

INFORMATION ON DOCTORAL THESIS

1. Full name: Pham Van Ha
2. Sex: Male
3. Date of birth: 24/01/1989
4. Place of birth: Bac Giang
5. Admission decision number: 1006/QĐ-CTSV Dated 07/12/2015
6. Changes in academic process:
(List the forms of change and corresponding times)
7. Official thesis title: Improvement of PM_{2.5} estimation models using multi-source and multi-resolution data
8. Major: Information System.....
9. Code: 9480104.01
10. Supervisors:
 1. Prof. Dominique Laffly
 2. Assoc. Prof. Nguyen Thi Nhat Thanh
11. Summary of the **new findings** of the thesis:

The dissertation has studied the relevant content on multi-source and multi-resolution data processing, analysis, and evaluation methods to improve the PM_{2.5} estimation models. The main contribution of the dissertation can be concluded as follow:

i) The dissertation proposed a process for improving the PM estimation method using numerical model. Firstly, the thesis proposed a method of adjusting input emissions data based on the ECLIPSE emission scenario dataset. The HTAPv2 and REASv3.1 global emissions datasets are used. Next, the WRF-Chem model is configured to simulate PM concentrations over the Vietnam in January and June 2019. Finally, the output maps corresponding to each emission dataset are compared with the monitoring data. The results indicated that the WRF-Chem model can simulate PM concentrations well, the correlation between modeled and measured PM_{2.5} ranges from 0.221 to 0.636. The emissions adjustment method proved to be effective in improving PM₁₀ and PM_{2.5} concentrations. Correlation increased by 0.272 for HTAPv2 and 0.26 for REASv3.1 emissions dataset meanwhile the MFE error decreased significantly by 30.4% for HTAPv2 and 15.7% for REASv3.1.

Additionally, the PM concentration is influenced by the seasonal, monsoon and fire emission.

ii) The dissertation proposed a process for improving the PM estimation method using statistical model. First, georeferencing methods were tested and evaluated on multi-source satellite data MODIS Terra/Aqua and VIIRS NPP to find the best georeferencing method in Vietnam. Next, multi-source satellite images are fused to enhance the data coverage and quality. Finally, the PM mapping model is built and verified based on multi-source data. The results show that TPS is the best georeferencing method in which correlation of satellite and ARONET AOD data increased by 24%, 21.2%, and 25.4% for MODIS Aqua/Terra and VIIRS NPP. Moreover, the evaluation show that the GWR data fusion method increase the data coverage significantly and gives the best quality of fused images. The data coverage of the GWR fused image increase 31-50% compared to the MODIS Aqua/Terra images while the relative error decrease 48.2 – 61.4%. Finally, daily PM_{2.5} maps are estimated using two MEM models which was better than previous research in Vietnam. The estimated PM_{2.5} daily maps using MEM model have been applied in many studies on public health impact assessment in Vietnam (Hoang et al., 2023; Nguyen T T Nhung et al., 2022; Nguyen Thi Trang Nhung et al., 2022).

iii) The thesis proposes methods to improve the performance of the PM_{2.5} estimation models. Firstly, several factors are considered to optimize the performance of the WRF-Chem model. The results show that the optimal number of cores for simulation is around 38 cores which reduce simulation time by up to 9 times (compared to using 4 cores). Secondly, sampling threshold of 144 GCPs points produce acceptable error of VIIRS georeferenced images. The processing time reduces from 193.75 seconds to 0.13 seconds. The VIIRS NPP AOD image sampling method can be used to shorten the processing time when georeferencing and still ensure the quality of the data.

12. Practical applicability, if any:

- Application in adjustment of emission inventory datasets.
- Application in creating daily PM_{2.5} concentration maps to monitor air quality nationwide.
- Application in public health impact assessment, national environmental status reports.

13. Further research directions, if any:

- Incorporate local emission inventory to improve the model's accuracy, including emission inventory specific to Vietnam and different sources can provide more reliable and localized information.
- Try to apply other methods for emission adjustment.
- Apply other models such as GWR, Random Forest and Deep Learning for estimating PM.
- Implement data assimilation techniques to integrate diverse data sources and improve the accuracy of the model's predictions.
- Develop monitoring networks in Vietnam, collect and evaluate and improve the quality of monitoring data from various sources.
- Research and apply solutions to improve model performance using Cluster Servers, GPU servers or cloud computing.

14. Thesis-related publications:

- [1] Ngo TX, **Pham HV**, Phan HDT, Nguyen ATN, To HT, Nguyen TTN. A daily and complete PM_{2.5} dataset derived from space observations for Vietnam from 2012 to 2020. *Sci Total Environ.* 2023 Jan 20;857(Pt 3):159537. doi: 10.1016/j.scitotenv.2022.159537. Epub 2022 Oct 19. PMID: 36270373. (**SCIE, Q1, IF= 10.753**)
- [2] Do, T.N.N., Ngo, X.T., **Pham, V.H.** et al. Application of WRF-Chem to simulate air quality over Northern Vietnam. *Environ Sci Pollut Res* (2020). <https://doi.org/10.1007/s11356-020-08913-y> (**SCIE, Q1, IF= 5.19**)
- [3] Thanh T.N. Nguyen, **Ha V. Pham**, Kristofer Lasko, Mai T. Bui, Dominique Laffly, Astrid Jourdan, Hung Q. Bui (2019). Spatiotemporal analysis of ground and satellite-based aerosol for air quality assessment in the Southeast Asia region. *Environmental Pollution*. <https://doi.org/10.1016/j.envpol.2019.113106>. (**SCIE, Q1, IF= 9.988**)
- [4] **Pham Van Ha**, Ngo Xuan Truong, Astrid Jourdan, Dominique Laffly, Nguyen Thi Nhat Thanh. Evaluation of Maximum Likelihood Estimation and regression methods for fusion of multiple satellite Aerosol Optical Depth data over Vietnam. In *Proceeding of The 11th International Conference on Knowledge and Systems Engineering (KSE 2019)*
- [5] **Pham Van Ha**, Nguyen Thi Nhat Thanh, Bui Quang Hung, Pascal Klein, Astrid Jourdan, Dominique Laffly, Assessment of georeferencing methods on MODIS Terra / Aqua and VIIRS NPP satellite images in Vietnam. In *Proceeding of The 10th International Conference on Knowledge and Systems Engineering (KSE 2018)*, 01-03 November 2018, Ho Chi Minh City, Vietnam.

Other publications:

- [1] **Pham , V.H.**, Nguyen , T.N.T. and Laffly , D. (2020). Remote Sensing Case Studies. In TORUS 2 – Toward an Open Resource Using Services, D. Laffly (Ed.). doi:10.1002/9781119720553.ch7
- [2] **Pham , V.H.**, Luu , V.H., Phan , A., Laffly , D., Bui , Q.H. and Nguyen , T.N.T. (2020). Remote Sensing Products. In TORUS 2 – Toward an Open Resource Using Services, D. Laffly (Ed.). doi:10.1002/9781119720553.ch4
- [3] Thi Nhat Thanh Nguyen, Hoang Anh Le, Thi Minh Tra Mac, Thi Trang Nhung Nguyen, **Van Ha Pham**, Quang Hung Bui (2018). “Current Status of PM_{2.5} Pollution and its Mitigation in Vietnam”. Global Environmental Research, vol.22, no.1&2.
- [4] Nguyen , T.N.T., Luu , **V.H., Pham** , V.H., Bui , Q.H. and Nguyen , T.K.O. (2020). Particulate Matter Concentration Mapping from Satellite Imagery. In TORUS 3 – Toward an Open Resource Using Services, D. Laffly (Ed.). doi:10.1002/9781119720522.ch5
- [5] T. X. Hoang, T. X. Ngo, H. D. T. Phan, **H. V. Pham**, T. H. Nguyen and T. T. N. Nguyen, "POPGIS – An Application Service for Air Pollution Management and Analysis in Vietnam," 2023 IEEE Statistical Signal Processing Workshop (SSP), Hanoi, Vietnam, 2023, pp. 512-516, doi: 10.1109/SSP53291.2023.10208045.

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