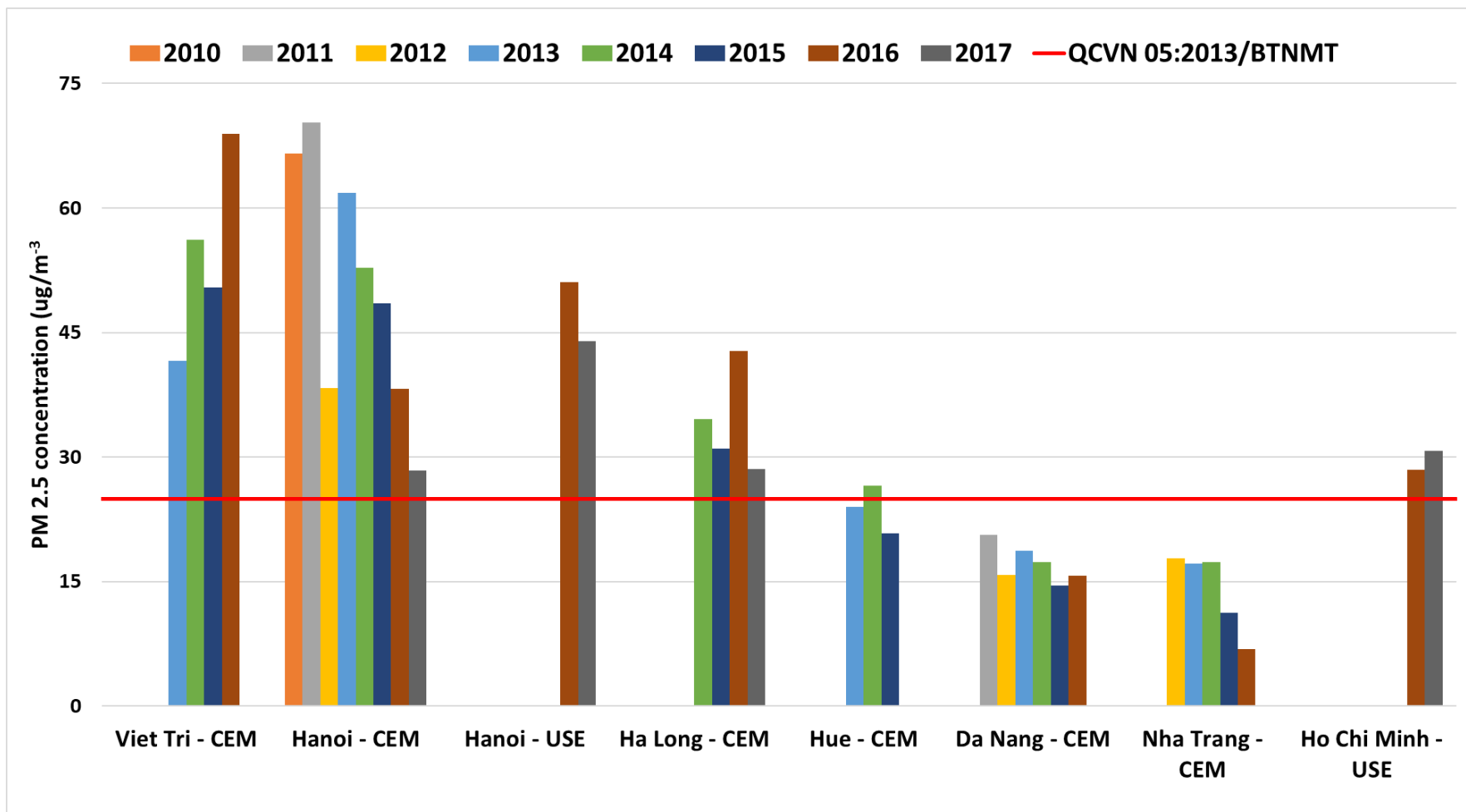


CEM PM2.5 (Source: GER)

Annual PM2.5 over Hanoi (2015)



Annual PM2.5 over Hanoi (2015)



CEM PM2.5 (Source: GER)

Annual PM2.5 over hanoi (2004 – 2015)

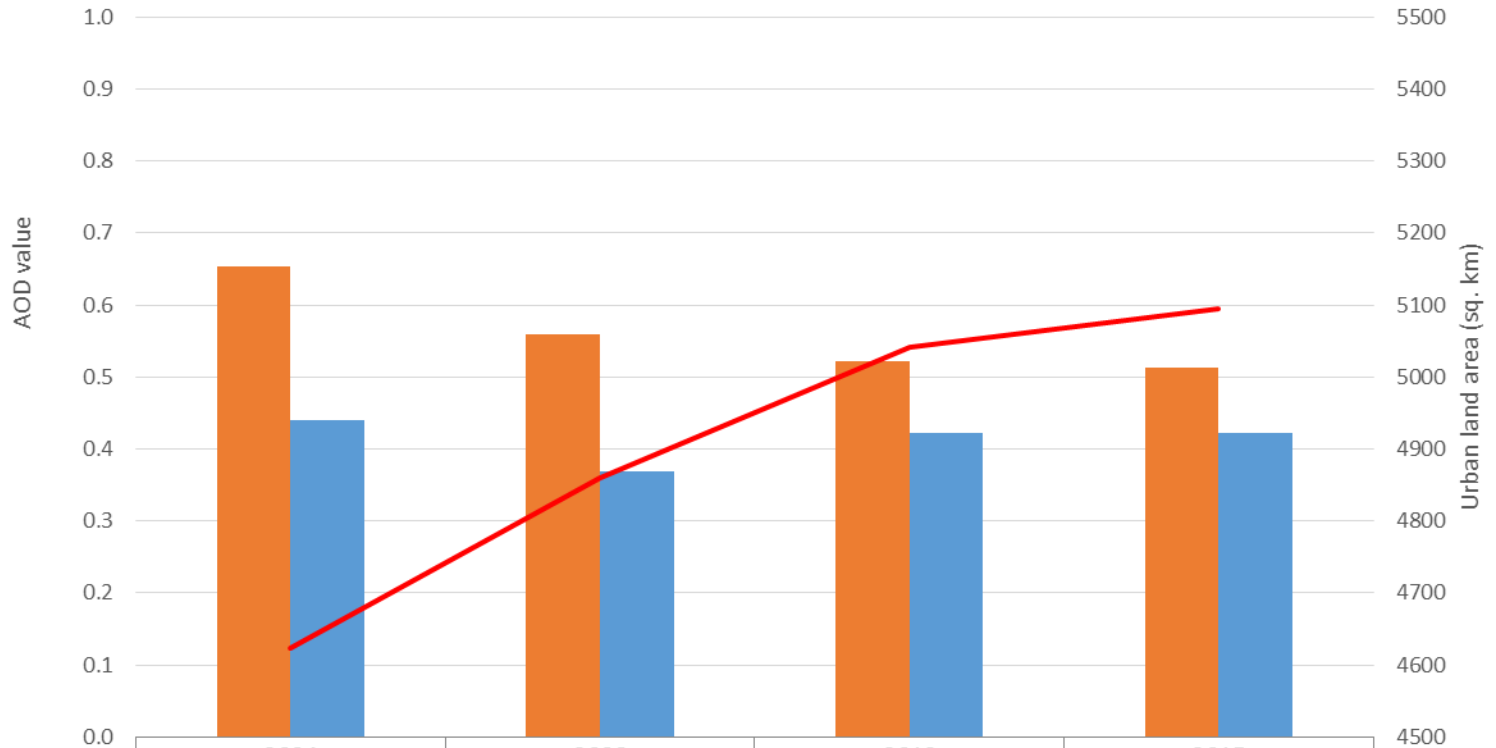
Year	PM2.5 Concentration
2004	31.076
2008	30.399
2012	26.707
2015	23.660

IMPACTS OF URBAN EXPANSION ON AIR POLLUTION



Impacts of urban expansion on air pollution

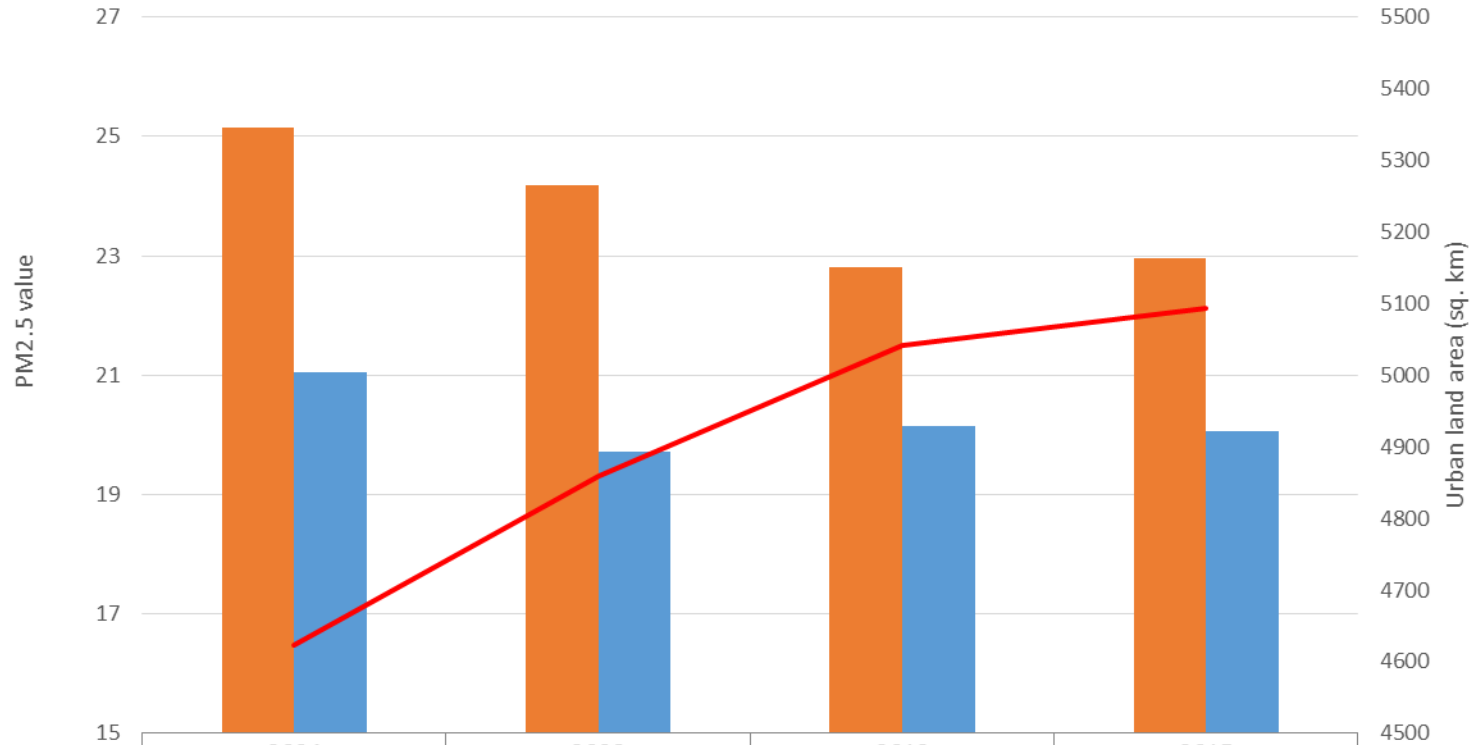
Correlation between urban expansion and AOD value in Vietnam from 2004 to 2015



	2004	2008	2012	2015
Urban	0.653	0.560	0.521	0.513
Non-urban	0.441	0.369	0.421	0.422
Urban land area (sq. km)	4623	4860	5041	5094

Impacts of urban expansion on air pollution

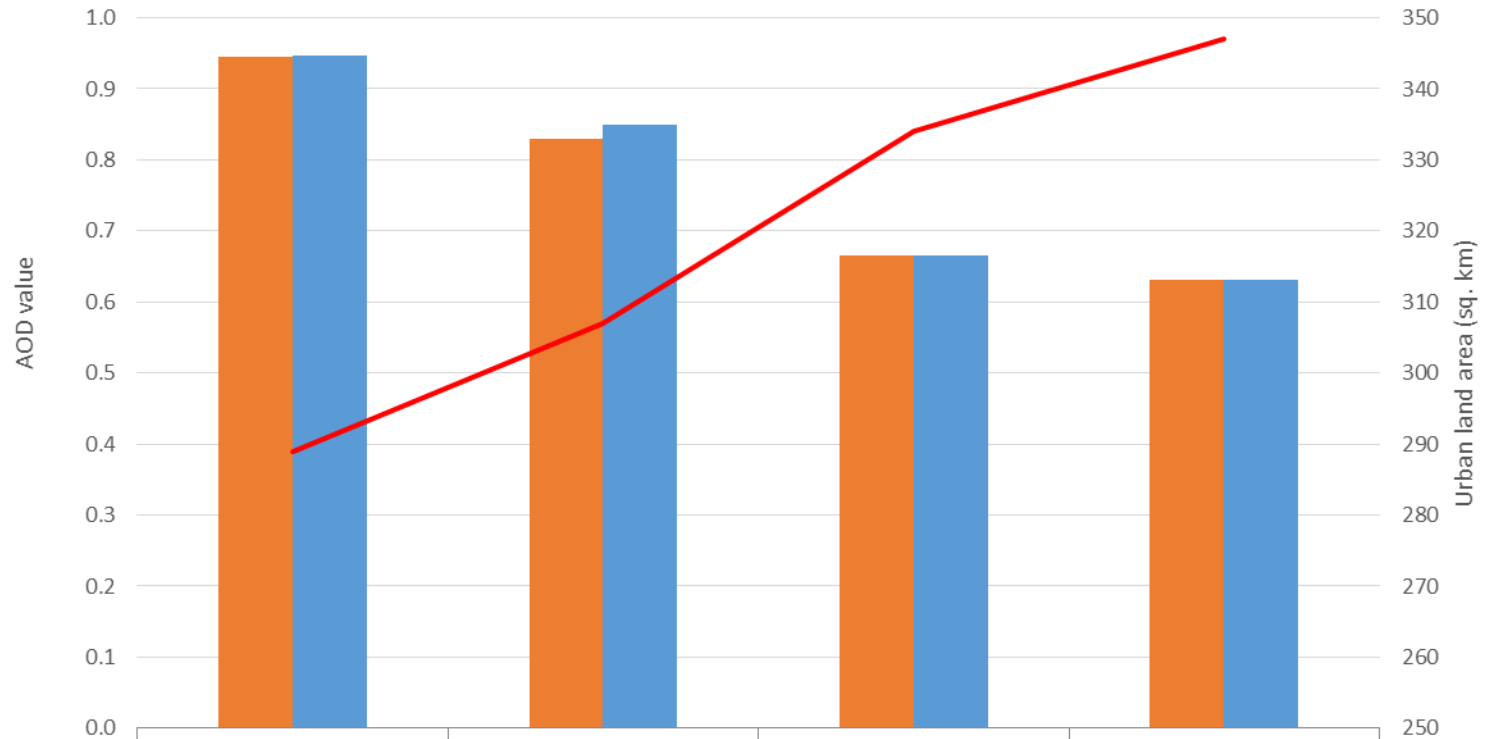
Correlation between urban expansion and PM2.5 value in Vietnam from 2004 to 2015



	2004	2008	2012	2015
Urban	25.142	24.176	22.797	22.954
Non-urban	21.056	19.707	20.156	20.054
Urban land area (sq. km)	4623	4860	5041	5094

Impacts of urban expansion on air pollution

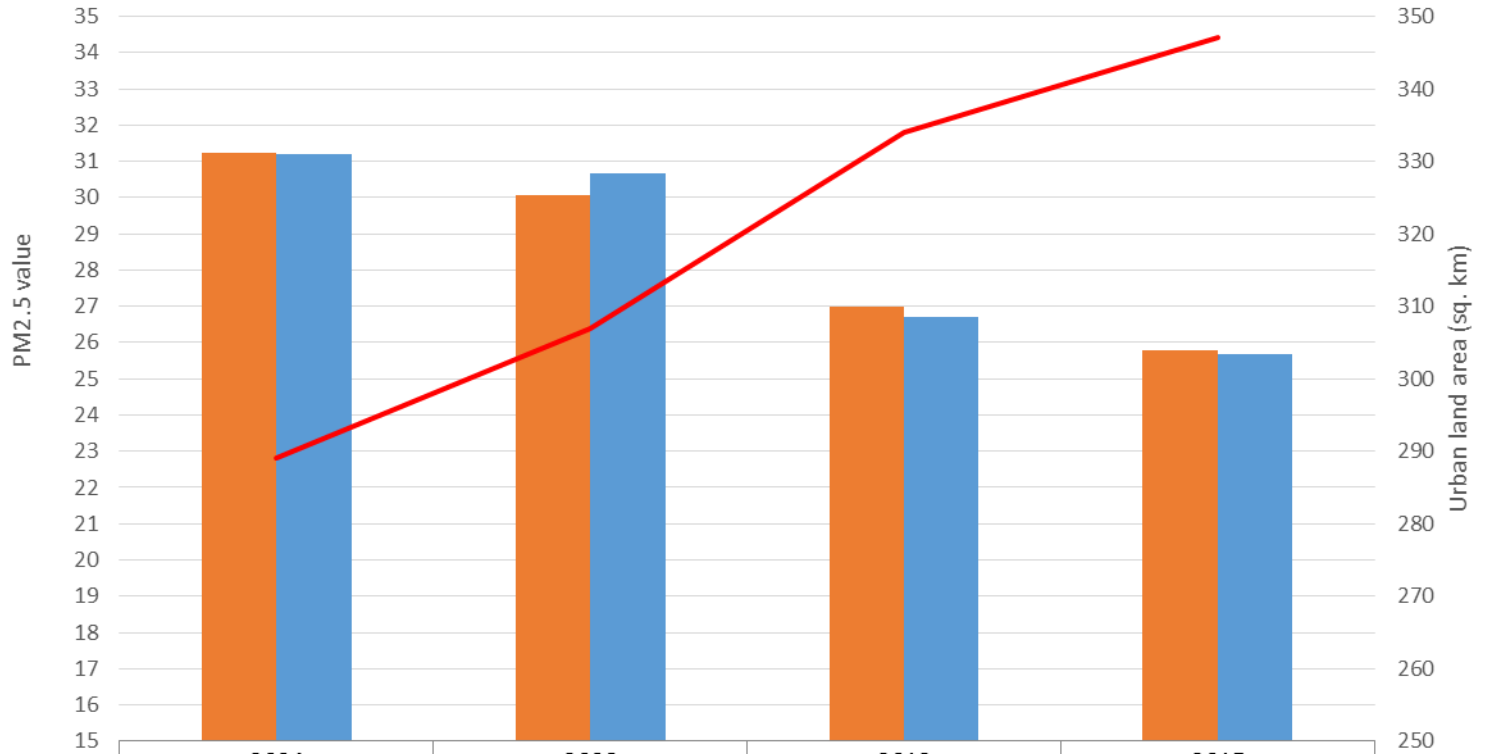
Correlation between urban expansion and AOD value in Hanoi from 2004 to 2015



Urban	0.945	0.829	0.665	0.632
Non-urban	0.947	0.849	0.665	0.631
Urban land area (sq. km)	289	307	334	347

Impacts of urban expansion on air pollution

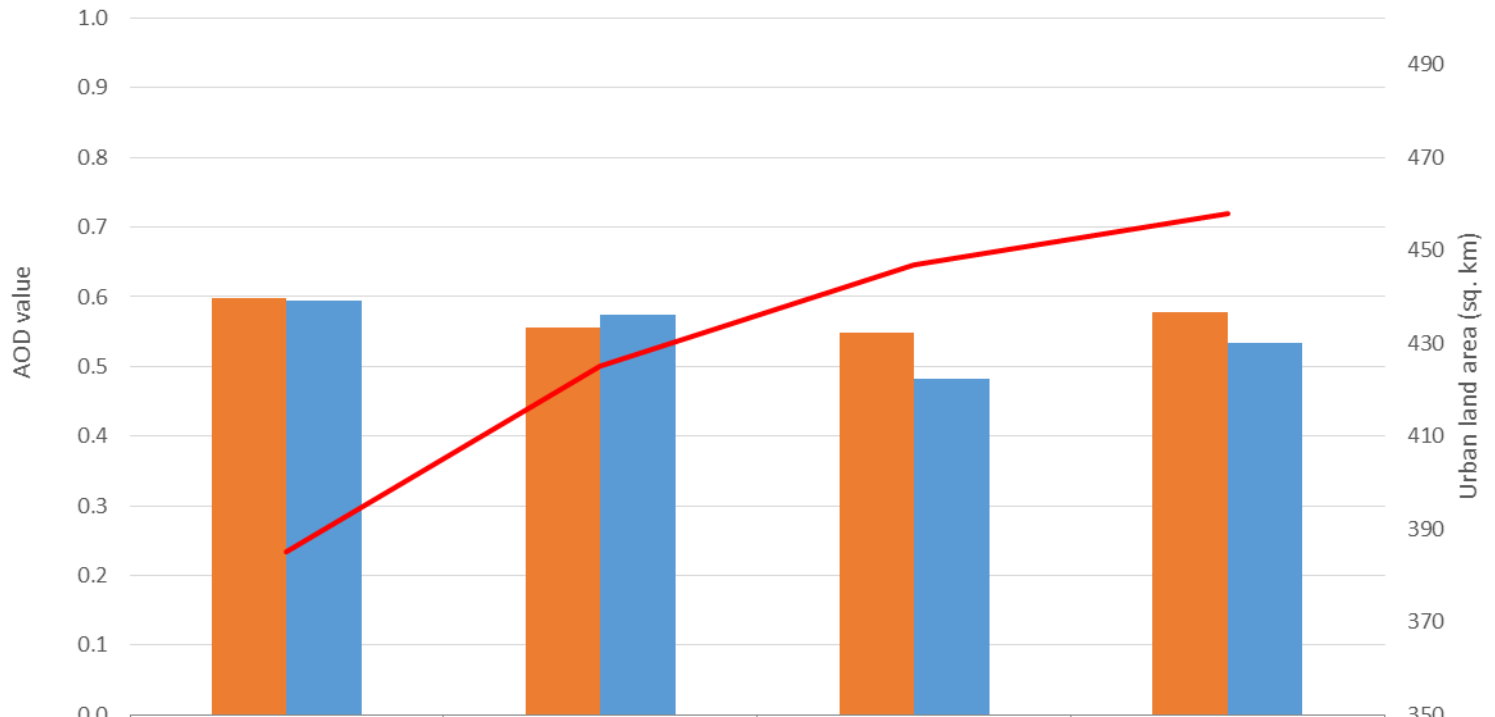
Correlation between urban expansion and PM2.5 value in Hanoi from 2004 to 2015



Urban	31.245	30.056	27.004	25.782
Non-urban	31.200	30.670	26.714	25.679
Urban land area (sq. km)	289	307	334	347

Impacts of urban expansion on air pollution

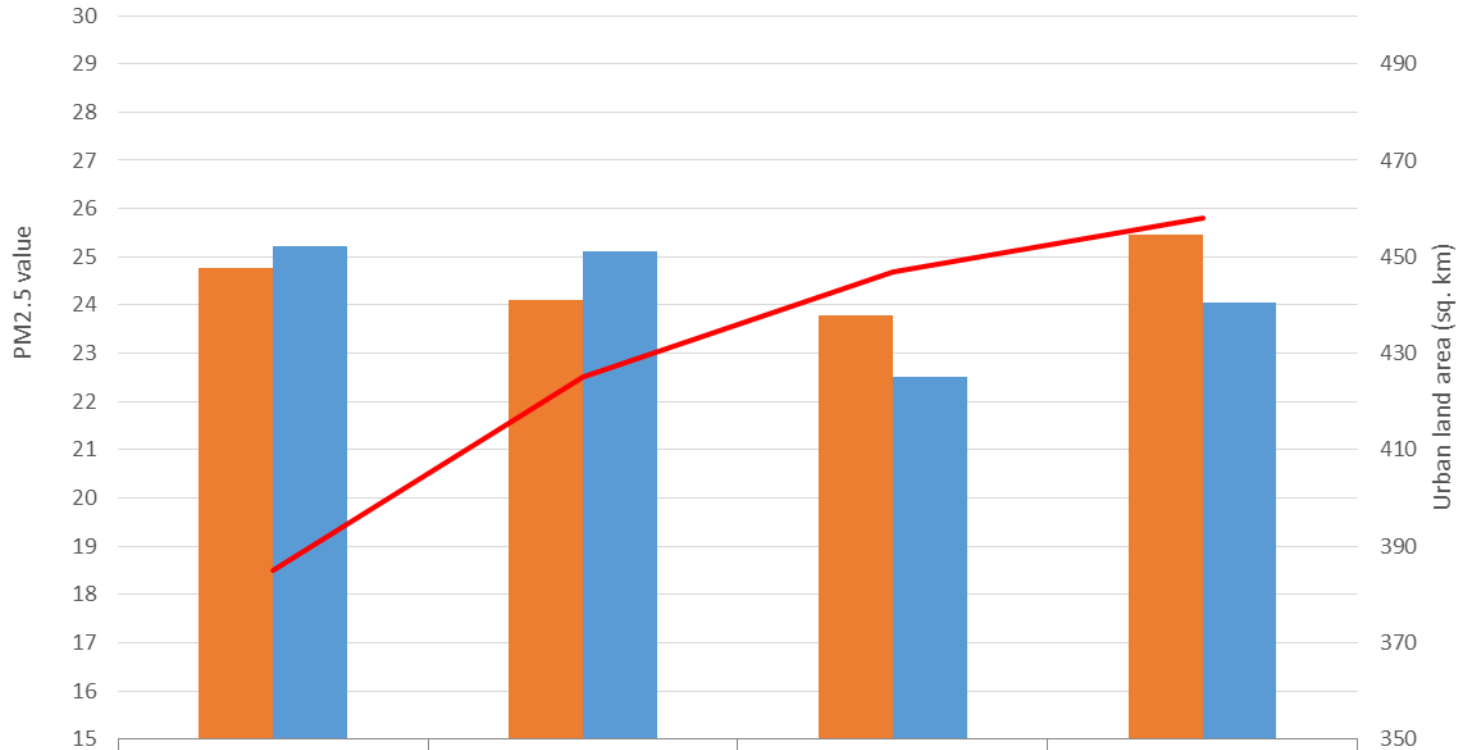
Correlation between urban expansion and AOD value in Hochiminh city from 2004 to 2015






	2004	2008	2012	2015
Urban	0.598	0.556	0.549	0.578
Non-urban	0.594	0.574	0.482	0.534
Urban land area (sq. km)	385	425	447	458

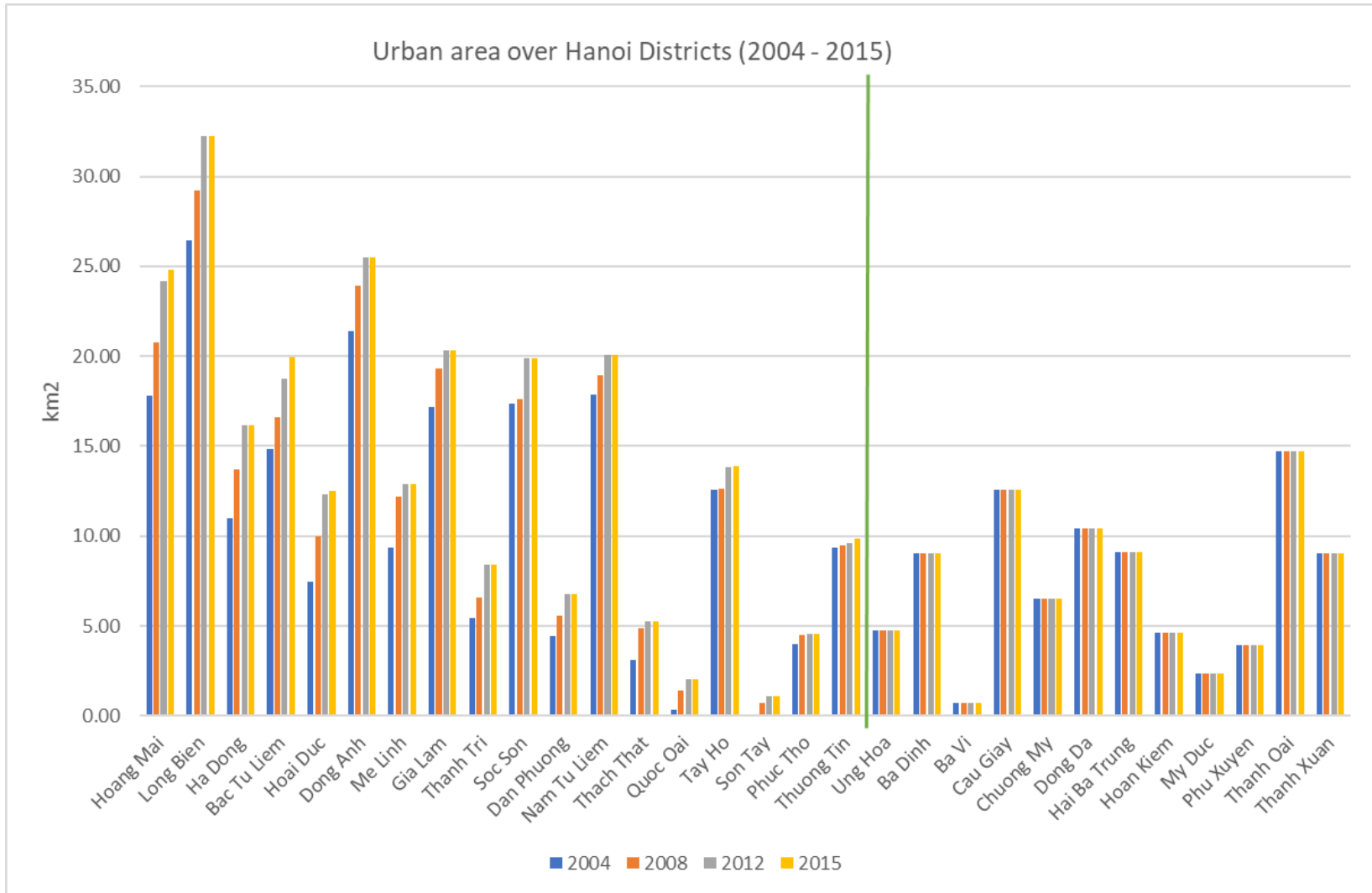
Impacts of urban expansion on air pollution

Correlation between urban expansion and PM2.5 value in Hochiminh city from 2004 to 2015

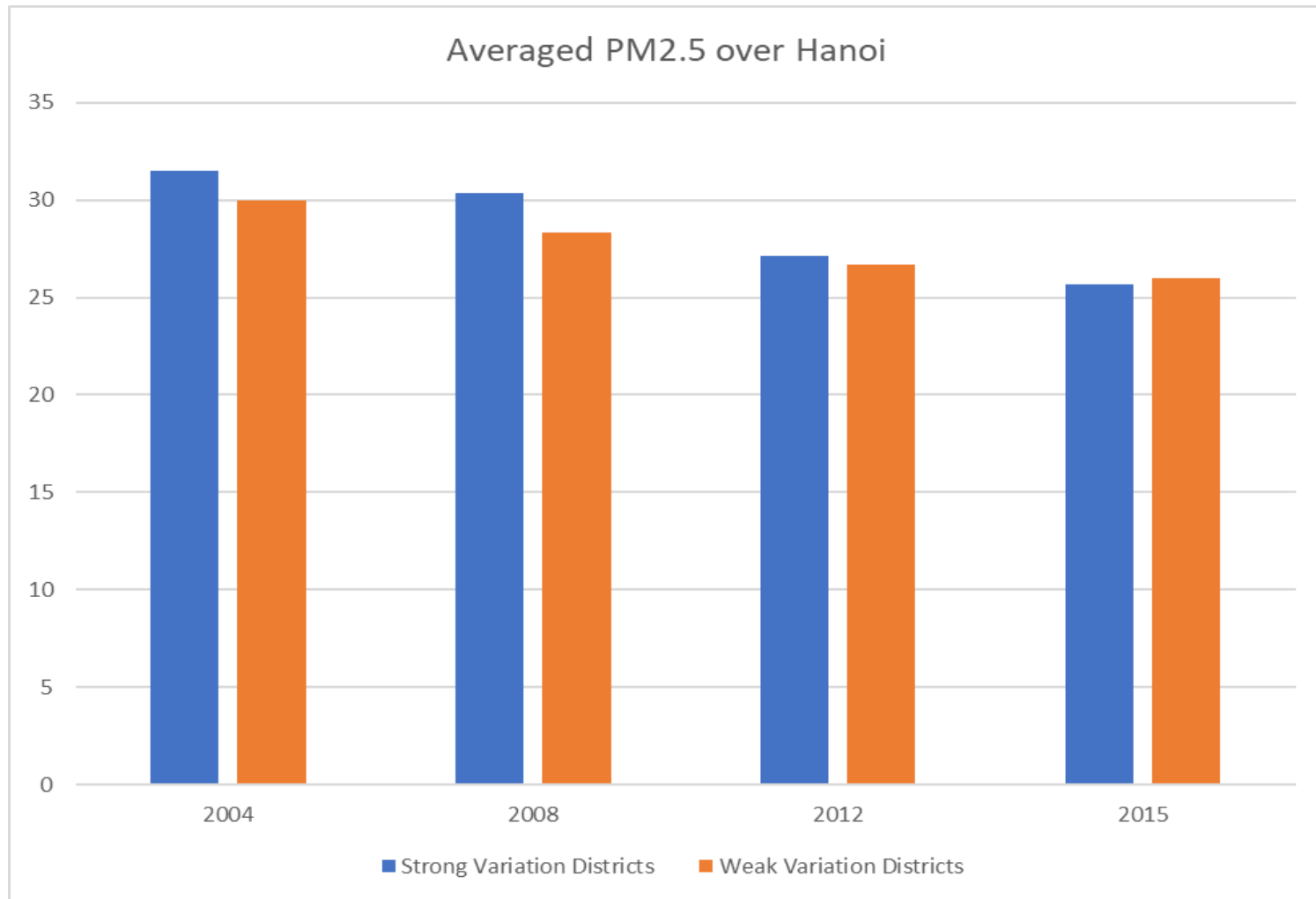


 Urban	24.772	24.115	23.781	25.462
 Non-urban	25.232	25.105	22.498	24.049
 Urban land area (sq. km)	385	425	447	458

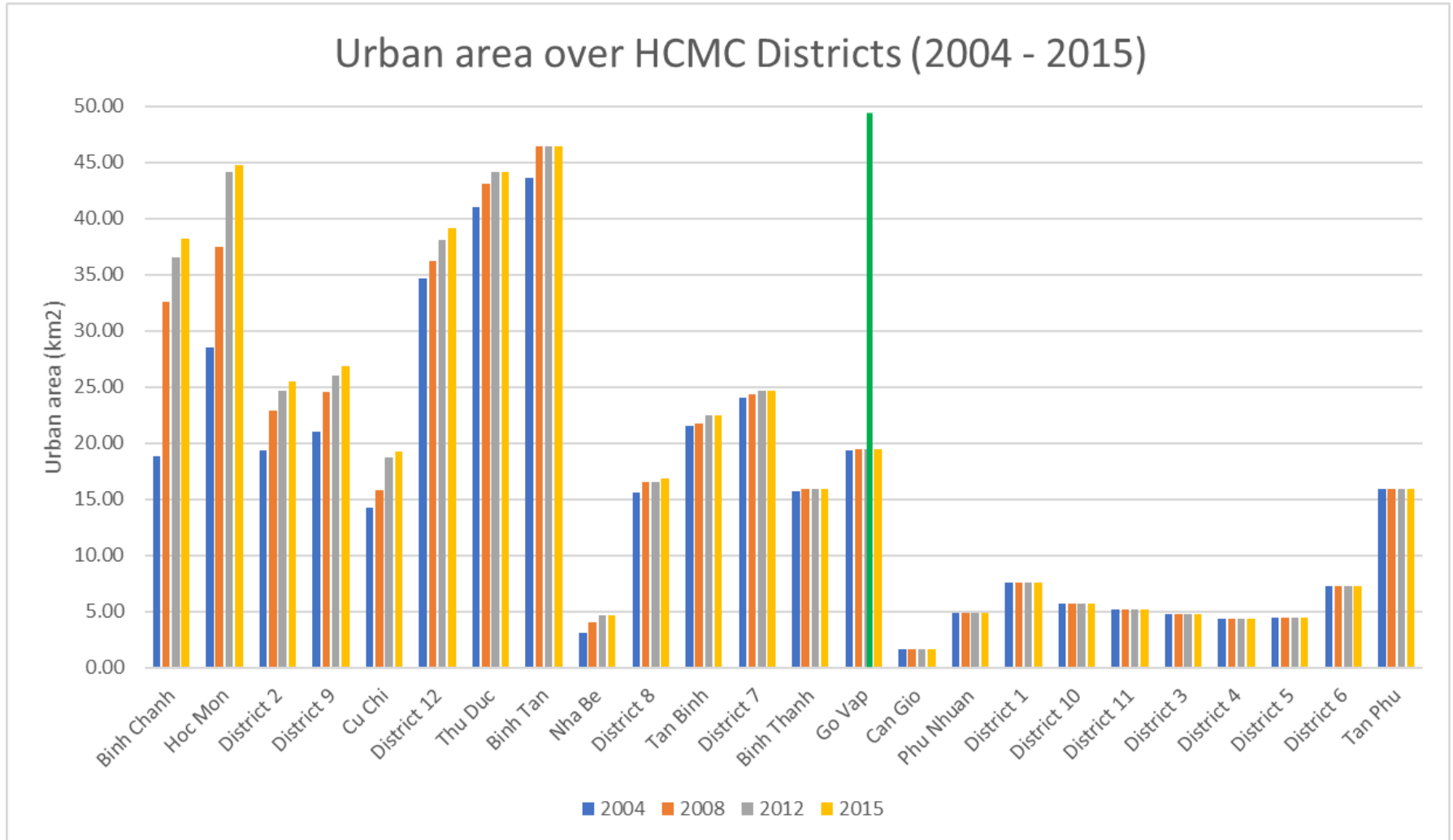
Urban area over Hanoi districts (2004 – 2015)



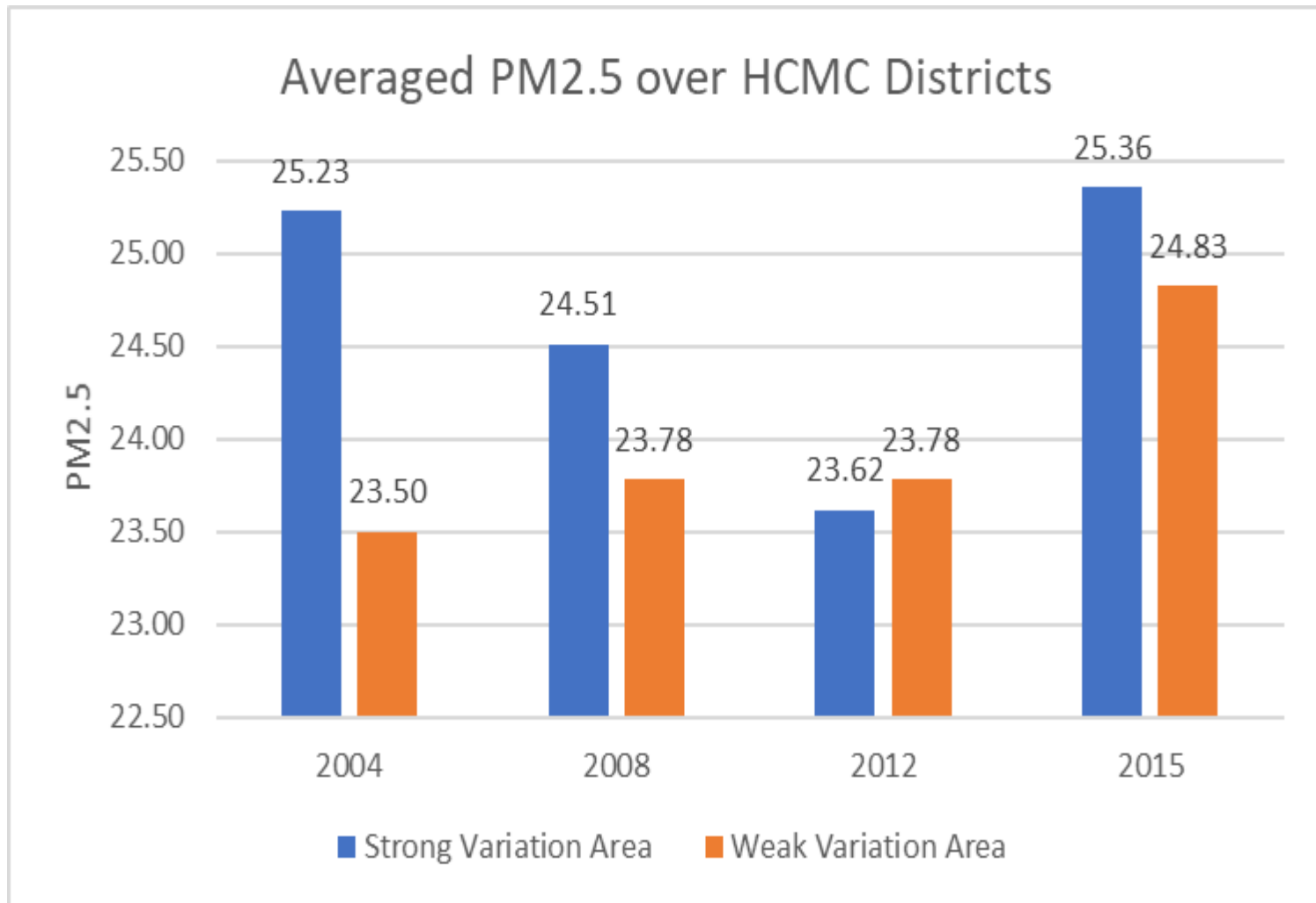
Urban area over Hanoi districts (2004 – 2015)



Urban area over HCMC districts (2004 – 2015)



Urban area over HCMC districts (2004 – 2015)



**SEAP: A SPATIAL DATA
EXPLORATION AND ANALYSIS
PLATFORM FOR MONITORING
ENVIRONMENT CHANGE**



Current state of spatial data

- The era of Big Spatial Data
 - Data sources



Satellite



UAV



IOT



Smart phones

- FIMO satellite station
 - 3 satellite: Terra, Aqua, Suomi NPP
 - Boundary: Vietnam
 - Total data: ~700 TB
 - Up to 60 GB daily spatial data



Spatial big data analysis platforms



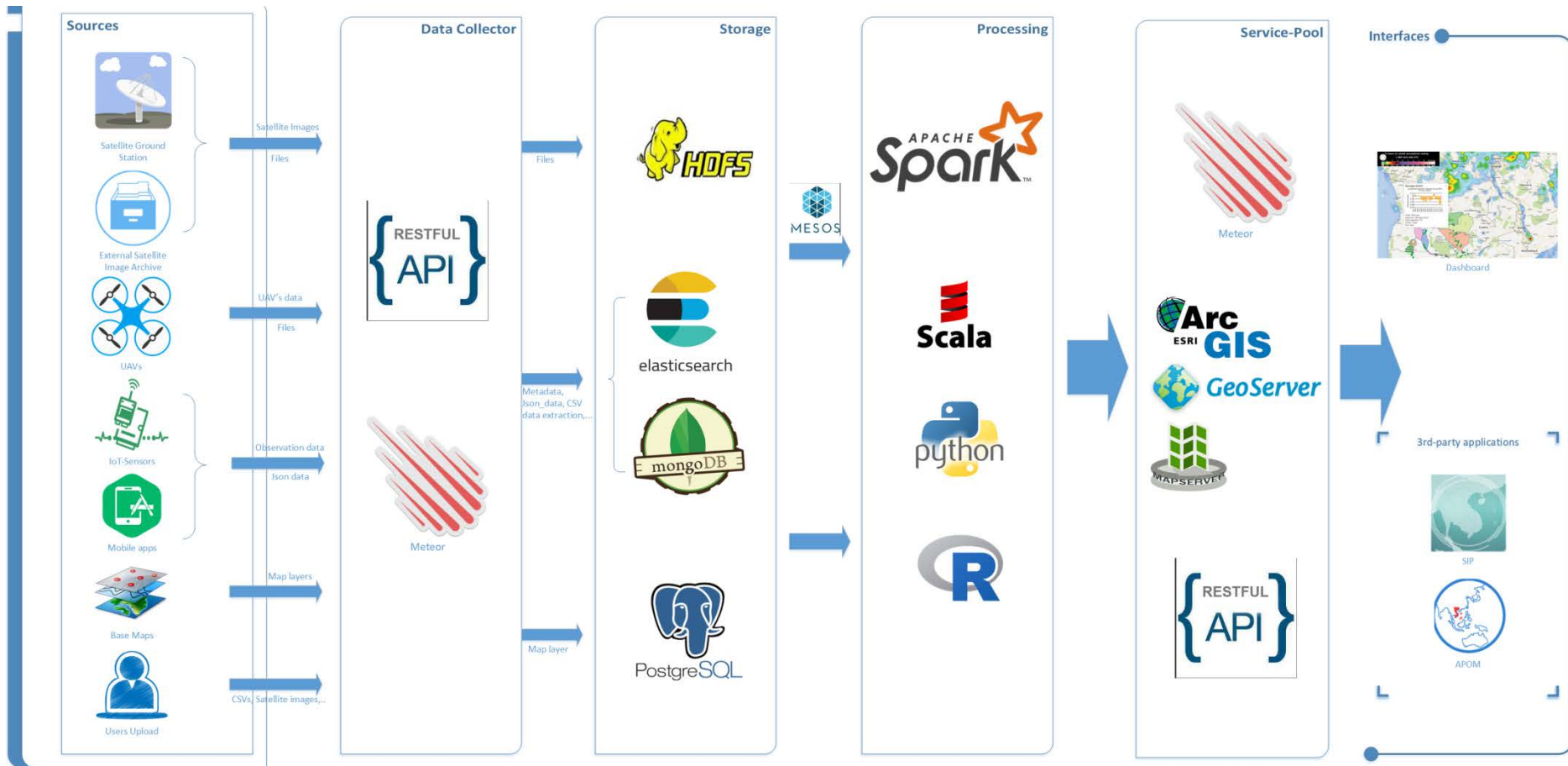
NASA Earth Exchange (NEX)



Earth Observation Datacube



SEAP: a Spatial data Exploration and Analysis Platform for Monitoring Environment Change

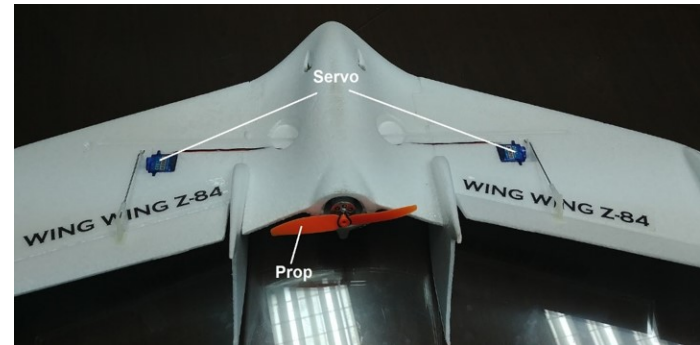
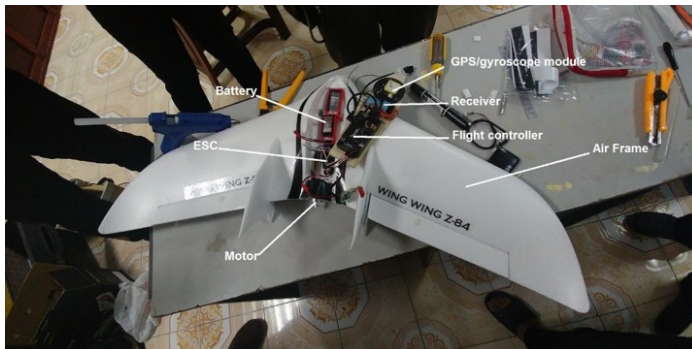


Data sources

- Satellite images
 - FIMO Satellite station (Modis Terra/Aqua, NPP VIIRS)
 - Open satellite data sources



▪ UAV



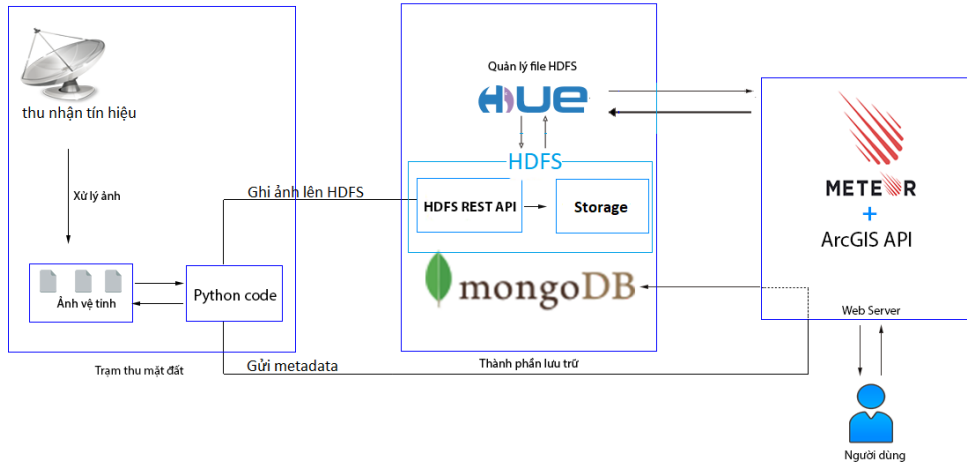
▪ IOT



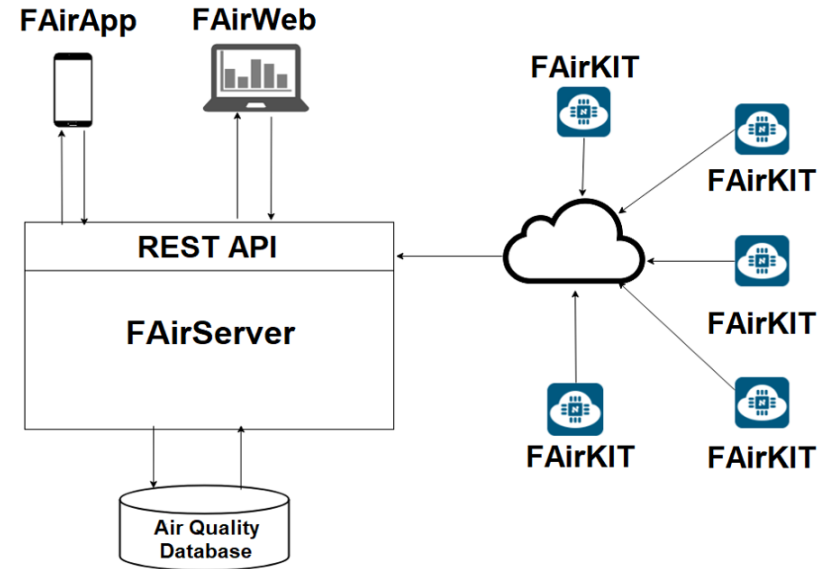
Data collector



A satellite image SHaring - ReceIving - Management System



FIMO IOT Platform



Name	Type	Date Time	Preview	Download
AVAFO_rpp_c20180129_11943256_e1853231_b00001_c20180129190639_h5	AVAFO	Feb 29 2018 18:18:00		
NPP-HRD RAW	RAW	Feb 29 2018 18:18:00		
RNSCA-RVIRS_rpp_c20180228_11817097_e1825419_b00001_c20180228182703112000_at_dev_h5	RAW	Feb 29 2018 18:18:00		
RCRIS-RNSCA_rpp_c20180228_11817032_e1825352_b00001_c20180228182703319000_at_dev_h5	RAW	Feb 29 2018 18:18:00		

Chợ Đồng Xuân
Cập nhật: 07:00:00, 26/10/2018

112
AQI
Hạn chế ra ngoài đường

27.1°C Nhiệt độ
99.9% Độ ẩm
252 lượt xem
Cách vị trí của bạn 6.518km

Thêm ưa thích Đăng kí

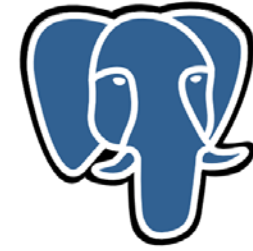
AQI PM2.5 PM10 CO O3 NO2

Ngày: 105 AQI, 26.77°C Nhiệt độ, 99.9% Độ ẩm
Cập nhật: 07:59:46, 26/10/2018

Biểu đồ thống kê AQI theo 1 Ngày

Data storage

- Hadoop – HDFS
 - Satellite image
- MongoDB + Elasticsearch
 - Observing data in IoT
 - LRIT/AIS data
- PostgreSQL
 - Base-map
 - Metadata

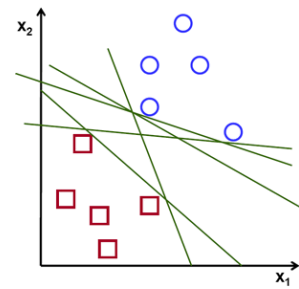
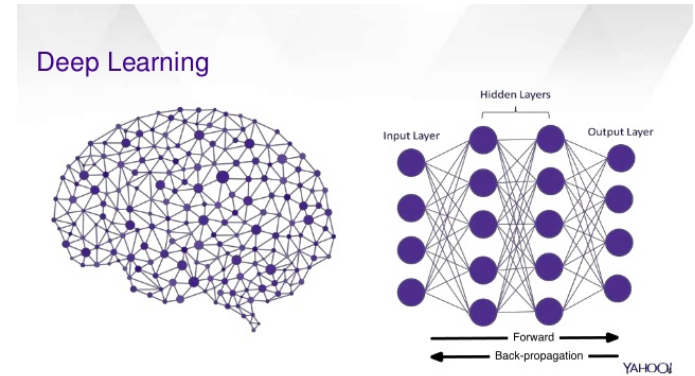


PostgreSQL

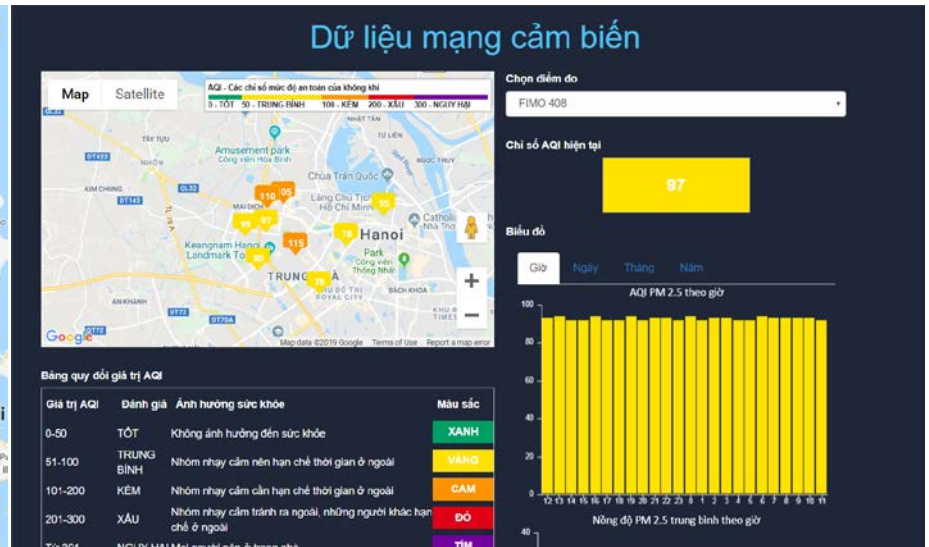
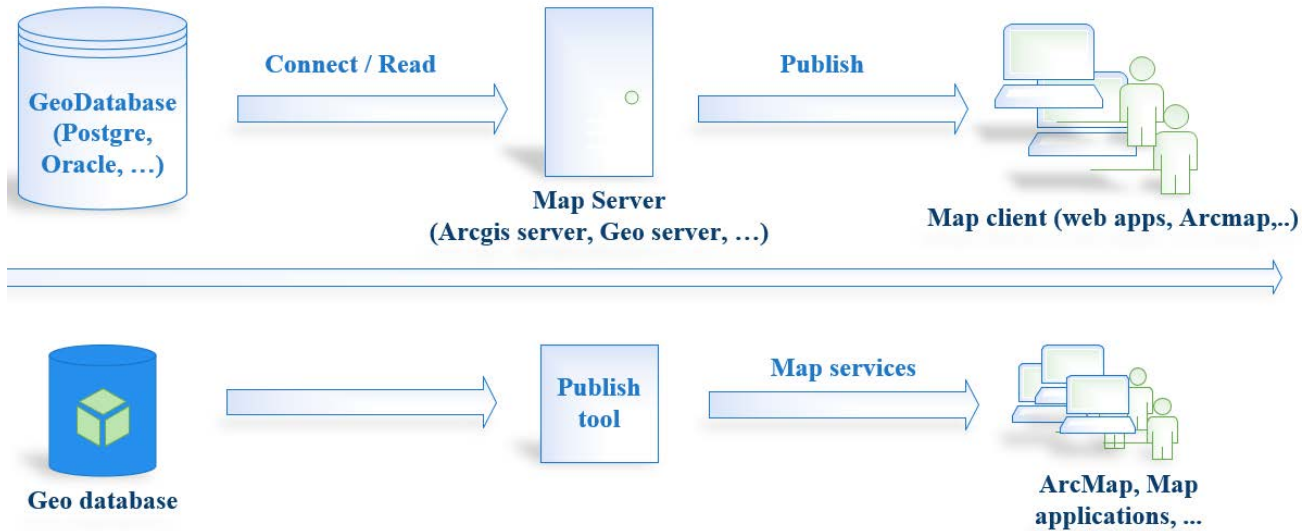


Data processing

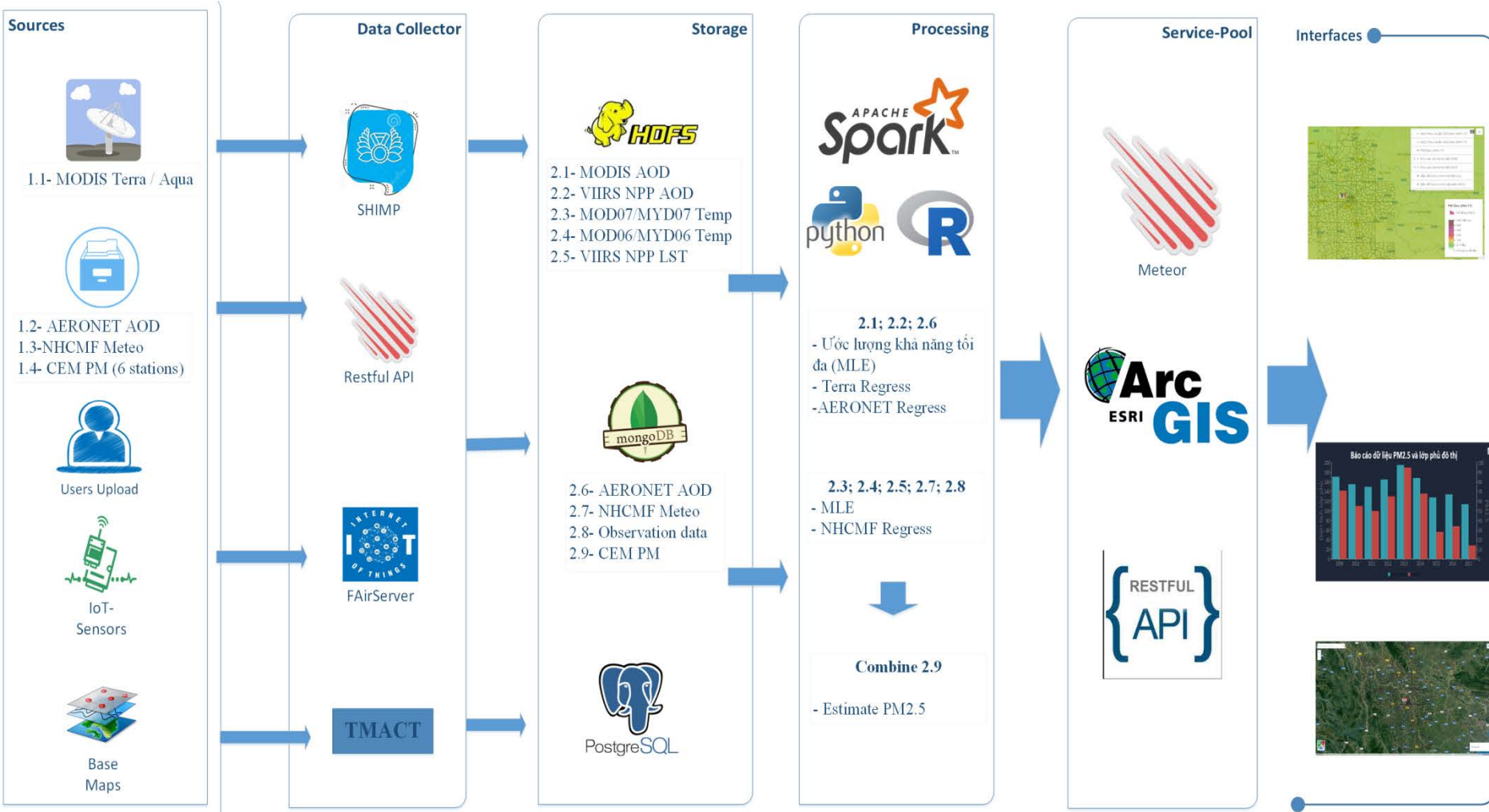
- Big data processing
 - Apache Spark
- Technology
 - Spatial data analysis
 - Machine learning
 - Deep Learning
- Programming language
 - Python
 - R
 - Scala



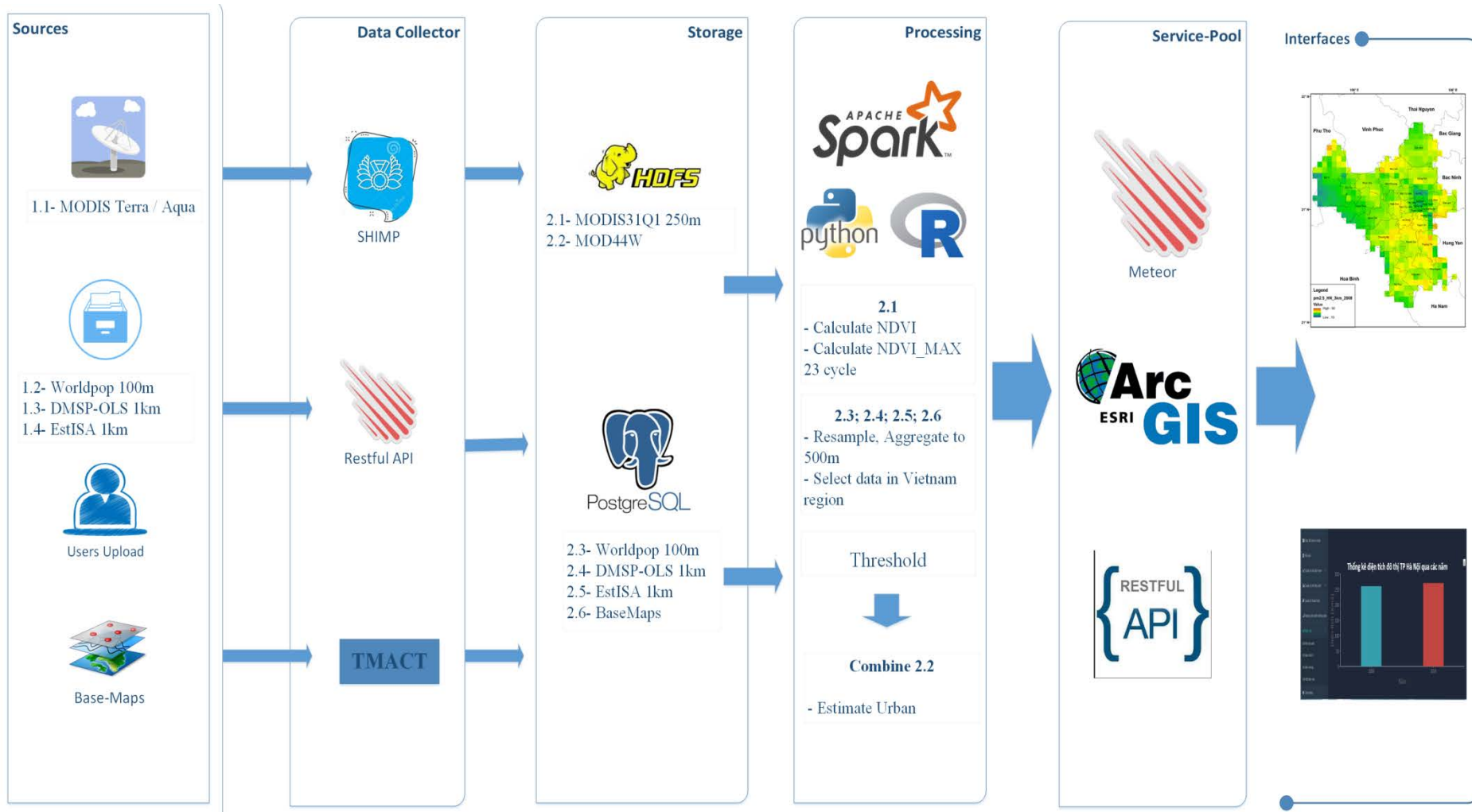
Service pool



Air quality monitoring system based on SEAP













Urban monitoring system based on SEAP



Quản lý dữ liệu trạm & thống kê:

Trạm CEM - Dữ liệu Độ ẩm

Thêm mới Phục hồi tất cả

Mã trạm	Địa điểm	Độ ẩm (%)	Thời gian tạo	Thời gian cập nhật	Chức năng
80	21.0491,105.8831	79	01:00 07/09/2009	16:54 09/01/2018	 
80	21.0491,105.8831	79.286	02:00 07/09/2009	09:00 05/01/2018	 
80	21.0491,105.8831	79.3	03:00 07/09/2009	09:00 05/01/2018	 
80	21.0491,105.8831	81.934	04:00 07/09/2009	09:00 05/01/2018	 
80	21.0491,105.8831	83.799	05:00 07/09/2009	09:00 05/01/2018	 

Danh sách thuật toán

Urban Analysis Air Analysis

Terra, Aqua, Data Station

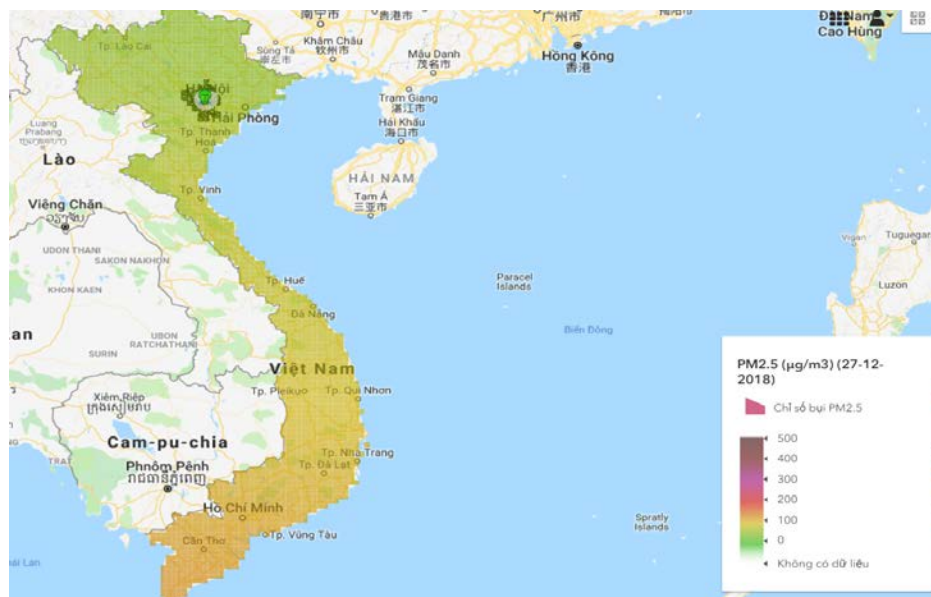
Lấy ảnh từ hệ thống Modis quy trình Hoàn thành

Npp Lấy ảnh từ hệ thống NPP quy trình Hoàn thành

PM Modis, PM Npp, PM Wsn

Lấy ảnh từ hệ thống PM validate Hoàn thành

STT	Image	Input	Output	Start	End	Status
1	PM_MOD04_L2_A2017211_ALL	modis	value PM	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	success
2	TCVN_MOD04_L2_A2017211_AL	modis	value PM	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	success
3	TCQT_MOD04_L2_A20181227_A	modis	value PM	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	Thu Dec 27 2018 11:23:32 GMT+0700 (Giờ Đồng Dương)	success



Dữ liệu mạng cảm biến



Chọn điểm đo

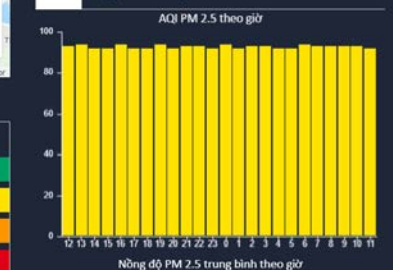
FIMO 408

Chỉ số AQI hiện tại

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Biểu đồ

Giờ Ngày Tháng Năm



Bảng quy đổi giá trị AQI

Giá trị AQI	Đánh giá	Ảnh hưởng sức khỏe	Màu sắc
0-50	TỐT	Không ảnh hưởng đến sức khỏe	XANH
51-100	TRUNG BÌNH	Nhóm nhạy cảm nên hạn chế thời gian ở ngoài	VÀNG
101-200	KÉM	Nhóm nhạy cảm cần hạn chế thời gian ở ngoài	CAM
201-300	XÁU	Nhóm nhạy cảm tránh ra ngoài, những người khác hạn chế ở ngoài	ĐỎ
Từ 301	NGUY HẠI	Mọi người nên ở trong nhà	TÍM

Q&A

Thanks for your attention!

