LASER PULSE

Delivering practical, research-driven solutions to global development challenges

Improving air pollution monitoring and management in Vietnam with satellite $PM_{2.5}$ observation

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The LASER PULSE program

- LASER (Long-term Assistance and SErvices for Research) PULSE (Partners for University-Led Solutions Engine) is a five-year, $70M program funded through USAID's Innovation, Technology, and Research Hub, that delivers research-driven solutions to field-sourced development challenges in USAID interest countries.
- A consortium led by Purdue University, with core partners Catholic Relief Services, Indiana University, Makerere University, and the University of Notre Dame, implements the LASER PULSE program through a growing network of 2,400+ researchers and development practitioners in 56 countries.
- LASER PULSE collaborates with USAID missions, bureaus, and independent offices and other local stakeholders to identify research needs for critical development challenges, and funds and strengthens capacity of researcher-practitioner teams to co-design solutions that translate into policy and practice.
- More information on the Laser Pulse program: https://laserpulse.org/about-us/

Project Introduction

Background

Problems

- Air pollution ($PM_{2.5}$) is serious problem in Vietnam, especially in big cities such as Hanoi, Hochiminh city. Air pollution strongly impacts on public health.
- The number of ground station is limited to reflect air quality at national scale for assessing the current status.

Objectives

- Supplementing $PM_{2.5}$ at the national scale;
- Developing products to provide status of $PM_{2.5}$ concentration in different forms;
- Promoting and disseminating embedded research translation (ERT) product to end users.

Air Pollution in Hanoi

Implementation

Performance period: 24 months (Project will end in July 2023)

Implementing units:

- University of Engineering and Technology, Vietnam National University Hanoi
- Department of Geographic Science, University of Maryland, U.S.A
- Live and Learn for Environment and Community

Collaborating units:

- Universities and research groups, Environmental agencies, Development organizations, NGOs, CSOs, Corporations, The media and press, and other organizations

Details on the project: https://laserpulse.org/portfolio/improving-air-pollution-monitoring-and-management-of-vietnam-with-satellite-observation/

Key products

- Co-creation and dissemination workshops
- A dataset of daily $PM_{2.5}$ maps nationwide at 3x3 km from 2019 to 2021;
- A report on “The current status of $PM_{2.5}$ and its impact on public health in Vietnam 2021”;
- A WebGIS to provide NRT observation of $PM_{2.5}$ over the Vietnam region;
- Educational videos on the state of $PM_{2.5}$ pollution;

Current status of the projects

The workshop completed

- Dec. 2021
  - Analysis of $PM_{2.5}$ status from 2019-2020 in Vietnam using multi-source datasets.
  - Application of satellite technology in air pollution monitoring and research
- Mar. 2022 and Jul. 2022
  - Consultant meetings to develop the report on “Current status of $PM_{2.5}$ and its impact on public health in Vietnam 2021”
- Nov. 2022
  - Launching and sharing the report results
- Feb. 2023
  - The regional meeting on Air pollution in Asia – Inventory, Monitoring and Mitigation

The dataset of daily $PM_{2.5}$ distribution maps

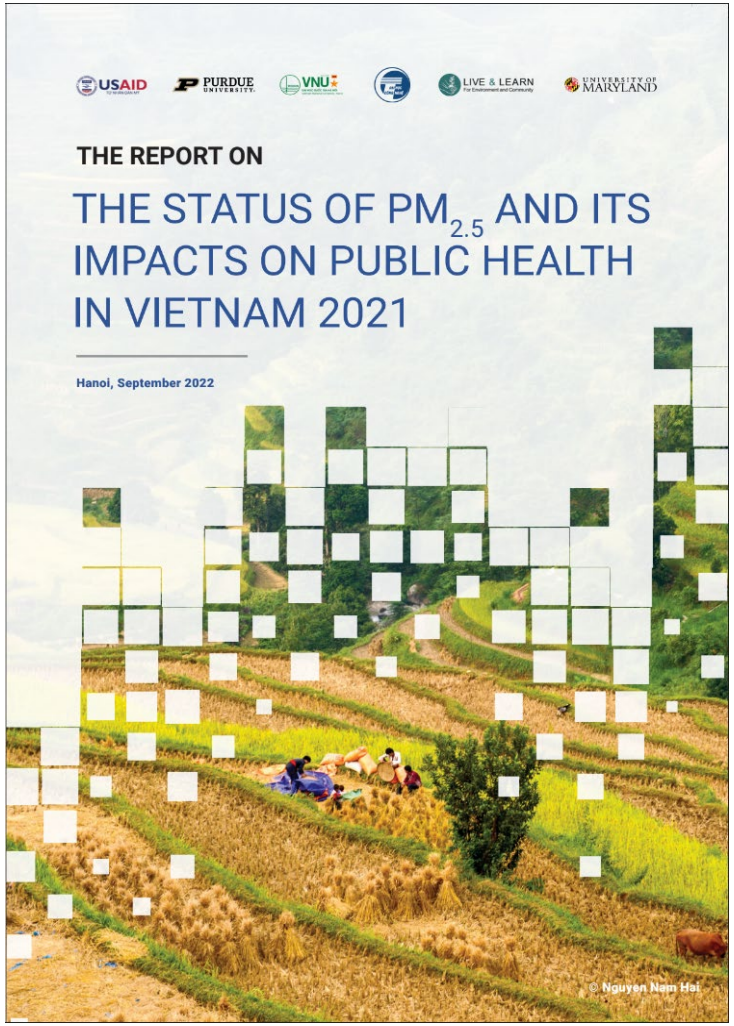
- Content: daily $PM_{2.5}$ distribution on a 3x3 km grid, on a national scale
- Data span: 2019 – 2021
- Format: image (tif, ...), data frame (csv, ...)
  - Values can be averaged to different spatial level (nationwide, provincial, district, ward) and different temporal levels (annual, monthly, daily)
- Methodology(*): the Mixed Effect Model using multisource data from 2012 to 2021 including: Ground-based $PM_{2.5}$ from standard stations, satellite images (MODIS and VIIRS AOD), land use and meteorological data
- Map quality: Results from evaluation with data from monitoring stations showed RMSE (MRE) of annual mean maps were 4.32 µg/m^3 (10,98%), 8.79 µg/m^3 (30.76%), and 9.78 µg/m^3 (29.15%) for 2019, 2020, and 2021 respectively.
- Target users: research groups, environmental agencies

(*)*Truong X. Ngo, Ha V. Pham, Hieu D.T. Phan, Anh T.N. Nguyen, Hien T. To, Thanh T.N. Nguyen, A daily and complete $PM_{2.5}$ dataset derived from space observations for Vietnam from 2012 to 2020,Science of The Total Environment, Volume 857, Part 3, 2023, 159537, ISSN 0048-9697, https://doi.org/10.1016/j.scitotenv.2022.159537.*

Key milestones achieved

- Data co-creation/dissemination to government agencies
  - Developing monthly $PM_{2.5}$ maps for Vietnam from 2021 – present. The results are internally used by the Northern Center for Environmental Monitoring partner (NCEM), MONRE.
  - Providing $PM_{2.5}$ map data for the development of the vehicle emission inventory in Danang and air quality management plan for 2022-2025 in Haiphong.
- Data dissemination to research groups
  - Hanoi University of Public Health (HUPH), Ricardo Energy & Environment, Vietnam Academy of Science and Technology (VAST), Hanoi University of Science and Technology (HUST), Sen Asia group.
- Scientific publications using $PM_{2.5}$ datasets

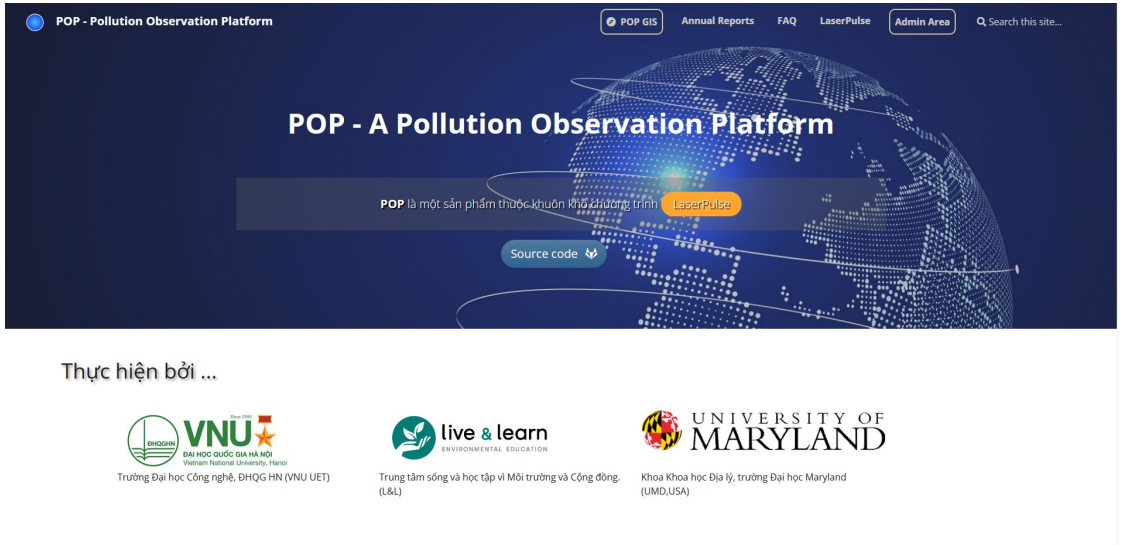
The report



- Objectives
  - Analyze the status of $PM_{2.5}$ nationwide (63 provinces), and go for district level in 5 provinces/cities in 2021
  - Conduct health impact assessment on a national scale. This is the avoidable deaths if Vietnam had implemented different measures to cut down emission sources of $PM_{2.5}$ like the measures taken in 2020 to prevent the spread of COVID-19.
  - Provide Recommendation for state units/organizations and research institutes/universities based on the report results
- Target audiences: General public, Government agencies, Media, press
- The full report at link: https://drive.google.com/drive/folders/1aIaZTQiOSsVDTeIKcc5apVbButHfivse?usp=share_link

The WebGIS

- Objectives
  - Bring the observation of $PM_{2.5}$ and analytic results to everybody.
  - Disseminate knowledge on facts related to $PM_{2.5}$
  - Research result verification
- Target users: General public, Government agencies, Media and press

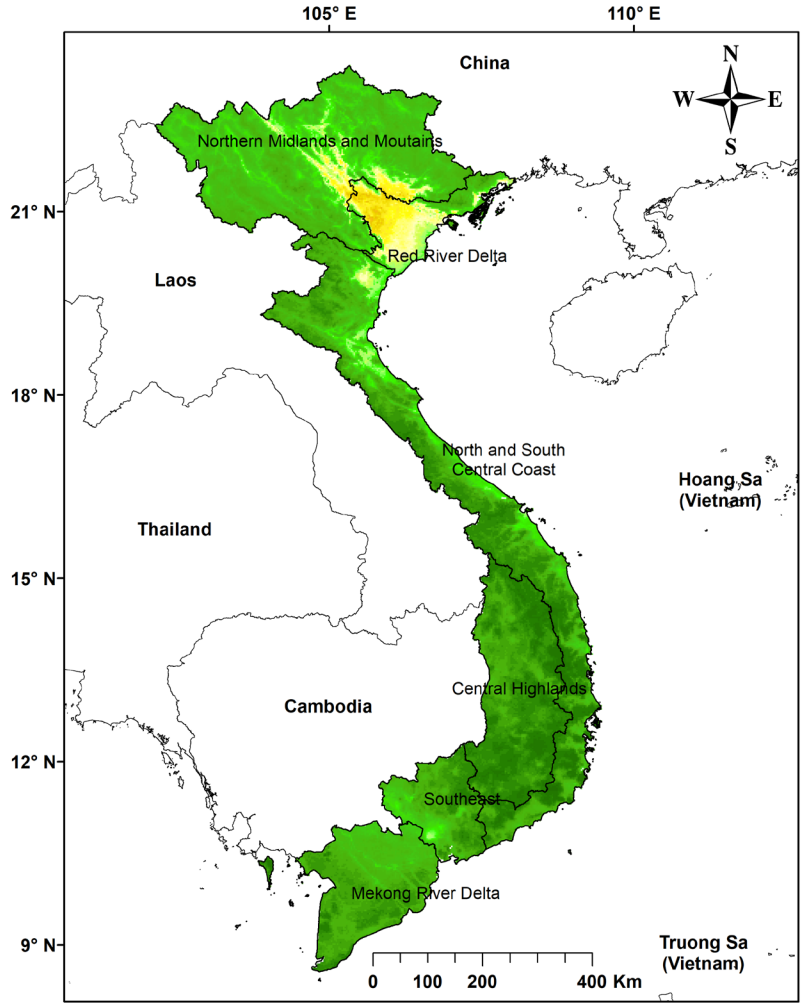


- Some feature completed: AQI ranking of cities/provinces, viewing and interacting with $PM_{2.5}$ maps on Vietnam, …
- See the presentation next day on: **POPGIS - Pollution Observation Platform for Monitoring $PM_{2.5}$ using Satellite Data**

Opportunities, Challenges, and Mitigation Measures

Opportunities

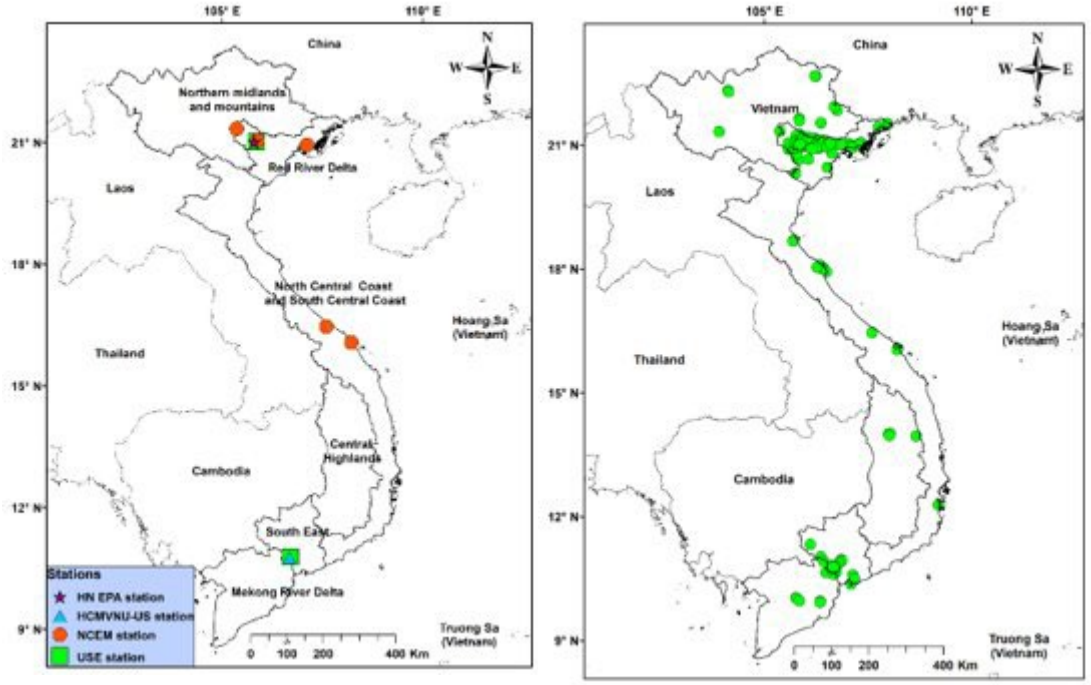
- $PM_{2.5}$ map can provide information of air pollution where the ground stations are not existed.
- $PM_{2.5}$ datasets can be largely used by researchers/scientists on impact assessment of air pollution on environment, public health, and economy.
- $PM_{2.5}$ datasets can provide the status of $PM_{2.5}$ up to Vietnamese provincial and city levels to develop the air quality management plan at each province.



Annual mean of $PM_{2.5}$ concentration in 2021

Challenges/Threats

- The ground measurements are various in type, number, quality, and distribution; The inconsistence occurs among datasets; The sharing mechanism of ground-based $PM_{2.5}$ datasets.
- The acceptance of modelled/satellite $PM_{2.5}$ map from governmental units in air quality management in Vietnam. The issue comes from their quality and user.



Standard stations in Vietnam before 2020 (left) and from 2020 – 2021 (right)

- A complete WebGIS in operation for daily $PM_{2.5}$ observation will need more time, work, and user feedbacks
- The sustainability of the project products: yearly $PM_{2.5}$ datasets, annual air quality report, the WEBGIS in operation.

Mitigation Measures

- Need a quality control protocol/standard for ground measurements, sharing mechanism, and research on ground-based datasets.
- Need more research to enhance quality of satellite $PM_{2.5}$ map in Vietnam.
- Need more collaboration/joint projects between researcher and policy makers.
- Need to continue to be funded for the sustainable development of the project's products.

Thank you for your attention