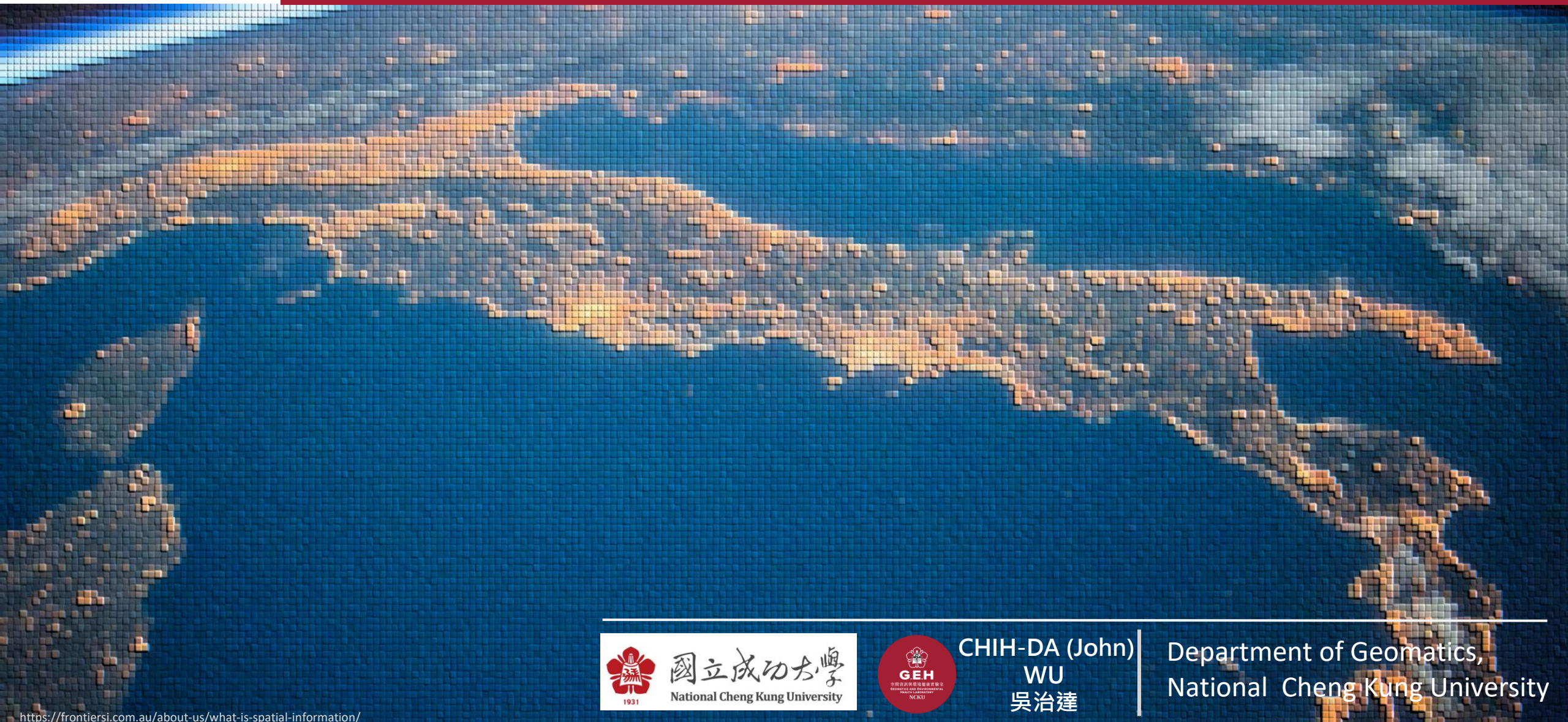
APCN x TSN 2025
23rd Asian Pacific Congress of Nephrology
Gene, Immunology, Vast, MEtabolism at its Finest!

Geospatial Artificial Intelligence (Geo-AI) and Air Pollution Exposure Assessment

- application in environmental epidemiology studies



國立成功大學 National Cheng Kung University

CHIH-DA (John) WU
吳治達

Department of Geomatics,
National Cheng Kung University

https://frontiersi.com.au/about-us/what-is-spatial-information/

G.E.H
空間資訊與環境健康實驗室
GEOMATICS AND ENVIRONMENTAL HEALTH LABORATORY
NCKU

CHIH-DA (JOHN) WU (吳治達)

成大測量及空間資訊學系吳治達 https://www.geomatics.ncku.edu.tw/member.php?id=96&tpl=6
成大空間資訊及環境健康實驗室 https://sites.google.com/view/geh-ncku2/home

Professor: 2023 Department of Geomatics, National Cheng Kung University

Join Appointment Professor: 2025 Chronic Diseases and Health Promotion Research Center, Chang Gung University of Science and Technology

Adjunct Research Fellow: 2024 Research Center for Precision Environmental Medicine, Kaohsiung Medical University

Join Investigator: 2024 National Institute of Environmental Health Sciences, National Health Research Institutes

President: 2024 Taiwan Society of Architectural Medicine

Visiting Scientist: 2016 The Center for Health and the Global Environment, Harvard T. H. Chan School of Public Health

Visiting Scientist: 2013 Harvard T. H. Chan School of Public Health

Research Fellow: 2012 Harvard School of Public Health

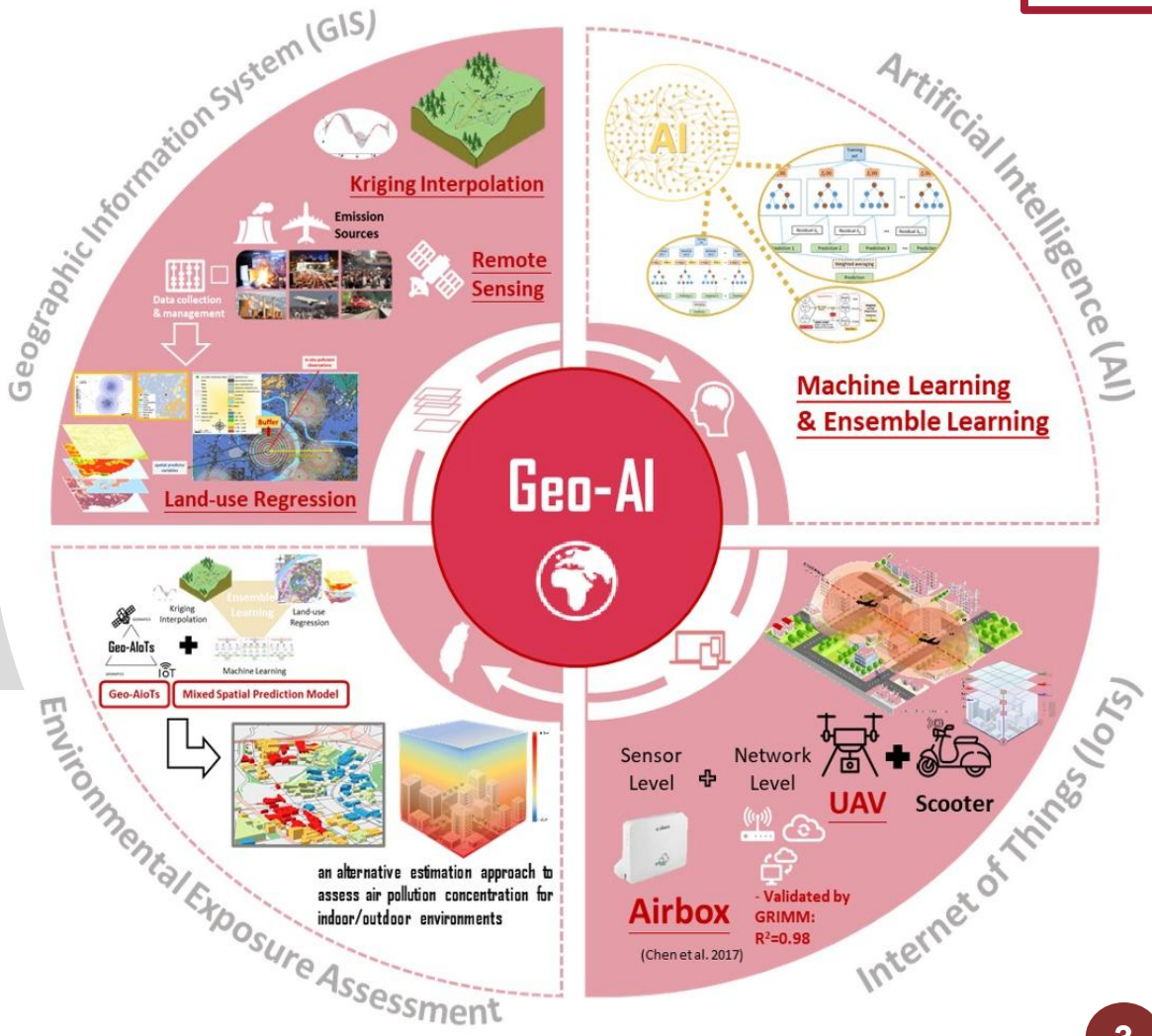
Postdoctoral Fellow: 2010 Research Center for Environment Changes, Academia Sinica

測量及空間資訊學系
吳治達
教授
CHIH-DA (JOHN) WU

RESEARCH INTEREST

Application of Geospatial Artificial Intelligence (Geo-AI) on environmental health

- Air pollution modelling
- Green space assessment



空間資訊與
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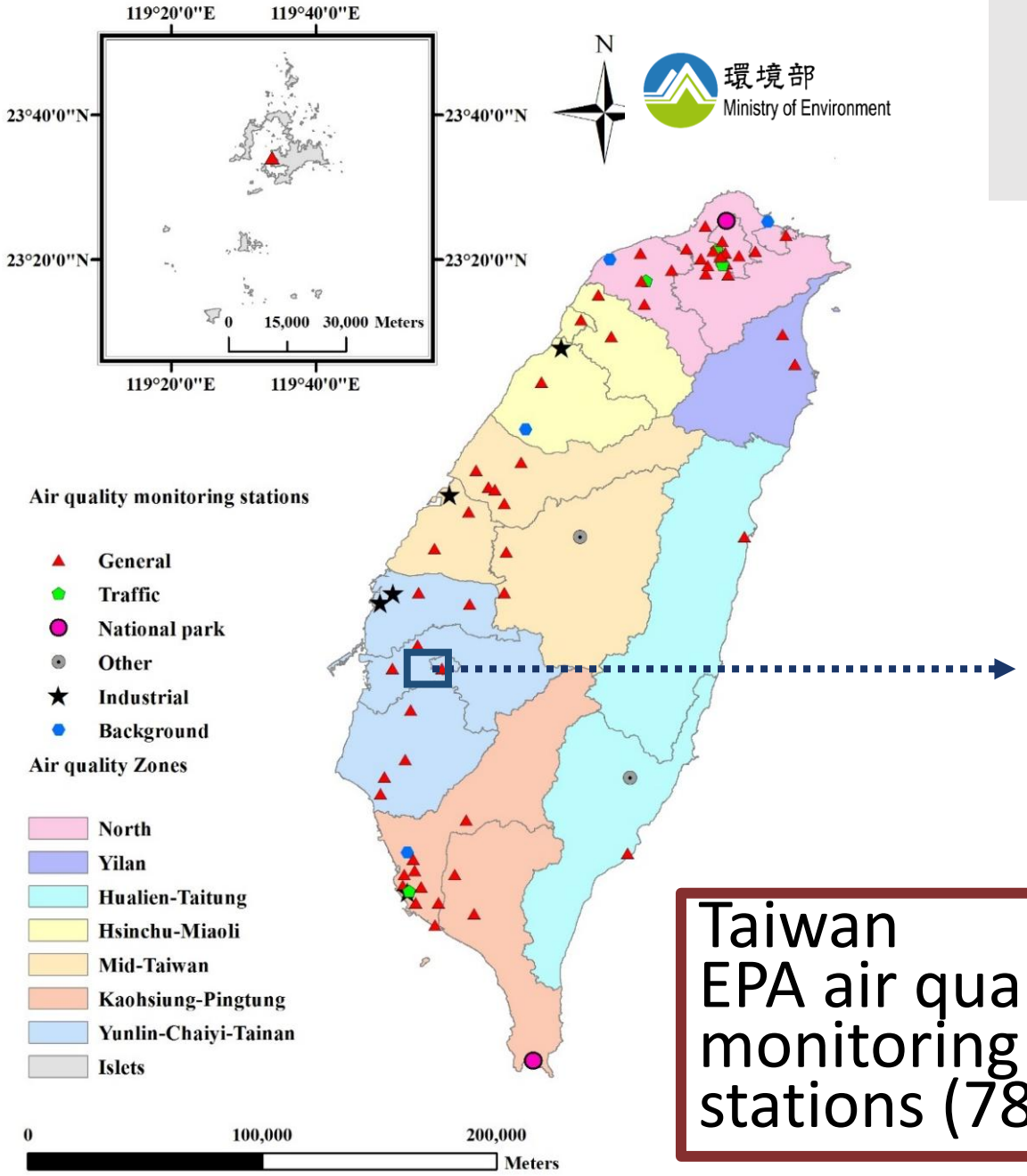
HEALTH LABORATORY

AIR POLLUTION MODELLING using「GEO-AI」

CHIH-DA (JOHN) WU Ph.D.「吳治達」
Professor, Department of Geomatics, NCKU



Taiwan
EPA air quality monitoring stations (78)

CHIAYI CITY ▶ 「~ 0.3 million residents」

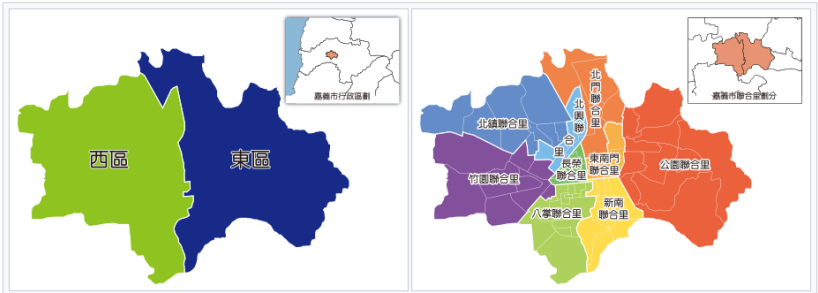
Only 1 EPA station

區劃人口 [編輯]

主條目：嘉義市行政區劃和嘉義市聯合里列表

嘉義市在民國34年（1945年）改制為省轄市，初分為東門、西門、北門、南門、八獎、竹圍、北鎮、東山等八區，後於民國35年（1946年）改劃分為新東、新西、新南、新北四區，同時水上、太保自臺南縣劃入，併為水上區、太保區。民國39年（1950年）調整行政區域，嘉義市改制為新東、新西、新南、新北四鎮及水上、太保二鄉。民國40年（1951年）新東、新西、新南、新北四鎮併為一個縣轄市。民國71年（1982年）升格為省轄市後，行政區劃於民國79年（1990年）行政區再度劃分為東西兩個區，兩區之間大略以文化路作為分界線[25][33]。

民國99年（2010年）2月1日，又將東西兩個區的分界做調整，並將原有108里調整為84里，1,778鄰調整成1,379鄰。[11][34]



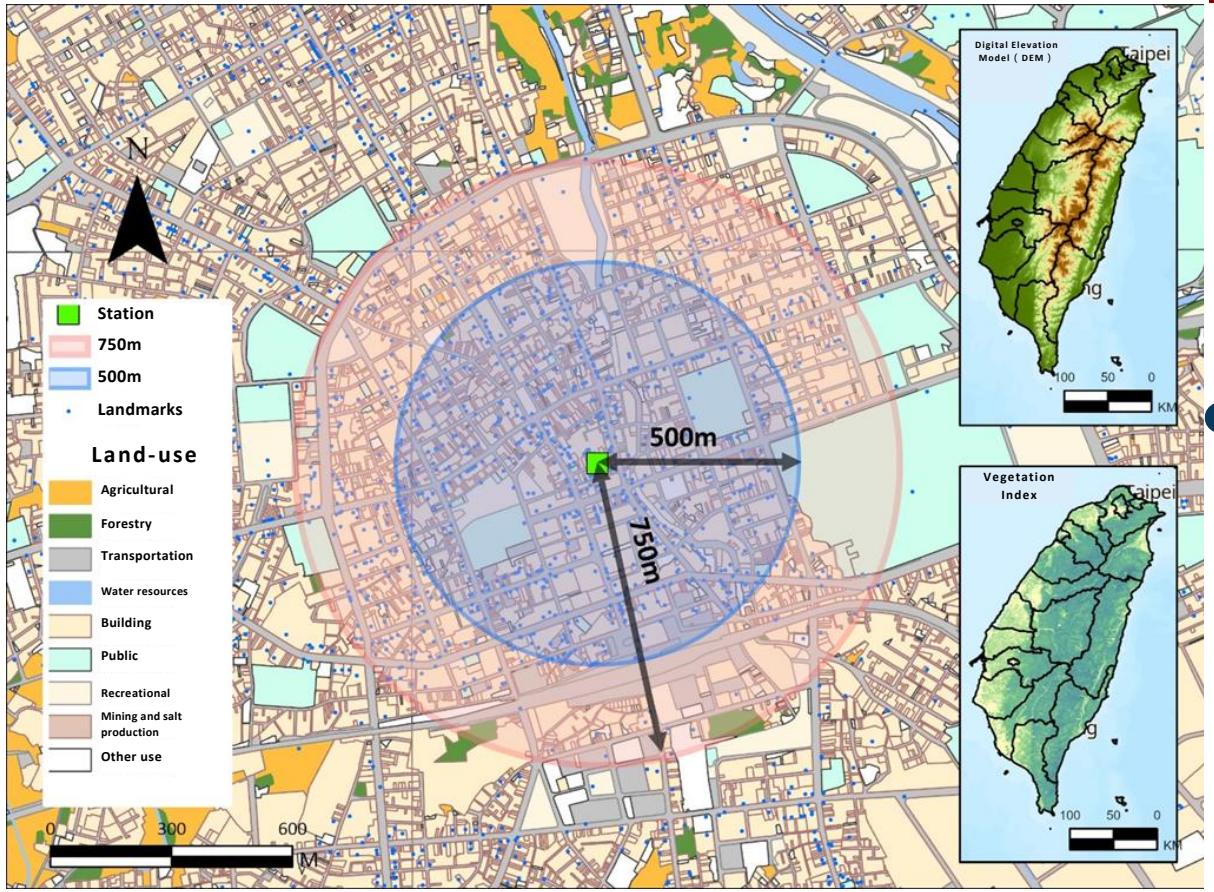
嘉義市行政區劃（左）與嘉義市聯合里劃分圖（右）。

need an appropriate method to assess air pollution exposures

GEO

Geospatial Information Spatial Analysis

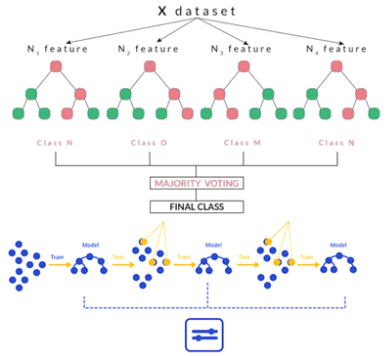
- Obtain comprehensive information on spatial environmental distributions
- Simulate spatiotemporal patterns and produce visualizations



AI

Machine Learning Ensemble Learning

- High-accuracy modeling
- Handling complex nonlinear patterns



SHAP

Variable Selection

OPTUNA

A hyperparameter optimization framework

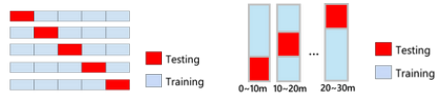
Machine Learning Models

Selection of important variables / Model training

- Random Forest
- Gradient Boosting
- Extreme Gradient Boosting
- Light Gradient Boosting
- Category Boosting

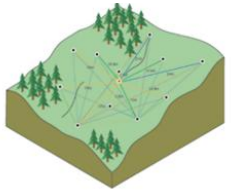
Model Validation

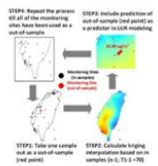
- Ten-fold cross validation
- Data Split Verification
- External data verification
- Temporal and spatial layered verification

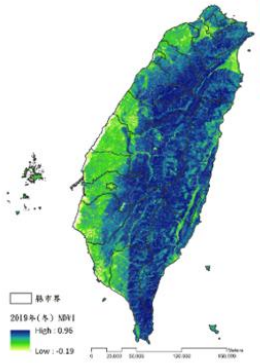


GEO: Geographic Information System (GIS), Remote sensing, UAV, Internet of Things (IoTs)

Kriging Interpolation

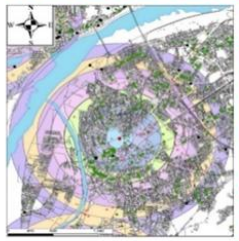






LULC patterns

Industrial, traffic, residential, thermal power plants, airport, harbor



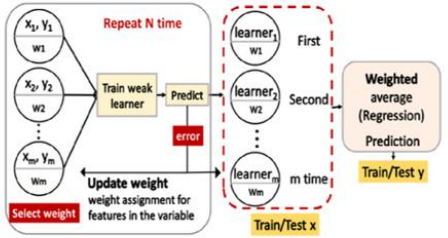
Specific emission sources

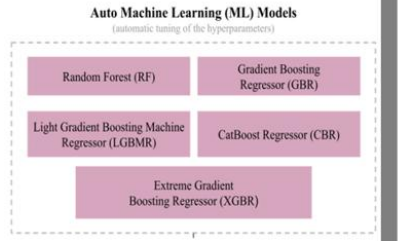
Chinese restaurant

Temple

AI:

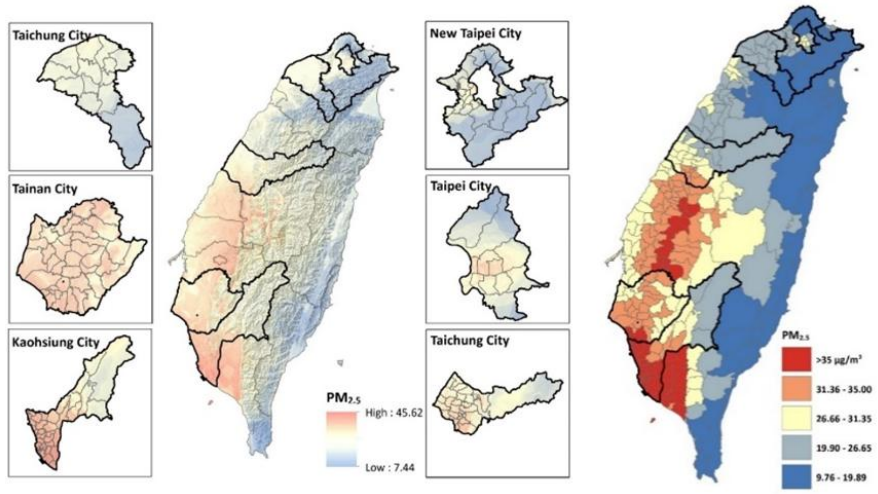
- Machine learning
- Stacking ensemble learning





PRELIMINARY ESTIMATION + **EXPLAINABLE VARIABLES** + **MODEL FITTING**

Application of Geo-AI Technologies in Air Pollution Estimation



28 PUBLISHED ARTICLES 「AIR POLLUTION MODELLING」

METHODS	POLLUTANT	STUDY AREA	RESOLUTION	PUBLICATIONS*
(3) Geo-AI Model 中	$PM_{2.5}$	Taiwan	Daytime/Nighttime/Daily	Wong and Wu* et al. 2023. Science of the Total Environment (IF=10.8; JIF%=90.1%)
		Taiwan	Daily	Wong and Wu* et al. 2021. Environmental Pollution (IF=10; JIF%=90.1%)
		Taiwan	Morning/Dusk commute period	Wong and Wu* et al. 2024. Environmental Pollution (IF=8.9; JIF%=90%)
		Kaohsiung City	Daily (Indoor)	Wong and Wu* et al. 2022. Building and Environment (IF=7.1; JIF%=93.1%)
	UFP	Zhunan-Miaoli	Minute (3-D distribution)	Hsu and Wu* et al. 2025. Environmental Pollution (IF=7.3; JIF%=87.8%)
	NO_2	Taiwan	Daily	Wong and Wu* et al. 2021. Journal of Cleaner Production (IF=11.1; JIF%=91.6%)
	NO_2	Taiwan	Daytime/Nighttime /Daily	Babaan and Wu*, et al. 2024. Journal of Environmental Management (IF=8.7; JIF%=88.9%)
	NO_x	Taiwan	Daytime/Nighttime /Daily	Asri and Wu* et al. 2024. Science of the Total Environment (IF=10.8; JIF%=90.9%)
	CO	Taiwan	Daily	Wong and Wu*, et al. 2021. Environmental Modelling & Software (IF=8.9; JIF%=88.4%)
	O_3	Taiwan	Daytime/Nighttime /Daily	Babaan and Wu*, et al. 2023. Journal of Hazardous Materials (IF=14.2; JIF%=97%)
	O_3	Taiwan	Morning/Dusk commute period	Hsu and Wu*, et al. 2023. Journal of Environmental Management (IF=8.7; JIF%=90%)
	SO_2	Taiwan	Daily	Wong and Wu*, et al. 2025. Environmental Technology & Innovation (IF=6.7; JIF%=89.9%)
	NH_3	Taiwan	Hourly	Wu and Hsu*, et al. 2024. Environment International (IF=11.8; JIF%=94.0%)
	Benzene	Houston, USA	Daily	Asri and Wu* et al. 2024. Journal of Hazardous Materials (IF=13.6; JIF%=96.5%)
	Benzene	Taiwan	Daily	Hsu and Wu*, et al. 2022. Chemosphere (IF=8.9; JIF%=88.4%)
	Dioxin	Taiwan	Daily	Hsu and Wu*, et al. 2024. Journal of Hazardous Materials (IF=14.2; JIF%=97%)
	Fungal Spore	Tainan City	Daily	Wong and Wu*, et al. 2024. Earth Systems and Environment (IF=5.3; JIF%=90%)
	Phytoncide	Xitou Experimental Forest	Hourly	Asri and Wu* et al. 2025. Ecological Indicators (IF=7.4; JIF%=88.1%)

METHODS	MAIN FINDINGS			
	POLLUTANT	STUDY AREA	RESOLUTION	PUBLICATIONS*
(2) Hybrid Kriging-LUR Model	$PM_{2.5}$	Taiwan	Annual/Monthly	Wu et al. 2018. Science of the Total Environment (IF=4.6; JIF%=89.1%)
	NO_2	Taiwan	Annual/Monthly	Chen and Wu*, et al. 2020. Environmental Pollution (IF=4.4; JIF%=83.7%)
	VOCs (BTEX)	Kaohsiung City	Monthly	Hsu and Wu*, et al. 2021. International Journal of Environmental Research and Public Health (IF= 3.4; JIF%=77%)
(1) Localized LUR	$PM_{2.5}$	Taipei City	Annual	Wu et al. 2017. Environmental Pollution (IF=4.4; JIF%=83.7%)
		Taipei VS Jakarta	Annual	Widya and Wu et al. 2019. International Journal of Environmental Research and Public Health (IF= 2.9; JIF%=81.6%)
	$PM_{2.5}$ Constitutes	Taiwan	Annual	Hsu and Wu* et al. 2018. Remote Sensing (IF=3.5; JIF%=75%)
	PM_{10} & NO_2	Surabaya, Indonesia	Annual	Widya and Wu* et al. 2020. International Journal of Environmental Research and Public Health (IF= 3.4; JIF%=77%)
	O_3	Taiwan	Annual	Hsu and Wu* et al. 2019. International Journal of Environmental Research and Public Health (IF= 2.9; JIF%=81.6%)
	Fungal spores	Taipei	Annual	Kallawicha and Wu et al. 2015. Environmental Pollution (IF=4.84; JIF%=92.67%)
	Bacteria and Endotoxin	Taipei	Annual	Kallawicha and Wu et al. 2014. Aerosol and Air Quality Research (IF=2; JIF%=65. 6%)

$PM_{2.5}$

Ensemble mixed spatial model

- Kriging interpolation
- \+ Land-use regression
- \+ Machine learning
- \+ Stacking ensemble

Model performance

(50-m grid/daily resolution)

Daytime

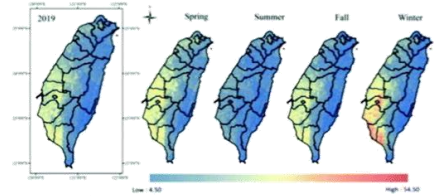
R^2=0.879
RMSE=6.97 μg/m³

Nighttime

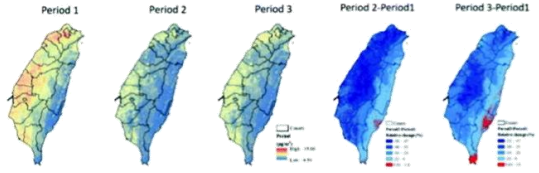
R^2=0.878
RMSE=7.11 μg/m³

Implementation

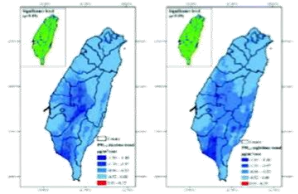
- Daytime/nighttime estimation for the last three decades



- COVID-19 period



- Trend analysis

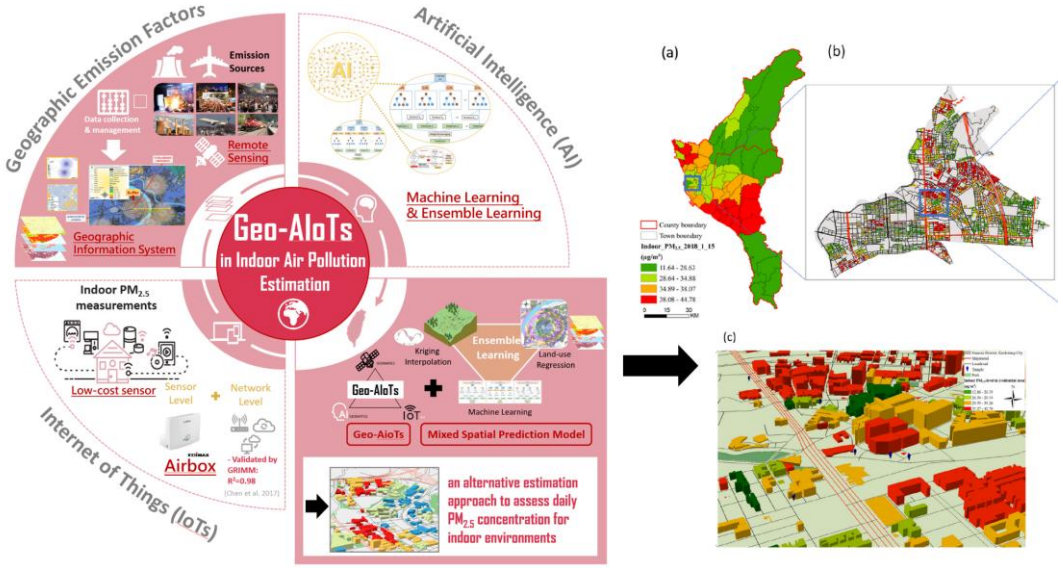


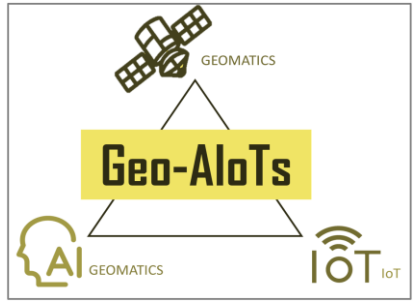
Wong, P. Y., H. J. Su, S. C. C. Lung, **C. D. Wu*.** 2023. An ensemble mixed spatial model in estimating long-term and diurnal variations of PM2.5 in Taiwan. **Science of the Total Environment 866, 161336 (IF=10.8; JIF%=90.9%)**.

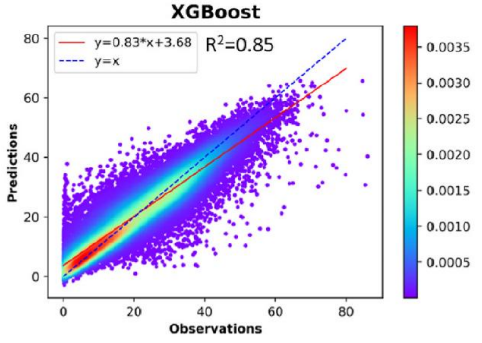
(MOST 111-2121-M-006-004-)

Wong, P. Y., H. Y. Lee, L. J. Chen, Y. C. Chen, N. T. Chen, S. C. C. Lung, H. J. Su, **C. D. Wu*,** J. G. C. Laurent, G. Adamkiewicz, J. D. Spengler. 2022. An alternative approach for estimating large-area indoor $PM_{2.5}$ concentration – a case study of schools. **Building and Environment 109249 (IF=7.1; JIF%=93.1%).**

MOST 106-2119-M-415-001 -

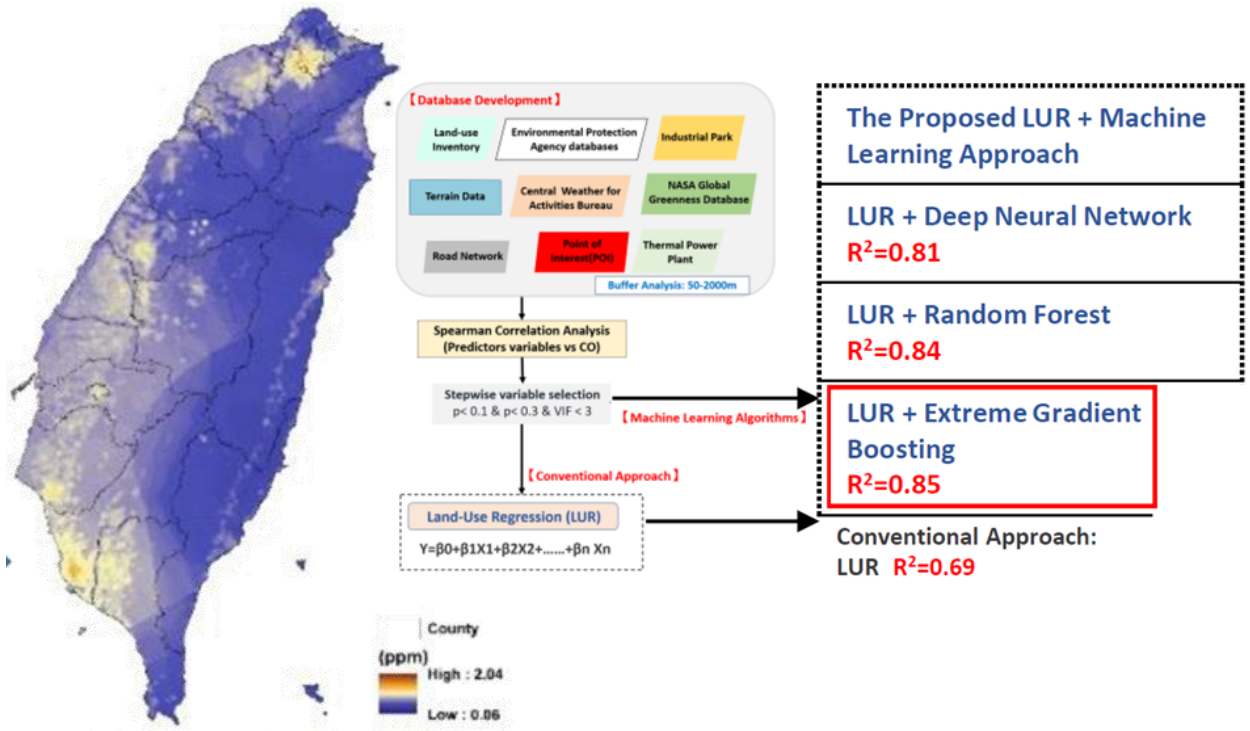






INDOOR $PM_{2.5}$

CO



Spatial-temporal Variation Estimations of CO

Wong, P. Y., C. Y. Hsu, J. Y. Wu, T. A. Teo, J. W. Huang, H. R. Guo, H. J. Su, **C. D. Wu***, J. D. Spengler. 2021. Incorporating Land-Use Regression into Machine Learning Algorithms in Estimating the Spatial-Temporal Variation of Carbon Monoxide in Taiwan. **Environmental Modelling & Software 139:104996 (IF=5.5; JIF%=84.5%).**

NSTC 國科會
MOST 108-2638-B-006 -001 -MY2

NO_2

Land-Use Regression

$NO_2=\beta0+\beta1X1+\beta2X2+\beta3X3+...+\beta nXn$

- Conventional LUR
- Hybrid-Kriging LUR

Stepwise variable selection
p<0.1 & p<0.3 & VIF<3

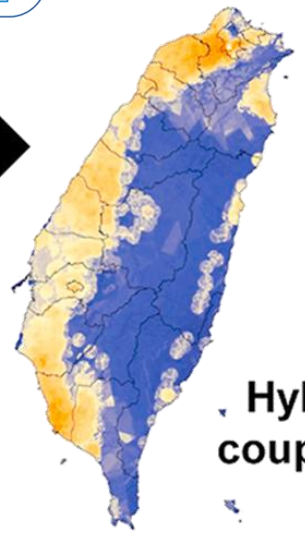
Machine Learning Algorithms

- Deep Neural Network
- Random Forest
- XGBoost

Model Validation

- 80% training/ 20% testing data for model building
- 10-fold cross validation
- External data validation

Spatial-Temporal Estimation of NO_2 Variability



Conventional LUR
R^2= 0.65

+26%

Hybrid-Kriging LUR coupled with XGBoost
R^2= 0.91

Wong, P. Y., H. J. Su, H. Y. Lee, Y. C. Chen., Y. P. Hsiao, J. W. Huang, T. A. Teo, **C. D. Wu*,** J. D. Spengler. 2021. Using land-use machine learning models to estimate daily NO_2 concentration variations in Taiwan. **Journal of Cleaner Production 317: 128411 (IF=11.1; JIF%=92%).**

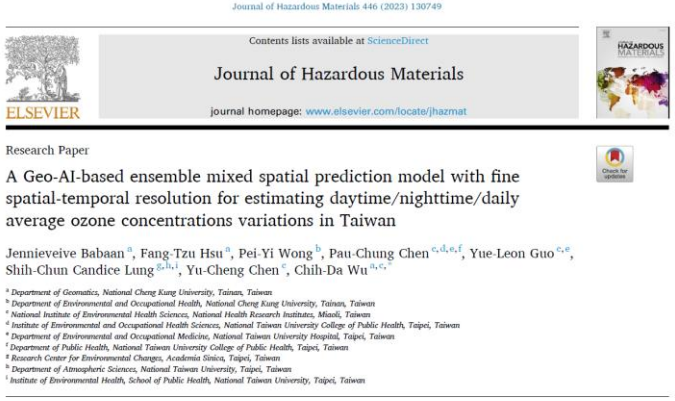
國家衛生研究院 National Health Research Institutes
(NHRI-109A1-EMCO-02202212)

OZONE (O_3)

國家衛生研究院 National Health Research Institutes

(NHRI-109A1-EMCO-02202212)

Prof. Jennieveive Babaan-Mabaquiao



Journal of Hazardous Materials 446 (2023) 130749

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Research Paper

A Geo-AI-based ensemble mixed spatial prediction model with fine spatial-temporal resolution for estimating daytime/nighttime/daily average ozone concentrations variations in Taiwan

Jennieveive Babaan [a], Fang-Tzu Hsu [a], Pei-Yi Wong [b], Pau-Chung Chen [c,d,e,f], Yue-Leon Guo [c,e], Shih-Chun Candice Lung [g,h,i], Yu-Cheng Chen [c], Chih-Da Wu [a,c,*]

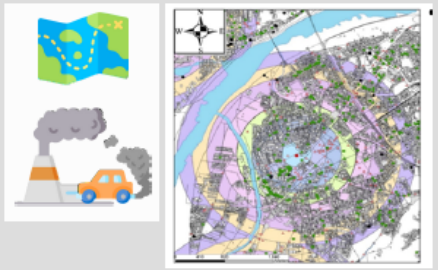
[a] Department of Geomatics, National Cheng Kung University, Tainan, Taiwan
[b] Department of Environmental and Occupational Health, National Cheng Kung University, Tainan, Taiwan
[c] National Institute of Environmental Health Sciences, National Health Research Institutes, Miaoli, Taiwan
[d] Institute of Environmental and Occupational Health Sciences, National Taiwan University College of Public Health, Taipei, Taiwan
[e] Department of Environmental and Occupational Medicine, National Taiwan University Hospital, Taipei, Taiwan
[f] Department of Public Health, National Taiwan University College of Public Health, Taipei, Taiwan
[g] Research Center for Environmental Changes, Academia Sinica, Taipei, Taiwan
[h] Department of Atmospheric Sciences, National Taiwan University, Taipei, Taiwan
[i] Institute of Environmental Health, School of Public Health, National Taiwan University, Taipei, Taiwan

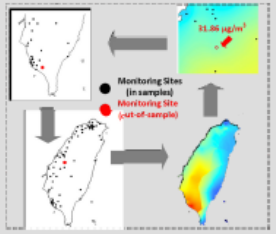
Geo-AI - based ensemble mixed spatial model (EMSM)

statistical analysis

- Land Use Regression

*using a 20-year ozone observation data





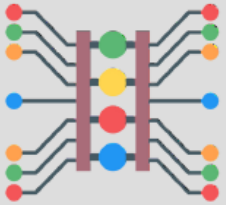
spatial interpolation

- Hybrid - Kriging LUR

artificial intelligence

- Machine Learning
- Ensemble Learning

Random Forest, Light Gradient Boosting, Gradient Boosting, CatBoost, Extreme Gradient Boosting



EMSM Performance

Daytime	Nighttime	Daily
$R^2 = 0.91$	$R^2 = 0.88$	$R^2 = 0.88$
RMSE = 4.64 ppb	RMSE = 4.23 ppb	RMSE = 4.04 ppb

Daytime O_3 > Nighttime O_3

(36.73 ± 15.18 ppb) (20.92 ± 12.39 ppb)

Higher O_3 levels in mountainous regions than in urban areas.

Babaan, J, F. T. Hsu, P. Y. Wong, P. C. Chen, Y. L. Guo, S. C. C. Lung, Y. C. Chen, **C. D. Wu***. 2023. A Geo-AI -based Ensemble Mixed Spatial Prediction Model with Fine Spatial-Temporal Resolution for Estimating Daytime/Nighttime/Daily Average Ozone Concentrations Variations in Taiwan. **Journal of Hazardous Materials 446: 130749 (IF=14.2; JIF%=97%)**.

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成大發表新研究 郊區是臭氧熱區

詹伯望／臺南報導

越近郊區臭氧汙染越密集？臭氧為何最愛停留在郊區？新冠肺炎和臭氧汙染有何關係？成功大學測量系副教授吳治達等組成團隊，運用近二十年環保署約一百八十多萬筆空汙監測數據，發展出對區域臭氧濃度變化有高達百分之九十二準確度的「集成混合空間推估模型」，成功登上頂尖期刊《Journal of Hazardous Materials》。吳治達今天將受邀到國科會環境遙測與健康效應科技論壇，發表研究成果。

以臺南市為例，臭氧熱區主要分布在安平、山上、南化、關廟、左鎮等區域，其中安平是唯一鄰近市中心的區域。吳治達研判，安平工業區提供較多氮氧化物、揮發性有機化合物，成為臭氧的組成來源，且地形起伏，讓生物性揮發性有機化合物堆積機率更高，也是安平成為臭氧熱區的原因之一。

至於南化、關廟、左鎮等郊區，區內多為森林、農業等植被地區，可能產生更多生物性揮發性有機化合物，加上陽光充足，自然形成臭氧熱區，而其中有知名旅遊景點，更需要監測和關注，保障國人出遊健康。

因應研究過程適逢新冠肺炎三級警戒，吳治達團隊將警戒前後的臭氧熱區數據製成視覺化模擬圖，發現交通空汙排放物最密集的臺北市，因為人車減少，整體臭氧數值下降。

棒球經典賽 日本

吳啟綜／綜合報導

第五屆世界棒球經典賽（WBC）冠軍戰，昨天在美國邁阿密馬林魚球場登場，日本隊以三比二擊敗衛冕軍地主美國……

▲大谷翔平（中）舉起獎杯，與隊友齊聲歡呼，慶祝日本奪得世界棒球經典賽冠軍。

台南

成大測量系吳治達團隊解密臭氧 台南熱區分布在安平、山上、南化、關廟、左鎮等區

2023-03-22

首頁 / 生活

台南「這幾區」是臭氧熱區 成大學者解祕

12:02 2023/03/22 | 中時 | 曹婷婷

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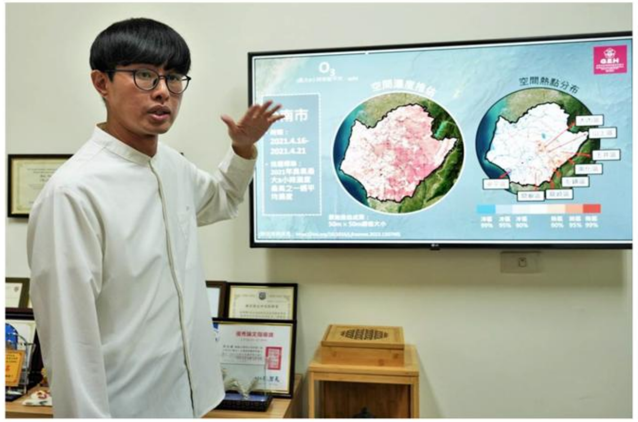
HOT 軍工股重挫 雷虎殺跌停 逾千張排隊等賣

台南「這幾區」是臭氧熱區 成大學者解祕

曹婷婷 2023.03.22



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中華日報 1.6k 人追蹤 ☆ 追蹤

成大測量系吳治達團隊解密臭氧 台南熱區分布在安平、山上、南化、關廟、左鎮等區

CDNS L
2023年3月22日 週三 下午5:56

關於成大 研究 創新 國立成功大學 教學 行政 招生

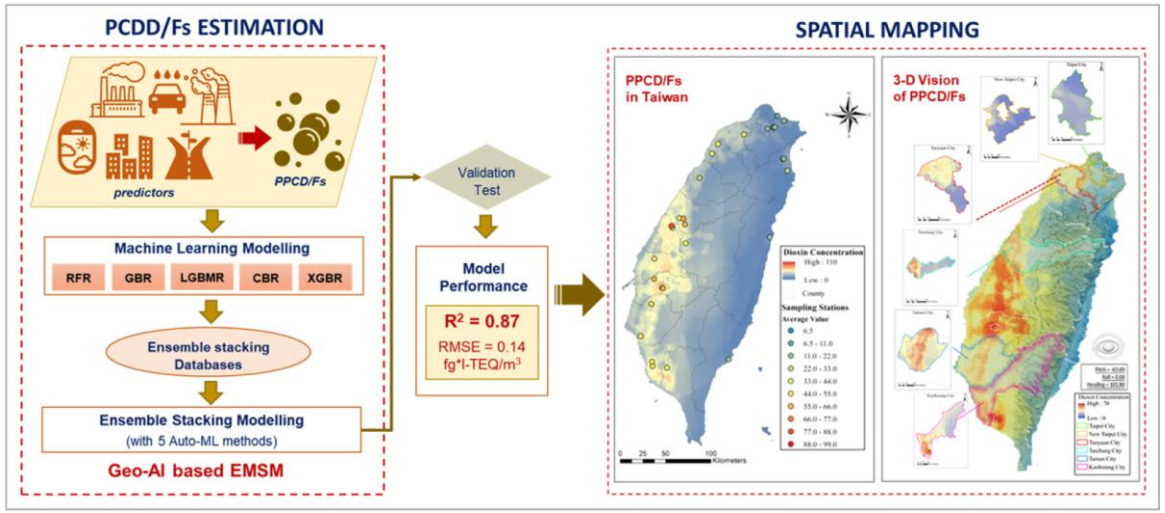
首頁 / 成大快訊 RSS

解開臭氧三大謎題 預測濃度變化準確高於90% 成大測量系吳治達副教授「集成混合空間推估模型」榮登國際頂尖期刊

文 / 周欣儒 圖 / 陳正明

關於「臭氧」你了解多少？除了地表高層遮蔽紫外線的臭氧層，神秘的「臭氧污染」早已無孔不入的滲入日常中。國立成功大學測量及空間資訊學系吳治達副教授團隊，透過「集成混合空間推估模型」為你解開臭氧的三大謎題：越近郊區臭氧污染越密集？臭氧為何最愛停在郊區？COVID-19 與臭氧污染有何關係？

DIOXIN



Hsu, C. Y., T. W. Lin, **J. B. Babaan,** A. K. Asri, P. Y. Wong, K. H. Chi, T. H. Ngo, Y. H. Yang, W. C. Pan, **C. D. Wu***. 2023. Estimating the Daily Average Concentration Variations of PCDD/Fs in Taiwan Using a Novel Geo-AI Based Ensemble Mixed Spatial Model. **Journal of Hazardous Materials 458:131859 (IF=14.2; JIF%=97%).**

[MOST 111-2121-M-006-004-]

National Science and Technology (NSTC) & ELSEVIER E-newsletter

NSTC 國家科學及技術委員會
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EN

最新消息 關於中心 各類補助 圖書期刊 活動專區 聚焦地科 電子報 影音專區 微電影

數位孿生(Digital-Twin)多維空間資訊整合分析於空氣污染之應用：地理人工智慧(Geo - AI)於環境戴奧辛污染模擬新進展

— 成功大學測量及空間資訊學系吳治達教授與團隊研究成果

「數位孿生」(Digital Twin)係國家科學及技術委員會空間資訊科技學門過去幾年來的重點研究主題之一。在空間資訊的研究領域中，數位孿生的主要概念是藉由各項空間科技以獲取真實世界的半即時 / 即時監測資訊後，透過物理、化學、統計或人工智慧的建模方法，於網路數位空間建構一個虛擬的世界，經營管理者可在這個虛擬世界進行各種政策或情境模擬並學習經驗，進而協助其在真實世界做出更正確的環境管理決策。

在各項環境議題中，空氣污染為近年最受重視的全球環境議題之一，因為人類生命的過程中無時無刻不能沒有空氣、也幾乎無法挑選所吸的空氣。與其它環境危害因子相比，空氣污染具有三維分布的特性，除了在水平空間上會有濃度的差異外，垂直高度的改變亦會影響其污染程度的高低。當前環保署的監測站僅於固定高度進行空污監測，並未提供垂直剖面上的變化資訊。再加上室外和室內的空氣品質具有高度相關性，這對於長時間(約有90%以上的時間)待在室內的民眾、尤其是居住在多為高樓層建築的大都會地區的人來說，如何準確推估空氣污染在水平及垂直維度上的三維分布，進而更精確估計都市居民的空污暴露濃度及其對健康的影響效應，是當前一項重大的挑戰。

在國家科學及技術委員會的經費支持下(MOST 111-2121-M-006-004-)，國立成功大學測量及空間資訊學系吳治達教授與團隊基於「數位孿生多維空間資訊整合於空氣污染應用」的核心概念，經由無人機與物聯網感測器獲取空氣污染，並利用地理人工智慧(Geo-AI)技術，發展集成混合空間推估模型(Ensemble Mixed Spatial Prediction Model，EMSM)，以估算三維空污分布。現階段EMSM模型的技術已臻完備，目前已實際應用於解析全臺細懸浮微粒($PM_{2.5}$)、苯、臭氧及環境戴奧辛等空氣污染物之空間分布，其中$PM_{2.5}$及苯的研究成果刊登於Science of the Total Environment 以及Chemosphere；臭氧及環境戴奧辛之成果則獲刊載於國際頂尖期刊 Journal of Hazardous Materials。

ELSEVIER

ScienceDirect 研究電子報 Sep - Oct, 2023

Scopus AI 專業測試版 研究捷報 如何區別研究的摘要與引言

Elsevier 恭喜國立成功大學測量及空間資訊學系團隊發表戴奧辛集成混合空間推估模型研究於 Elsevier 旗下環境科學領域頂尖期刊《*Journal of Hazardous Materials*》

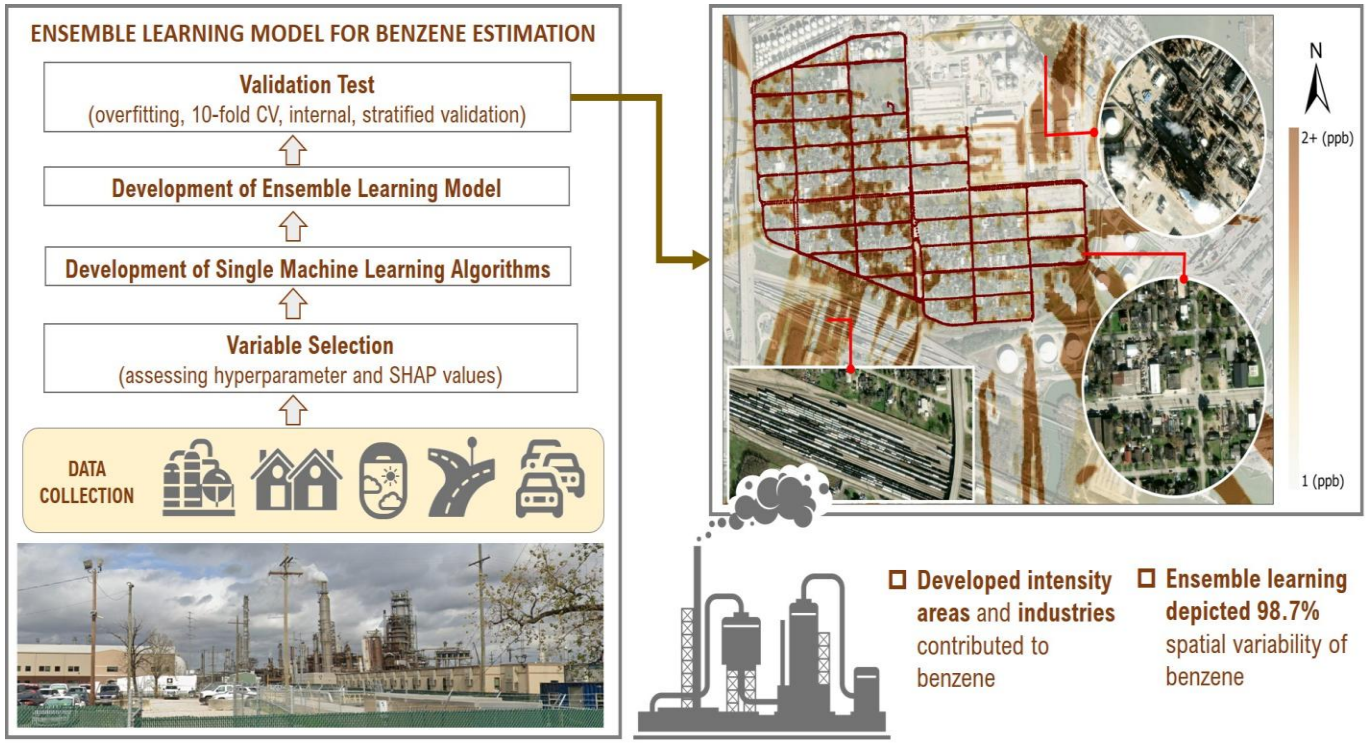
戴奧辛污染是台灣環境保護關注的重要議題，因為具有極高毒性危害人體健康及長期殘留的特性。而空氣中存在著多少戴奧辛？環保署受限於經費規劃，監測點位設定有限，無法長時間採集空氣樣本做準確評估，因此，國立成功大學空間資訊學系吳治達副教授及團隊，企圖打造高精度環境大氣中戴奧辛濃度的推估模型。吳治達副教授表示，2-3 年前意識到傳統統計迴歸模型遇到了瓶頸，隨著資料量增加，他也希望能夠更精細地解讀和分析，因此思考如何有更好的方式進行研究。

成大空間資訊學系吳治達副教授團隊，與明志科技大學環境與安全衛生工程系許金玉助理教授、國立陽明交通大學環境與職業衛生研究所紀凱獻所長及潘文驥副教授、菲律賓大學迪里曼分校（University of the Philippines Diliman）Jennieveive B. Babaan 助理教授（音譯：白嘉維，吳副教授指導的研究所畢業生）共同合作，使用地理人工智慧（Geo-AI）技術開發「集成混合空間推估模型（EMSM）」，用來模擬全台空氣中戴奧辛的空間分布與時間變異狀況。

國立成功大學 空間資訊學系 吳治達副教授研究團隊

後排左四 研究生林廷威（本研究第二作者）、左五 吳治達副教授、右五 博士生 Aji Kusumaning Asri（本研究第四作者），右四 碩士生 Jennieveive B. Babaan（本研究第二作者）

BENZENE (Houston)



Asri, A. K., G. D. Newman, Z. Tao, R. Zhu, H. L. Chen, , S. C. C. Lung, **C. D. Wu***. 2024. What is the spatiotemporal pattern of benzene concentration spread over susceptible area surrounding the Hartman Park community, Houston, Texas? **Journal of Hazardous Materials 474: 134666 (IF=13.6; JIF%=96.5%)**.

地球科學 研究亮點

【研究成果】地理人工智慧運算技術成功協助美國社區分析苯污染物來源 準確率高達98%！

發表者 SPEC科學推展中心 | 3124 觀看次數

撰稿 / **黃愷翊 (科學推展中心特約編輯)**

國立成功大學測量與空間資訊學系教授吳治達團隊與德州農工大學超級基金研究中心（Texas A&M University Superfund Research Center）合作，結合該中心在美國德州休士頓地區的Hartman Park社區內進行移動採樣的數據與成大團隊發展的地理人工智慧技術，以分析苯污染的重要來源，並模擬苯污染在社區中的濃度分布及變化。研究成果已經刊登於國際期刊《危險物質》(Journal of Hazardous Materials)。

團隊成員包括成大食品安全衛生暨風險管理研究所所長陳秀玲、美國德州農工大學景觀設計及都市計畫學系教授 Galen D. Newman、中央研究院環境變遷研究中心副主任龍世俊與成大測量系博士生 Aji Kusmaning Asri等，目前研究團隊仍持續分析德州達拉斯地區的污染情況。

苯（Benze）為空氣污染中的健康殺手

在造成空氣污染的因子中，苯（Benze）作為研究特別關注的成分，因為苯已經被國際癌症中心（IARC）確認為致癌物，會帶來各種健康風險，包括貧血、損害骨髓、增加感染機會、過度出血和免疫系統受損。此外，過去研究也指出，長期暴露於苯污染中與白血病、肺癌、惡性腫瘤和心血管疾病有顯著相關性。因此了解苯污染的來源及分佈為解決空氣污染的重要步驟。

美國德州休士頓的Hartman Park社區正面臨空氣污染威脅

一般而言，在我們的生活當中，車流量大的公路、工業區或加油站旁，都是相對來說接觸到苯機會較大的地方。美國德州休士頓的Hartman Park社區即為一個極端的例子，因為社區內以及鄰近地區有高密度的工業及儲油槽設施，高度空氣污染區，更被評為全美空氣品質排名倒數第六的城市。嚴峻的空氣污染對該地區的居民的健康安全造成高度風險，加上當地多為西班牙裔且社經地位相對較低的居民，嚴重的空污環境更加劇了社會資源分佈不均與環境正義等問題，調查環境空氣品質在此狀況下顯得刻不容緩。

人工智慧加上大數據機器學習，偵測準確率高達98%

研究團隊運用機器學習為基礎加上整合學習模型的方法，將實際監測社區住宅區的污染物的數據，結合地理資訊統、衛星地標、土地利用排放源分布圖層及氣象等多達300項的環境因子，並透過五種機器學習算法（即XGBR、GBR、LGBMR、CBR、RFR）組合成的新開發集成學習模型進行分析，展開人工智慧運算。研究進行了模型穩健性評估、過擬合測試、10倍交叉驗證、內部和分層驗證，最後集成模型能夠解釋苯空間變異性高達約98.7%（調整R2=0.987）。通過嚴格的驗證，確認了模型表現具有高度穩定性，即可精準判斷Hartman Park社區苯污染物來源與分布。

苯污染模式顯示交通與石化工業恐為元兇

從研究結果顯示，以時間上來說，早上時段苯的濃度較高，可能與工業與交通密集時段有密切相關，特別是與工業區相鄰的高速公路通常在早上常會交通壅塞。另一方面，通過分析空間模式，研究發現不管是工業區附近或住宅區都監測到超過1 ppb的苯擴散（如圖一）。

https://spec.ntu.edu.tw/research/research-detail51

熱門標籤

HotTag

物理 地球科學 化學 半導體 公告事項 研討會訊息 女性 奈米 跨領域 國科會 數學 研究亮點 ACS 整合型計畫 統計 演講與活動 女性研討會 徵才資訊 過去活動 實習計畫 學術活動成果 科學推展中心 淨零碳排 催化 活動報導 國際會議 細胞膜 放電細菌 量子元件 演講訊息 奈米粒子 生物有機 天文望遠鏡 量子震盪 台灣空間永續規劃 南極 熱力耦合模型 量子通訊 AlphaFold 研究成果 有機發光元件 天體力學 分析技術 候鳥 ChatGPT應用 整合型計畫徵求 富勒烯 估計量 2024分析技術交流 森林火災

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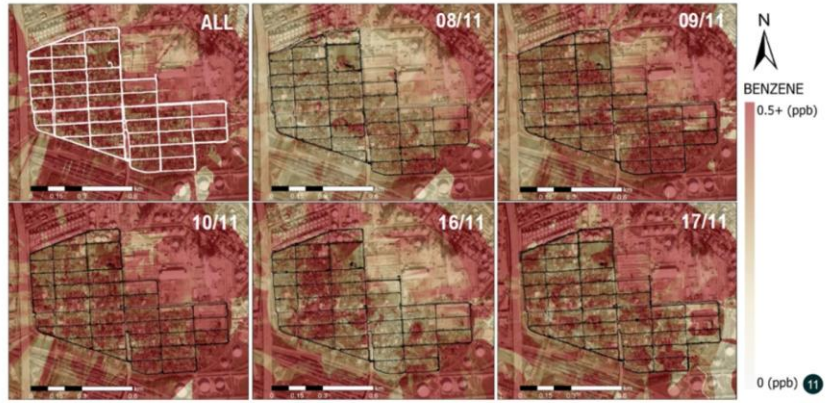
New Article

【研究成果】提出優化p值合併法 為醫學與基因研究的統計工具加分

【人物專訪31】林學庸，走一條人煙稀少的路，看見與眾不同的風景



圖一. 紅色代表苯的濃度，顏色越紅代表苯的濃度越高。透過模型運算顯示，Hartman Park的工業區和住宅區都有高濃度的苯擴散。

造成全區都有高濃度的苯擴散的可能原因是來自周圍的工業區、高速公路、鐵路及其產生的交通活動其中。研究監測到高濃度的苯在高速公路附近，這便證明了苯是交通所產生的空氣污染中的一部分。再者，該研究觀察到位於住宅區北部和東部的工業區每天都偵測到高濃度的苯（>1 ppb），該區有煉油廠，也靠近休士頓船運航道，由於有石化化合物的排放，可能增加空氣中有毒物質。另一個苯的高密度污染區為鐵路附近，因鐵路運行會燃燒化石燃料，會排放出多種化學物質，其中也包含苯（如圖二）。

圖二. 紅色代表苯的濃度，顏色越紅代表苯的濃度越高。透過模型顯示，含有極高濃度苯的區域為煉油廠與鐵道，皆與石化燃料的燃燒與排放相關。

3-D Distribution of Ultra Fine Particle (UFP)

Phd. Student
許家瑋 (Chia-Wei Hsu)

Y

3-D $PM_{0.1}$ Concentration

P-Trak Ultrafine Particle Counter 8525

X

2-D / 3-D Land Use Variable Database

auto ml

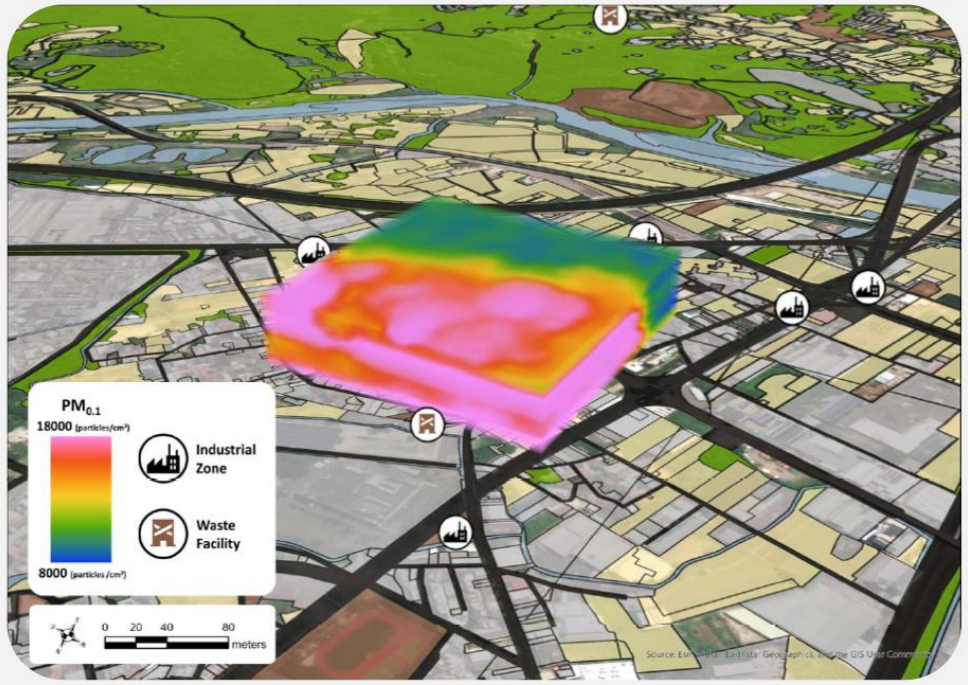
Geo-AI modeling

SHAP

Empirical Bayesian Kriging 3D

R^2 = 0.98

RMSE = 583.14 particles/cm³



Hsu, C. W., Y. R. Chern, J. J. Su, P. Y. Wong, A. K. Asri, C. Wijaya, Y. C. Chen, S. C. C. Lung, T. C. Hsiao, T. A. Teo, Y. L. Shih, **C. D. Wu***.
2025. Assessing 3-D Variability of Ultrafine Particle Using a Geo-AI Modelling Approach: A Case Study in Zhunan-Miaoli, Taiwan.
Environmental Pollution 383:126879 (IF=7.3; JIF%=87.8%).

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MOST 111-2121-M-006-004-
MOST 111-2121-M-006-004-

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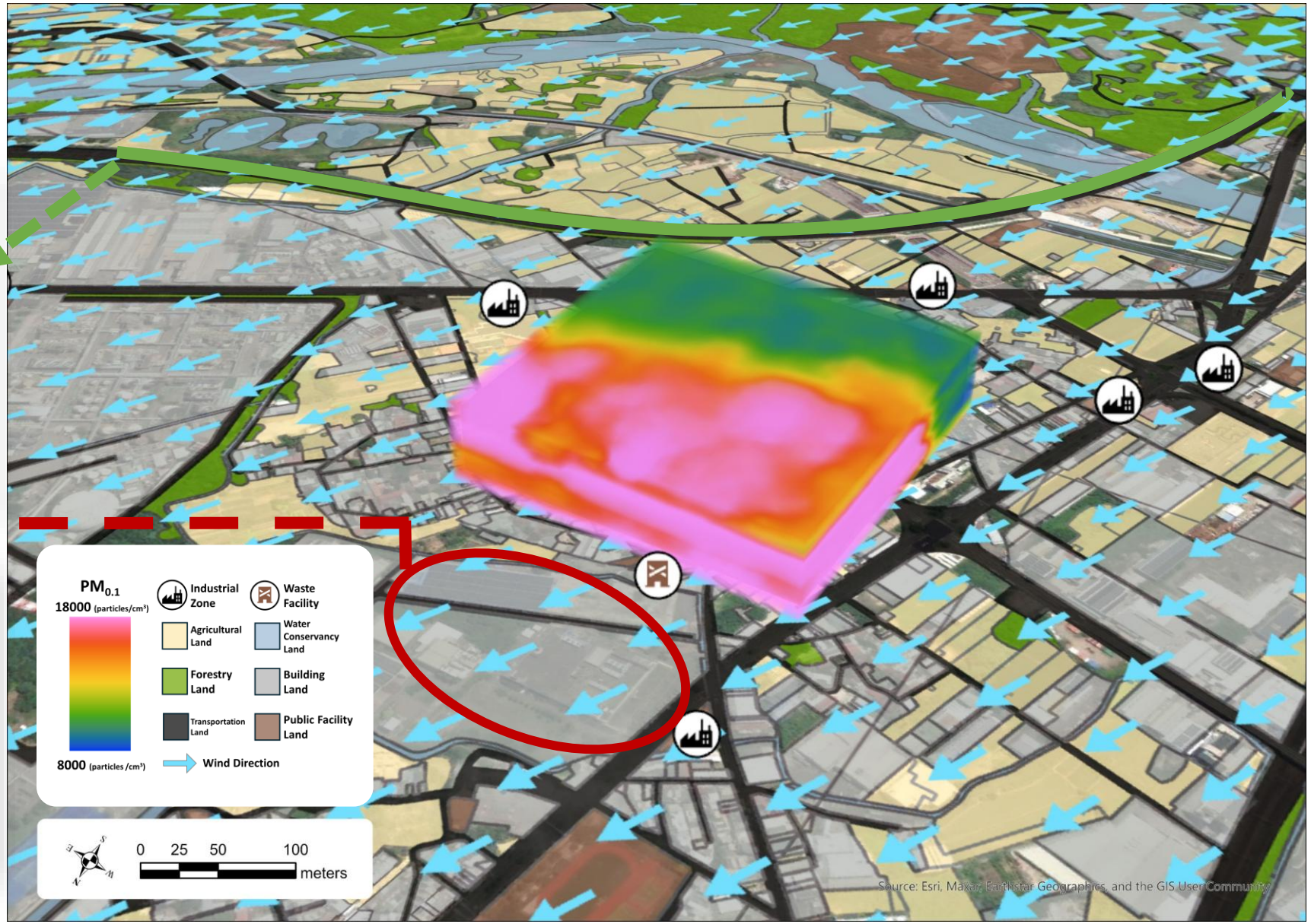
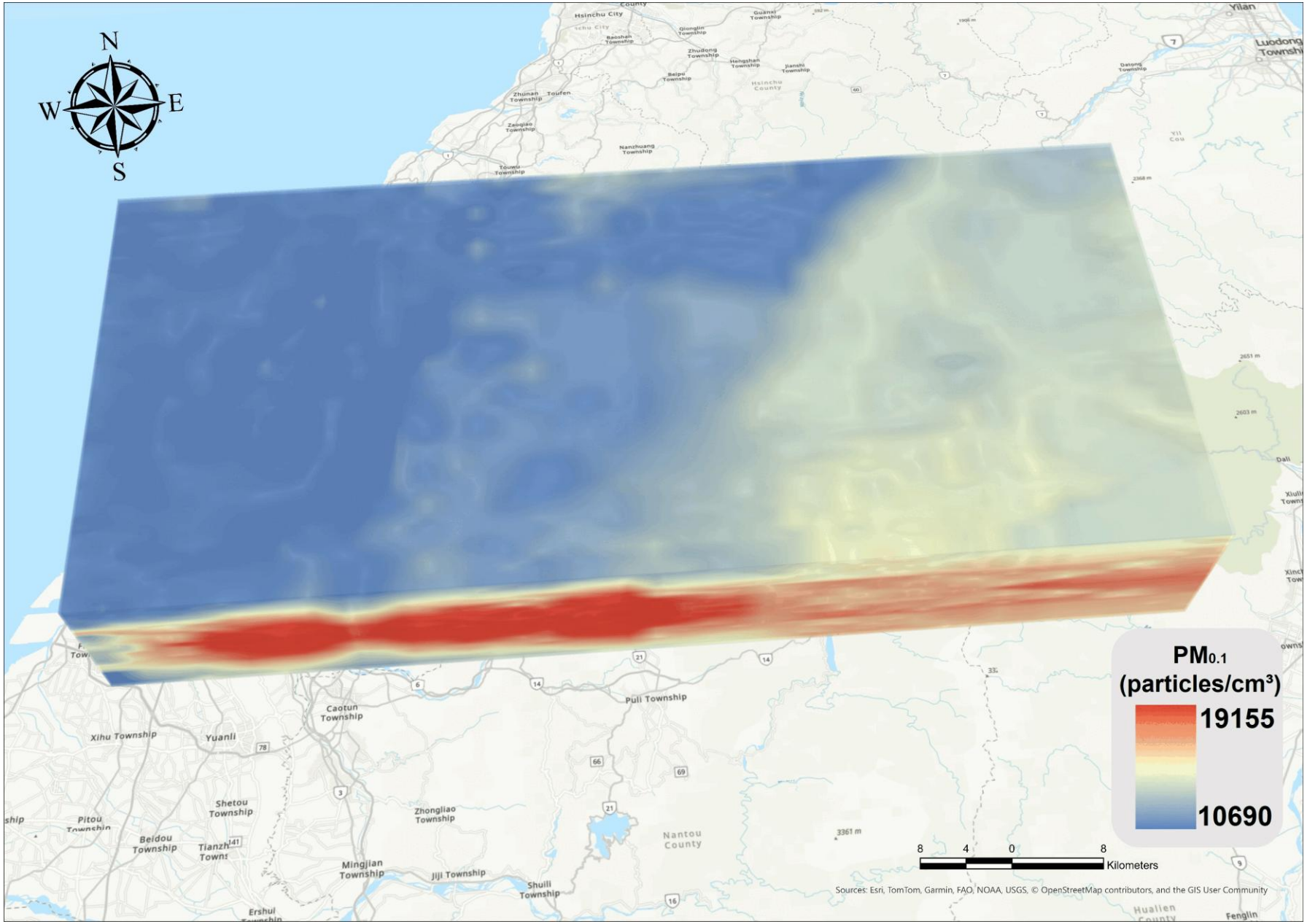


Geo-AI & Digital Twin Application on 3-D Distributions of UFP



2023 Qiusen Award (Outstanding Aerosol Young Scientist Award)

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2025

空間資訊與
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GEOMATICS AND
ENVIRONMENTAL
HEALTH LABORATORY

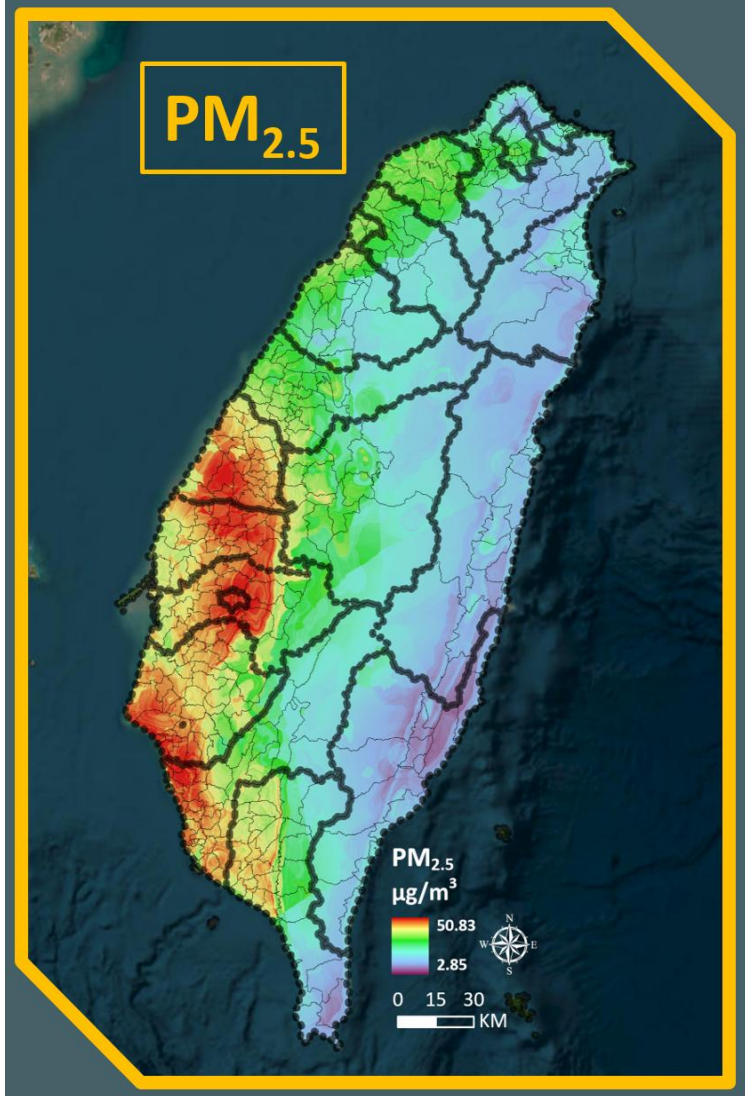
AIR POLLUTION ESTIMATES ASSOCIATED TO HEALTH OUTCOMES

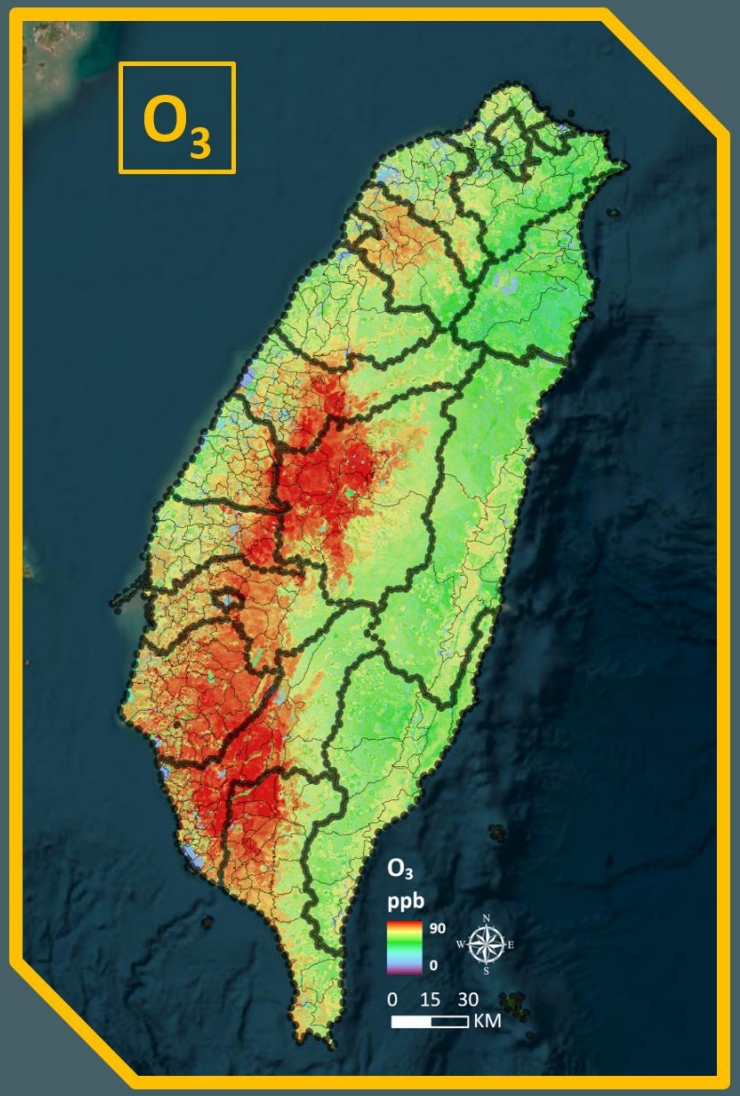
CHIH-DA (JOHN) WU Ph.D.「吳治達」
Professor, Department of Geomatics, NCKU

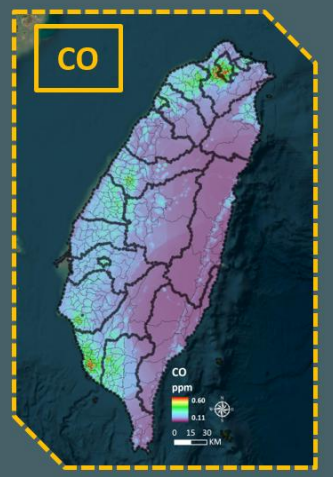
https://www.who.int/news-room/fact-sheets/detail/free-health-care-policies

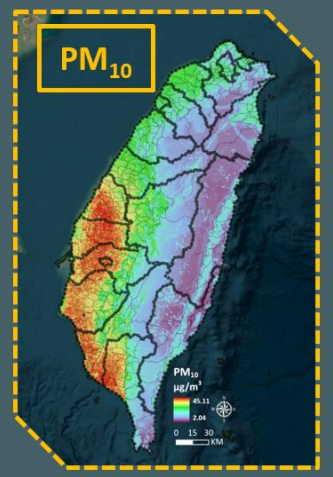
Air pollution perditions using Geo-AI models

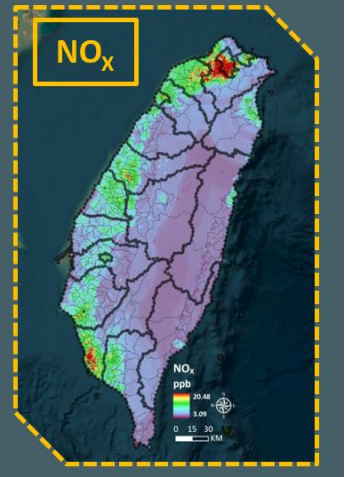
- 1994 to present, daily average
- 50-m*50-m grid size

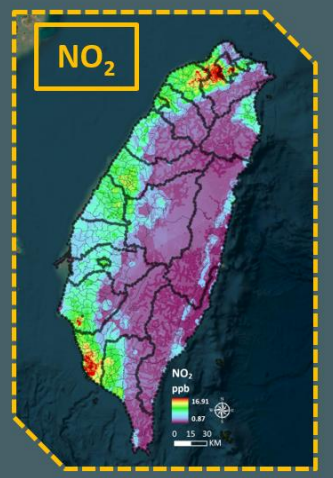


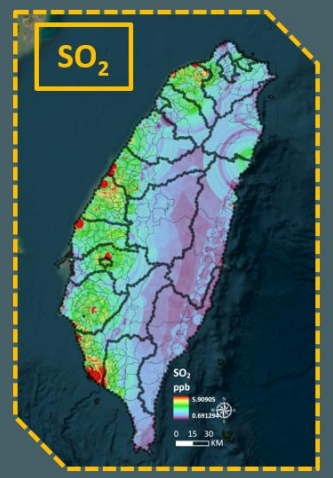


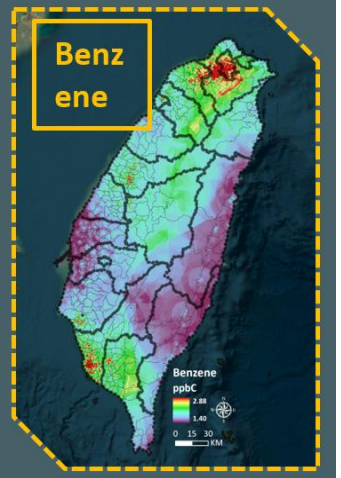












CHAPTER 10

A geospatial artificial intelligence–based approach for precise air pollution estimation in support of health outcome analysis*

Chih-Da Wu[1, 2, 3, 4, 5] and Aji Kusumaning Asri[1]

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Wu, C. D*., A. J. Asri. 2025. Chapter 10 - A geospatial artificial intelligence–based approach for precise air pollution estimation in support of health outcome analysis. In Zhuoumeng Lin & Wei-Chun Chou. (Eds.), Machine Learning and Artificial Intelligence in Toxicology and Environmental Health (p.245-270). Elsevier, Amsterdam, Netherlands (ISBN: 978-0-443-30010-3).

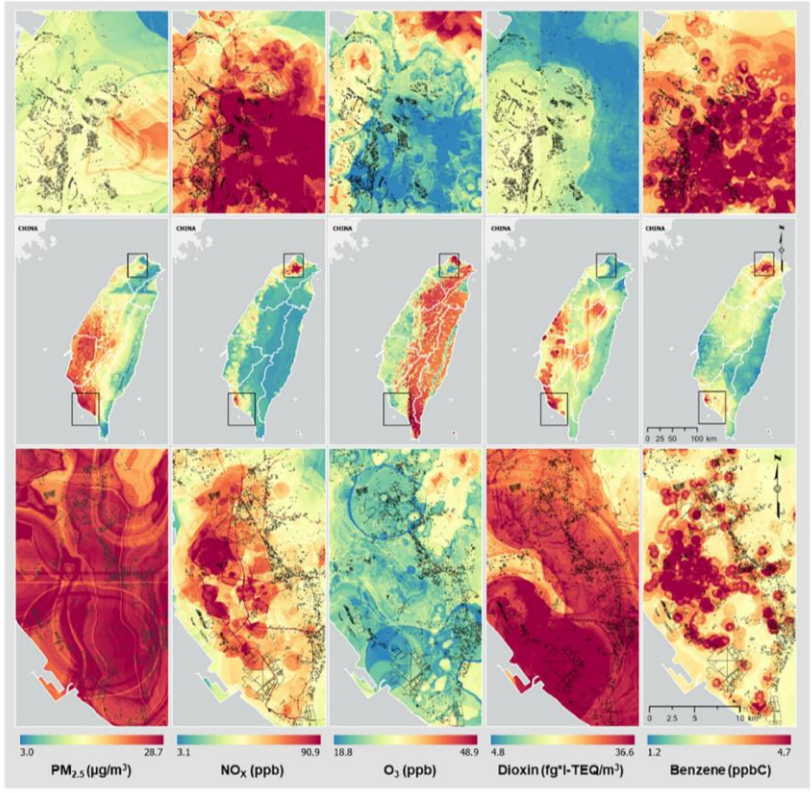

FIGURE 10.5 Map illustrating the estimated levels of air pollutants, including $PM_{2.5}$, NO_X, O_3, dioxin, and benzene across Taiwan (left to right).

The maps are generated using predictions from a geo-AI model. *Red areas* denote regions with the highest pollutant concentrations, while *blue areas* indicate lower exposure levels.

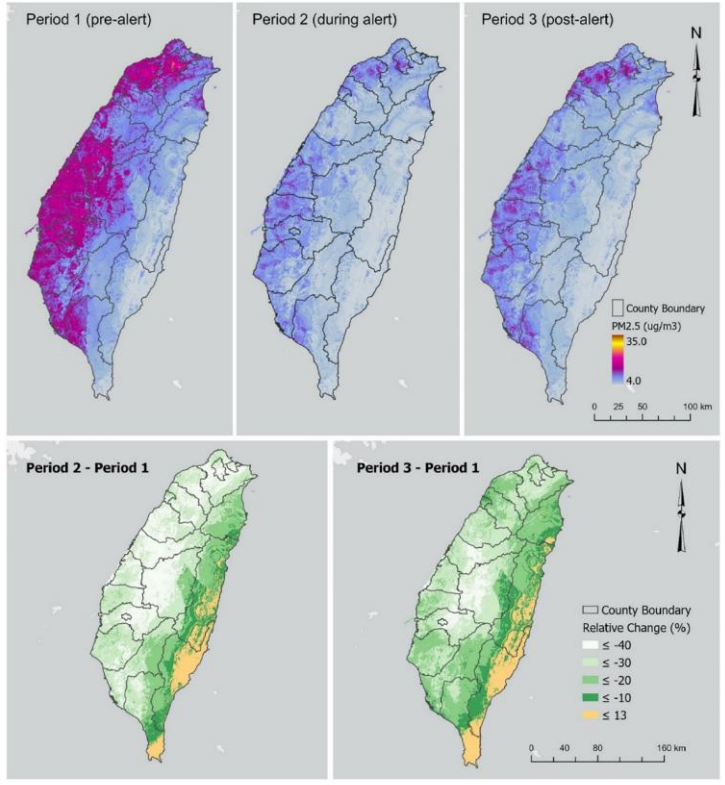

FIGURE 10.7

Relative changes in $PM_{2.5}$ concentration pre-, during, and post-third-level alerts of the COVID-19 pandemic in Taiwan.

Modified from Wong PY, Su HJ, Lung SCC, da Wu C. An ensemble mixed spatial model in estimating long-term and diurnal variations of $PM_{2.5}$ in Taiwan. Sci Total Environ 2023;866:161336. https://doi.org/10.1016/J.SCITOTENV.2022.161336

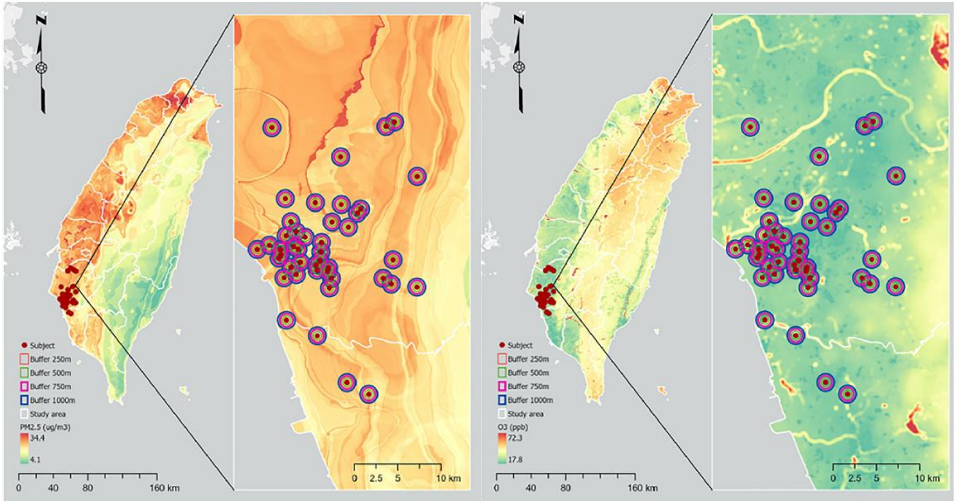

FIGURE 10.8

Exposure to $PM_{2.5}$ (left) and O_3 (right) at each location of asthmatic children. The maps generated using the estimation results of a geo-AI model.

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$PM_{2.5}$ Constitutes vs Mortality

Environment International 109 (2017) 89–100

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Review article

Acute effects of fine particulate matter constituents on mortality: A systematic review and meta-regression analysis

Souzana Achilleos[a,*], Marianthi-Anna Kioumourtzoglou[b], Chih-Da Wu[c], Joel D. Schwartz[a,d], Petros Koutrakis[a], Stefania I. Papatheodorou[e]

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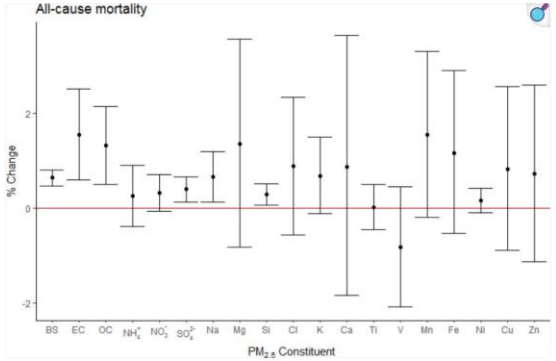
ARTICLE INFO

Keywords:
Particulate matter constituents
Fine particulate matter ($PM_{2.5}$)
Mortality
Time series
Acute effects
Meta-analysis

ABSTRACT

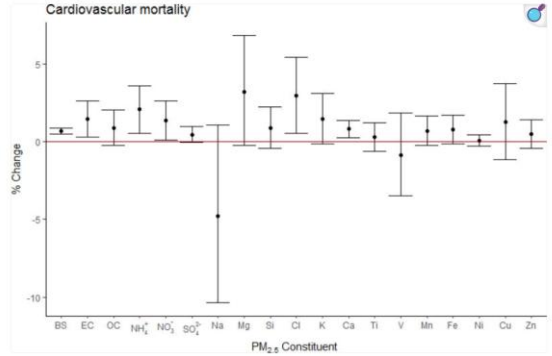
Background: The link between $PM_{2.5}$ exposure and adverse health outcomes is well documented from studies across the world. However, the reported effect estimates vary across studies, locations and constituents. We aimed to conduct a meta-analysis on associations between short-term exposure to $PM_{2.5}$ constituents and mortality using city-specific estimates, and explore factors that may explain some of the observed heterogeneity. *Methods:* We systematically reviewed epidemiological studies on particle constituents and mortality using PubMed and Web of Science databases up to July 2015.We included studies that examined the association between short-term exposure to $PM_{2.5}$ constituents and all-cause, cardiovascular, and respiratory mortality, in the general adult population. Each study was summarized based on pre-specified study key parameters (e.g., location, time period, population, diagnostic classification standard), and we evaluated the risk of bias using the Office of Health Assessment and Translation (OHAT) Method for each included study. We extracted city-specific mortality risk estimates for each constituent and cause of mortality. For multi-city studies, we requested the city-

Figure 2.



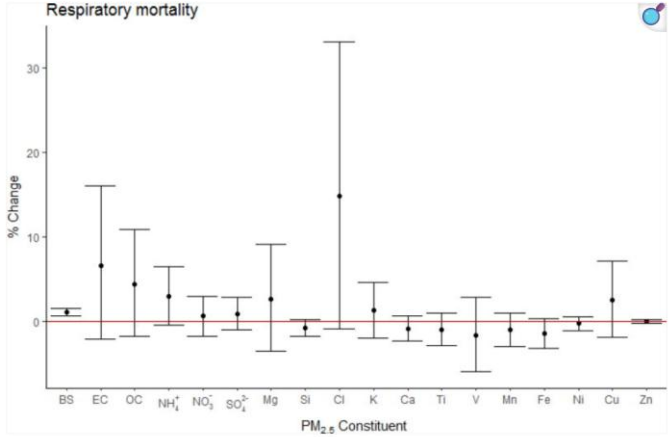
All-cause mortality pooled effect estimates using city-specific estimates, expressed in percent change in mortality per IQR* increase in $PM_{2.5}$ constituent with 95 % confidence intervals. (*BS:10, EC:2.6, OC:6.1, NH_4^+:4.7, NO_3^-:5.0, SO_4^{2-}:5.1, Na:0.48, Mg:0.17, Si:0.21, Cl: 1.1, K:0.53, Ca:0.17, Ti:0.017, V:0.007, Mn:0.009, Fe:0.15, Ni:0.005, Cu:0.014, Zn:0.054) μg/m^3).

Figure 3.



Cardiovascular mortality pooled effect estimates using city-specific estimates, expressed in percent change in mortality per IQR* increase in $PM_{2.5}$ constituent with 95 % confidence intervals. (*BS:10, EC:2.6, OC:6.1, NH_4^+:4.7, NO_3^-:5.0, SO_4^{2-}:5.1, Na:0.48, Mg:0.17, Si:0.21, Cl: 1.1, K:0.53, Ca:0.17, Ti:0.017, V:0.007, Mn:0.009, Fe:0.15, Ni:0.005, Cu:0.014, Zn:0.054) μg/m^3).

Figure 4.



Respiratory mortality pooled effect estimates using city-specific estimates, expressed in percent change in mortality per IQR* increase in $PM_{2.5}$ constituent with 95 % confidence intervals. (* BS: 10, EC: 2.6, OC: 6.1, NH_4^+: 4.7, NO_3^-: 5.0, SO_4^{2-}: 5.1, Na: 0.48, Mg: 0.17, Si: 0.21, Cl: 1.1, K: 0.53, Ca: 0.17, Ti: 0.017, V: 0.007, Mn: 0.009, Fe: 0.15, Ni: 0.005, Cu: 0.014, Zn: 0.054 μg/m^3).

Achilleos, S*., M. A. Kioumourtzoglou., **C. D. Wu**., J. D. Schwartz., P. Koutrakis., S. I. Papatheodorou. 2017. Acute effects of fine particulate matter constituents on mortality: a systematic review and meta-regression analysis. **Environment International 109:89-100 (IF=7.3; JIF%=97.3%)**.

Works with KMU Teams

Dr. Szu-Chia Chen

Dr. Jiun-Hung Geng

Clinical Kidney Journal, 2024, vol. 17, no. 7, sfae173
https://doi.org/10.1093/ckj/sfae173
Advance Access Publication Date: 22 June 2024
Original Article

ORIGINAL ARTICLE

Association between wet-bulb globe temperature and kidney function in different geographic regions in a large Taiwanese population study

Wei-Yu Su[1,2,3], Ping-Hsun Wu[2,3,4], Ming-Yen Lin[3], Pei-Yu Wu[1,3,4,5], Yi-Chun Tsai[3,4], Yi-Wen Chiu[3,4], Jer-Ming Chang[3,4], Chih-Hsing Hung[6,7,8], Chih-Da Wu[6,9,10,11], Chao-Hung Kuo[4,5,12] and Szu-Chia Chen[3,4,5,6]

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Correspondence to: Szu-Chia Chen; E-mail: scarchenone@yahoo.com.tw

Su, W. Y., P. H. Wu, M. Y. Lin, P. Y. Wu, Y. C. Tsai, Y. W. Chiu, J. M. Chang, C. H. Huang, **C. D. Wu**, C. H. Kuo, S. C. Chen*. 2024. Association between wet-bulb globe temperature with kidney function in different geographic region in a large Taiwanese population study. Clinical Kidney Journal 17(7): sfae173 **(IF=4.6; JIF%=81.3%).**

scientific reports

OPEN

Association between wet-bulb globe temperature with gastroesophageal reflux disease in different geographic regions in a large Taiwanese population study

Chien-Cheng Chen[1,2], Hsin-Yi Huang[3], Ting-Yi Wu[3], Wei-Yu Su[3,4], Tang-Huang Lin[5], Hung-Pin Tu[6], Chih-Da Wu[7,8,9,10], Chao-Hung Kuo[2,11,12]✉ & Szu-Chia Chen[4,5,11,12]✉

In this study, we investigated the association between wet-bulb globe temperature (WBGT) and gastroesophageal reflux disease (GERD) in different geographic regions of Taiwan in a large cohort. Participants (*n* = 120,424) residing in the four main geographical areas of Taiwan (North, Central, South and Eastern Taiwan) were enrolled from the Taiwan Biobank. Questionnaires were used to ascertain the presence of GERD based on self-reported physician diagnosis, and WBGT was assessed separately during working (8:00 AM to 5:00 PM) and noon (11:00 AM to 2:00 PM) periods. In Northern Taiwan, there is no significant association between WBGT and GERD during either the noon or working period. In Central Taiwan, the 1-, 3-, and 5-year WBGT values per 1 °C increase during the noon period (odds ratio [OR], 1.055 [95% CI 1.008–1.105]; 1.062 [95% CI 1.013–1.114]; 1.059 [95% CI 1.009–1.111]) and working period (OR, 1.089 [95% CI 1.034–1.146]; 1.092 [95% CI 1.037–1.150]; 1.084 [95% CI 1.031–1.139]) were significantly associated with GERD. Similarly, in Southern Taiwan, the 1-, 3-, and 5-year WBGT values per 1 °C increase during the noon period (OR, 1.292 [95% CI 1.236–1.351]; 1.323 [95% CI 1.261–1.389]; 1.386 [95% CI 1.316–1.460]) and working period (OR, 1.238 [95% CI 1.190–1.288]; 1.247 [95% CI 1.196–1.301]; 1.259 [95% CI 1.204–1.318]) were significantly associated with GERD. However, in Eastern Taiwan, the 1-, 3-, and 5-year WBGT values per 1 °C increase during the noon period were significantly associated with GERD (OR, 1.067 [95% CI 1.015–1.122]; 1.089 [95% CI 1.041–1.138]; 1.107 [95% CI 1.058–1.158]), whereas the 1-, 3-, and 5-year WBGT values per 1 °C decrease during the working period were significantly associated with GERD. Increases in average WBGT values were significantly associated with GERD during both the noon and working periods in Central and Southern Taiwan, and the impact of WBGT was much stronger in Southern Taiwan. While a similar result was found in Eastern Taiwan during the noon period, a reverse correlation was found during the working period. Our findings suggest that heat stress may be associated with GERD, although the impact may differ according to regional characteristics. The causal relationship could not be confirmed due to the cross-sectional design of the study. Further longitudinal studies are warranted to establish the relationship.

Chen, C. C, H. Y. Huang, T. Y. Wu, W. Y. Su, T. H. Lin, H. P. Tu, **C. D. Wu**, C. H. Kuo, S. C. Chen*. 2025. Association between wet-bulb globe temperature with gastroesophageal reflux disease in different geographic regions in a large Taiwanese population study. Scientific Reports 21339 **(IF=3.5; JIF%=56.8%).**

Gau et al. BMC Gastroenterology (2025) 25:216
https://doi.org/10.1186/s12876-025-03803-4
BMC Gastroenterology

RESEARCH Open Access

Association between wet-bulb globe temperature with peptic ulcer disease in different geographic regions in a large Taiwanese population study

Yuh-Ching Gau[1,2,3], Chia-Yu Kuo[4], Wei-Yu Su[5], Wan-Ling Tsai[6], Ying-Jhen Wu[4], Ping-Hsun Wu[5,8], Ming-Yen Lin[5], Chih-Da Wu[8,10,11,12], Chao-Hung Kuo[6,7,8*] and Szu-Chia Chen[5,6,8,9*]

Abstract

Background Peptic ulcer disease (PUD) is a common and important cause of morbidity worldwide, with a large impact on healthcare costs. Little research has been conducted on the association between wet-bulb globe temperature (WBGT) and PUD. The aim of this study was to explore this association among different geographical regions of Taiwan in a large sample of participants.

Methods This is a cross-sectional study. The study participants (*n* = 120,424) were enrolled from the Taiwan Biobank (TWB) and resided across northern, central, southern and eastern Taiwan. Self-reported questionnaires were used to ascertain the occurrence of PUD. Average WBGT values were recorded during working hours (8:00 AM to 5:00 PM) and the noon period (11:00 AM to 2:00 PM) for each participant at 1, 3, and 5 years before the TWB survey year. The association between WBGT and PUD was examined with logistic regression analysis.

Results The 1-year and 5-year noon WBGT values per 1°C increase were significantly associated with a low prevalence of PUD in northern Taiwan (odds ratio [OR], 0.960, 95% confidence interval [CI], 0.925–0.955; OR, 0.962, 95% CI, 0.929–0.997; respectively). In contrast, there were no significant associations between WBGT and PUD in central Taiwan. In southern Taiwan, the 1-, 3-, and 5-year WBGT values per 1°C increase during the noon period (OR, 0.875, 95% CI, 0.873–0.909; OR, 0.860, 95% CI, 0.825–0.896; OR, 0.848, 95% CI, 0.812–0.885; respectively) and working period (OR, 0.852, 95% CI, 0.825–0.880; OR, 0.845, 95% CI, 0.816–0.876; OR, 0.832, 95% CI, 0.801–0.863; respectively) were significantly associated with a low prevalence of PUD. However, in eastern Taiwan, the 1-, 3-, and 5-year WBGT values per 1°C increase during the noon period (OR, 1.074, 95% CI, 1.022–1.127; OR, 1.058, 95% CI, 1.013–1.104; OR, 1.058, 95% CI, 1.013–1.105; respectively), and the 3- and 5-year WBGT values per 1°C increase during the working period were significantly associated with a high prevalence of PUD (OR, 1.049, 95% CI, 1.003–1.097; OR, 1.047, 95% CI,

Gau, Y. C., C. Y. Kuo, W. Y. Su, W. L. Tsai, Y. J. Wu, P. H. Wu, M. Y. Lin, **C. D. Wu**, C. H. Kuo*, S. C. Chen*. 2025. Association between wet-bulb globe temperature with peptic ulcer disease in different geographic regions in a large Taiwanese population study. BMC Gastroenterology 25, 216 **(IF=2.5; JIF%=50%)**.

Alimentary Pharmacology & Therapeutics
WILEY
APT Alimentary Pharmacology & Therapeutics

ORIGINAL ARTICLE

Air Pollution Associated With Mortality Among Chronic Hepatitis B Patients Treated With Nucleotide/Nucleoside Analogues

Tyng-Yuan Jang[1,2,3,4] | Yu-Ting Zeng[5] | Po-Cheng Liang[2,3] | Chih-Da Wu[5,6] | Yu-Ju Wei[2,3] | Pei-Chien Tsai[2,3] | Ming-Yen Hsieh[2,3] | Yi-Hung Lin[2,3] | Meng-Hsuan Hsieh[2,3] | Chih-Wen Wang[2,3] | Jeng-Fu Yang[2,3] | Ming-Lun Yeh[2,3,7] | Chung-Feng Huang[2,3] | Wan-Long Chuang[2,3] | Jee-Fu Huang[2,3] | Ya-Yun Cheng[7] | Chia-Yen Dai[1,2,3,7] | Pau-Chung Chen[8,9,10,11] | Ming-Lung Yu[2]

[1]Ph.D. Program in Environmental and Occupational Medicine, College of Medicine, Kaohsiung Medical University and National Health Research Institutes, Kaohsiung, Taiwan | [2]Hepatobiliary Division, Department of Internal Medicine, Kaohsiung Medical University Hospital, Kaohsiung, Taiwan | [3]College of Medicine and Center for Liquid Biopsy and Cohort Research, Kaohsiung Medical University, Kaohsiung, Taiwan | [4]Department of Internal Medicine, Pingtung Hospital, Ministry of Health and Welfare, Ping-Tung, Taiwan | [5]Department of Geomatics, National Cheng Kung University, Tainan, Taiwan | [6]Innovation and Development Center of Sustainable Agriculture, National Chung Hsing University, Tainan, Taiwan | [7]School of Medicine and Doctoral Program of Clinical and Experimental Medicine, College of Medicine and Center of Excellence for Metabolic-Associated Fatty Liver Disease, National Sun Yat-Sen University, Kaohsiung, Taiwan | [8]Institute of Environmental and Occupational Health Sciences, National Taiwan University College of Public Health, Taipei, Taiwan | [9]Department of Public Health, National Taiwan University College of Public Health, Taipei, Taiwan | [10]Department of Environmental and Occupational Medicine, National Taiwan University Hospital and National Taiwan University College of Medicine, Taipei, Taiwan | [11]National Institute of Environmental Health Sciences, National Health Research Institutes, Miaoli, Taiwan

Correspondence: Chia-Yen Dai (daichiayen@gmail.com) | Pau-Chung Chen (pchen@ntu.edu.tw)

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Keywords: air pollution | HBV | mortality | NAs | NO_x

Jang, T. Y., Y. T. Zeng, P. C. Liang, **C. D. Wu**, Y. J. Wei, P. C. Tsai, P. Y. Hsu, M. Y. Hsieh, Y. H. Lin, M. H. Hsieh, C. W. Wang, J. F. Yang, M. L. Yeh, C. F. Huang, W. L. Chuang, J. F. Huang, Y. Y. Cheng, C. Y. Dai*, P. C. Chen*, M. L. Yu. 2025. Air pollution associated with mortality among chronic hepatitis B patients treated with nucleotide/nucleoside analogues. Alimentary Pharmacology & Therapeutics, https://doi.org/10.1111/apt.70019 **(IF=6.6; JIF%=91.2%)**.

scientific reports

OPEN

Sex differences in the association of long-term exposure to heat stress on kidney function in a large Taiwanese population study

Yi-Kong Chen[1,2,3], Ping-Hsun Wu[2,3,5], Pei-Yu Wu[1,3,4,5], Yi-Chun Tsai[3,5], Yi-Wen Chiu[3,5], Jer-Ming Chang[3,5], Chih-Hsing Hung[6,7,8], Chih-Da Wu[6,8,9,10,11], Chao-Hung Kuo[4,5,12], Yu-Chee Tseng[1,13] & Szu-Chia Chen[3,4,5,6]✉

The incidence and prevalence of dialysis in Taiwan are high compared to other regions. Consequently, mitigating chronic kidney disease (CKD) and the worsening of kidney function have emerged as critical healthcare priorities in Taiwan. Heat stress is known to be a significant risk factor for CKD and kidney function impairment. However, differences in the impact of heat stress between males and females remains unexplored. We conducted this retrospective cross-sectional analysis using data from the Taiwan Biobank (TWB), incorporating records of the wet bulb globe temperature (WBGT) during midday (11 AM–2 PM) and working hours (8 AM–5 PM) periods based on the participants' residential address. Average 1-, 3-, and 5-year WBGT values prior to the survey year were calculated and analyzed using a geospatial artificial intelligence-based ensemble mixed spatial model, covering the period from 2010 to 2020. A total of 114,483 participants from the TWB were included in this study, of whom 35.9% were male and 1053 had impaired kidney function (defined as estimated glomerular filtration rate < 60 ml/min/1.73 m^2). Multivariable analysis revealed that in the male participants, during the midday period, the 1-, 3-, and 5-year average WBGT values per 1 °C increase were significantly positively associated with eGFR < 60 ml/min/1.73 m^2 (odds ratio [OR], 1.096, 95% confidence interval [CI] = 1.002–1.195, $p = 0.044$ for 1 year; OR, 1.093, 95% CI = 1.000–1.196, $p = 0.005$ for 3 years; OR, 1.094, 95% CI = 1.002–1.195, $p = 0.045$ for 5 years). However, significant associations were not found for the working hours period. In the female participants, during the midday period, the 1-, 3-, and 5-year average WBGT values per 1 °C increase were significantly negatively associated with eGFR < 60 ml/min/1.73 m^2 (OR, 0.872, 95% CI = 0.778–0.976, $p = 0.018$ for 1 year; OR, 0.874, 95% CI = 0.780–0.978, $p = 0.019$ for 3 years; OR, 0.875, 95% CI = 0.784–0.977, $p = 0.018$ for 5 years). In addition, during the working hours period, the 1-, 3-, and 5-year average WBGT values per 1 °C increase were also significantly negatively associated with eGFR < 60 ml/min/1.73 m^2 (OR, 0.856, 95% CI = 0.774–0.946, $p = 0.002$ for 1 year; OR, 0.856, 95% CI = 0.774–0.948, $p = 0.003$ for 3 years; OR, 0.853, 95% CI = 0.772–0.943, $p = 0.002$ for 5 years). In conclusion, our results revealed that increased WBGT

Chen, Y. K., P. H. Wu, P. Y. Wu, Y. C. Tsai, Y. W. Chiu, J. M. Chang, C. H. Hung, **C. D. Wu**, C. H. Kuo, Y. C. Tseng, S. C. Chen*. 2024. Sex differences in the association of long-term exposure to heat stress on kidney function in a large Taiwanese population study. Scientifc Reports 14(1):14599 **(IF=3.8; JIF%= 81.7%)**.

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Research Paper

Association of Fine Particulate Matter (PM2.5) and Wet-Bulb Globe Temperature (WBGT) with Osteoporosis Incidence: A Nationwide Prospective Cohort Study

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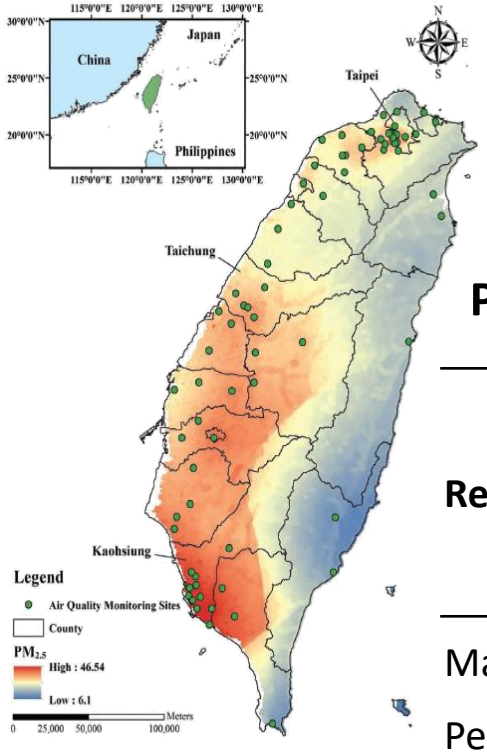
Chang, E. C., F. W. Liang, J. C. Huang, H. H. Chang, S. P. Huang, S. C. Chen, **C. D. Wu**, Y. C. Huang, J. H. Geng*. 2025. Association of Fine Particulate Matter ($PM_{2.5}$) and Wet-Bulb Globe Temperature (WBGT) with Osteoporosis Incidence: A Nationwide Prospective Cohort Study. International Journal of Medical Science 22(15):3974-3984 **(IF=3.2; JIF%=82.4%).**

$PM_{2.5}$ vs Liver Cancer



alanine aminotransferase (ALT, formerly called SGPT)

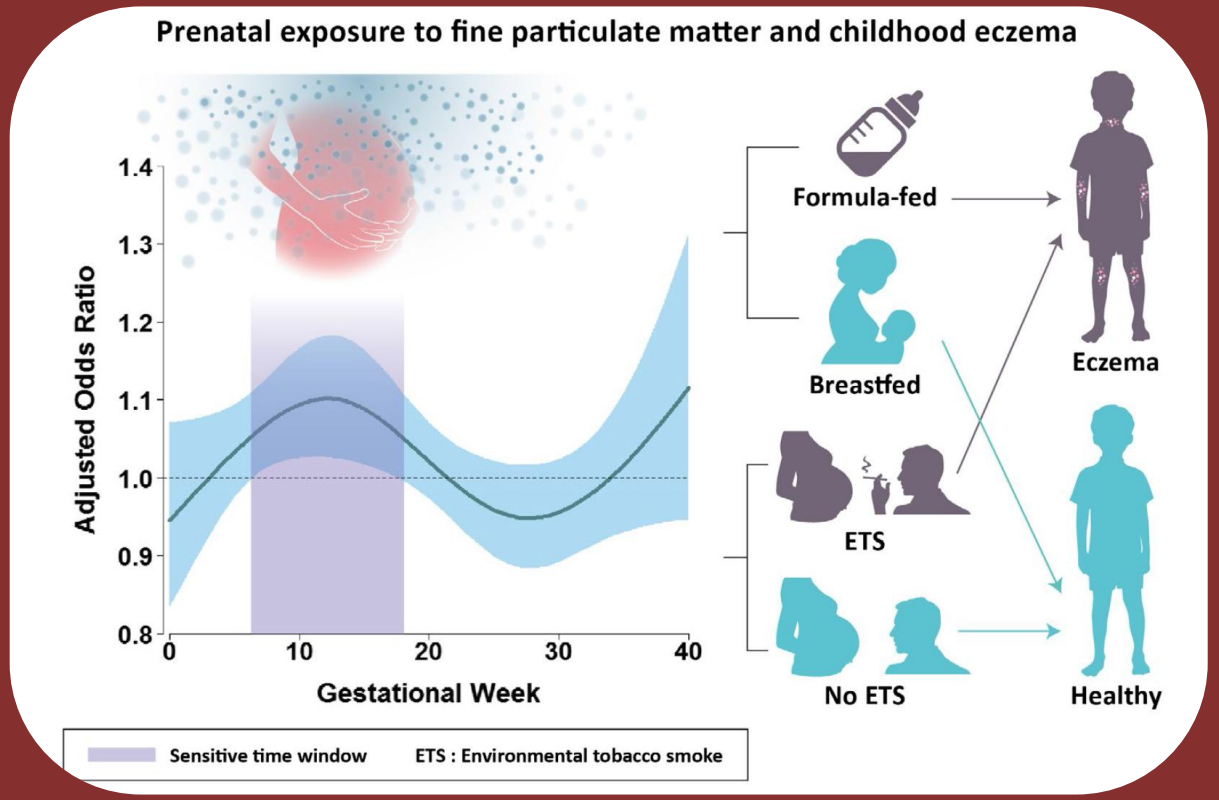
$$PM_{2.5} \rightarrow ALT \rightarrow HCC$$

Mediation effect of ALT levels on $PM_{2.5}$-associated incidence of HCC

Region	Natural indirect effect	
	HR (95% CI) per IQR increment of $PM_{2.5}$*	*P*
Main Island	1.17 (1.02 to 1.52)	.05
Penghu Islets	1.04 (1.03 to 1.07)	<.001
Combined	1.21 (1.06 to 1.41)	.005

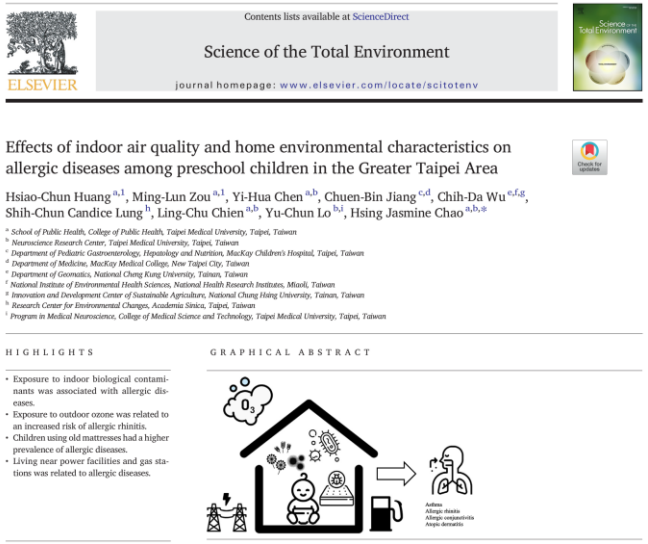
Pan, W. C., **C. D. Wu**., M. J. Chen., Y. T. Huang., C. J. Chen., H. J. Su*., H. I. Yang*. 2016. Fine Particle Pollution, Alanine Transaminase, and Liver Cancer: A Taiwanese Prospective Cohort Study (REVEAL-HBV). Journal of the National Cancer Institute 108(3): djv341doi: 10.1093/jnci/djv341 **(IF=12.6; JIF%=96.1%).**

$PM_{2.5}$ vs Childhood Eczema



Yao, T. C., H. Y. Huang, S. Y. Tsai, P. H. Lin, C. Y. Wu, C. Y. Hung, K. L. Lu, C. L. Zeng, W. C. Pan, **C. D. Wu**, Y. J. Huang, H. J. Tsai*. 2021. Association of Prenatal Exposure to Fine Particulate Matter Pollution with Childhood Eczema. Allergy 00:1–4 **(IF=14.7; JIF%=98.2%).**

Air Pollution vs Children's Health


Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Effects of indoor air quality and home environmental characteristics on allergic diseases among preschool children in the Greater Taipei Area

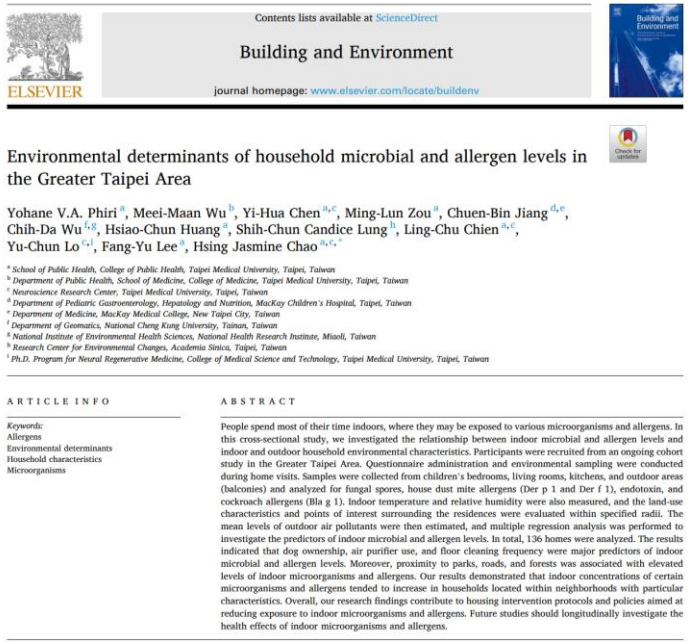
Hsiao-Chun Huang [a,1], Ming-Lun Zou [a,1], Yi-Hua Chen [a,b], Chuen-Bin Jiang [c,d], Chih-Da Wu [e,f,g], Shih-Chun Candice Lung [h], Ling-Chu Chien [a,b], Yu-Chun Lo [b,i], Hsing Jasmine Chao [a,b,*]

HIGHLIGHTS

- Exposure to indoor biological contaminants was associated with allergic diseases.
- Exposure to outdoor ozone was related to an increased risk of allergic rhinitis.
- Children using old mattresses had a higher prevalence of allergic diseases.
- Living near power facilities and gas stations was related to allergic diseases.

GRAPHICAL ABSTRACT

Huang, H. C., M. L. Zou, Y. H. Chen, C. B. Jian, **C. D. Wu**, S. C. C. Lung, L. C. Chien, Y. C. Lo, H. J. Chao*. 2023. Effects of indoor air quality and home environmental characteristics on allergic diseases among preschool children in the Greater Taipei Area. **Science of the Total Environment 897: 165392 (IF=9.8; JIF%=90.7%)**.


Contents lists available at ScienceDirect

Building and Environment

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Environmental determinants of household microbial and allergen levels in the Greater Taipei Area

Yohane V.A. Phiri [a], Meei-Maan Wu [b], Yi-Hua Chen [a,c], Ming-Lun Zou [a], Chuen-Bin Jiang [d,e], Chih-Da Wu [f,g], Hsiao-Chun Huang [a], Shih-Chun Candice Lung [h], Ling-Chu Chien [a,c], Yu-Chun Lo [c,i], Fang-Yu Lee [a], Hsing Jasmine Chao [a,c,*]

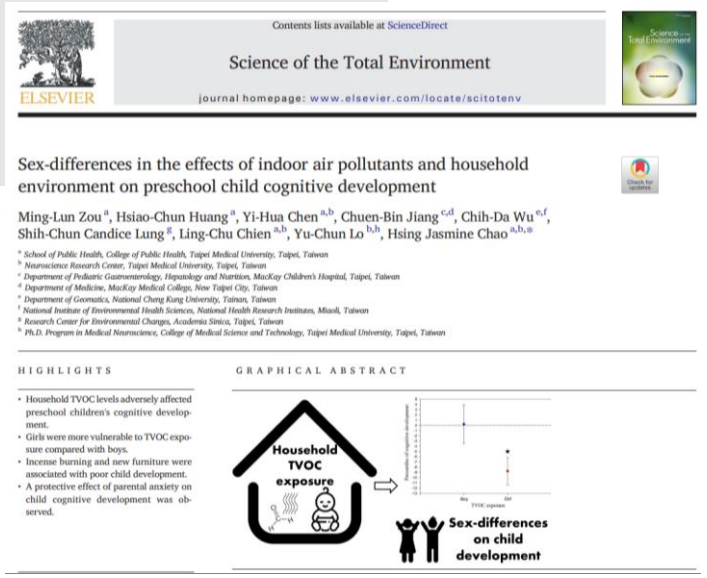
ARTICLE INFO

Keywords:
Allergens
Environmental determinants
Household characteristics
Microorganisms

ABSTRACT

People spend most of their time indoors, where they may be exposed to various microorganisms and allergens. In this cross-sectional study, we investigated the relationship between indoor microbial and allergen levels and indoor and outdoor household environmental characteristics. Participants were recruited from an ongoing cohort study in the Greater Taipei Area. Questionnaire administration and environmental sampling were conducted during home visits. Samples were collected from children's bedrooms, living rooms, kitchens, and outdoor areas (balconies) and analyzed for fungal spores, house dust mite allergens (Der p 1 and Der f 1), endotoxin, and cockroach allergens (Bla g 1). Indoor temperature and relative humidity were also measured, and the land-use characteristics and points of interest surrounding the residences were evaluated within specified radii. The mean levels of outdoor air pollutants were then estimated, and multiple regression analysis was performed to investigate the predictors of indoor microbial and allergen levels. In total, 136 homes were analyzed. The results indicated that dog ownership, air purifier use, and floor cleaning frequency were major predictors of indoor microbial and allergen levels. Moreover, proximity to parks, roads, and forests was associated with elevated levels of indoor microorganisms and allergens. Our results demonstrated that indoor concentrations of certain microorganisms and allergens tended to increase in households located within neighborhoods with particular characteristics. Overall, our research findings contribute to housing intervention protocols and policies aimed at reducing exposure to indoor microorganisms and allergens. Future studies should longitudinally investigate the health effects of indoor microorganisms and allergens.

Phiri, Y. V. A., Y. H. Chen, M. L. Zou, C. B. Jian, **C. D. Wu**, H. C. Huang, S. C. C. Lung, L. C. Chien, Y. C. Lo, F. Li, H. J. Chao*. 2023. Environmental Determinants of Household Microbial and Allergen Levels in the Greater Taipei Area. **Building and Environment 230: 110003 (IF=7.1; JIF%=93.1%)**.


Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Sex-differences in the effects of indoor air pollutants and household environment on preschool child cognitive development

Ming-Lun Zou [a], Hsiao-Chun Huang [a], Yi-Hua Chen [a,b], Chuen-Bin Jiang [c,d], Chih-Da Wu [e,f], Shih-Chun Candice Lung [g], Ling-Chu Chien [a,b], Yu-Chun Lo [b,h], Hsing Jasmine Chao [a,b,*]

HIGHLIGHTS

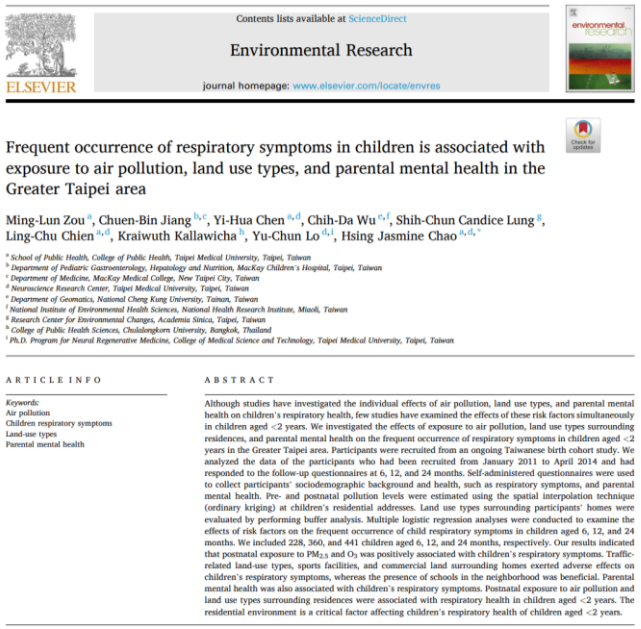
- Household TVOC levels adversely affected preschool children's cognitive development.
- Girls were more vulnerable to TVOC exposure compared with boys.
- Incense burning and new furniture were associated with poor child development.
- A protective effect of parental anxiety on child cognitive development was observed.

GRAPHICAL ABSTRACT

Household TVOC exposure

Sex-differences on child development

Zou, M. L., H. C. Huang, Y. H. Chen, C. B. Jian, **C. D. Wu**, S. C. C. Lung, L. C. Chien, Y. C. Lo, H. J. Chao*. 2023. Sex-differences in the effects of indoor air pollutants and household environment on preschool child cognitive development. **Science of the Total Environment 860: 160365 (IF=10.9; JIF%=90.9%)**.


Contents lists available at ScienceDirect

Environmental Research

journal homepage: www.elsevier.com/locate/envres

Frequent occurrence of respiratory symptoms in children is associated with exposure to air pollution, land use types, and parental mental health in the Greater Taipei area

Ming-Lun Zou [a], Chuen-Bin Jiang [b,c], Yi-Hua Chen [a,d], Chih-Da Wu [e,f], Shih-Chun Candice Lung [g], Ling-Chu Chien [a,d], Kraiwuth Kallawicha [h], Yu-Chun Lo [d,i], Hsing Jasmine Chao [a,d,*]

ARTICLE INFO

Keywords:
Air pollution
Children respiratory symptoms
Land-use types
Parental mental health

ABSTRACT

Although studies have investigated the individual effects of air pollution, land use types, and parental mental health on children's respiratory health, few studies have examined the effects of these risk factors simultaneously in children aged <2 years. We investigated the effects of exposure to air pollution, land use types surrounding residences, and parental mental health on the frequent occurrence of respiratory symptoms in children aged <2 years in the Greater Taipei area. Participants were recruited from an ongoing Taiwanese birth cohort study. We analyzed the data of the participants who had been recruited from January 2011 to April 2014 and had responded to the follow-up questionnaires at 6, 12, and 24 months. Self-administered questionnaires were used to collect participants' sociodemographic background and health, such as respiratory symptoms, and parental mental health. Pre- and postnatal pollution levels were estimated using the spatial interpolation technique (ordinary kriging) at children's residential addresses. Land use types surrounding participants' homes were evaluated by performing buffer analysis. Multiple logistic regression analyses were conducted to examine the effects of risk factors on the frequent occurrence of child respiratory symptoms in children aged 6, 12, and 24 months. We included 228, 360, and 441 children aged 6, 12, and 24 months, respectively. Our results indicated that postnatal exposure to $PM_{2.5}$ and O_3 was positively associated with children's respiratory symptoms. Traffic-related land-use types, sports facilities, and commercial land surrounding homes exerted adverse effects on children's respiratory symptoms, whereas the presence of schools in the neighborhood was beneficial. Parental mental health was also associated with children's respiratory symptoms. Postnatal exposure to air pollution and land use types surrounding residences were associated with respiratory health in children aged <2 years. The residential environment is a critical factor affecting children's respiratory health of children aged <2 years.

Zou, M. L., C. B. Jiang, Y. H. Chen, **C. D. Wu**, S. C. C. Lung, L. C. Chien, K. Kallawichah, Y. T. Yang, Y. C. Lo, H. J. Chao*. 2022. Frequent occurrence of respiratory symptoms in children is associated with exposure to air pollution, land use types, and parental mental health: A birth cohort study in the Greater Taipei area. **Environmental Research 206:112567 (IF=8.4; JIF%=90.2%)**.

Works with NCKU Dept. of Public Health

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Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

Residential greenness and birth outcomes: Evaluating the mediation and interaction effects of particulate air pollution

Pei-Chen Lee [a,b,c], Chih-Da Wu [d], Hui-Ju Tsai [e], Hsin-Yun Tsai [a], Sheng-Hsuan Lin [f], Chia-Kai Wu [a], Chi-Yen Hung [g], Tsung-Chieh Yao [h,*]

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Lee, P. C., **C. D. Wu,** H. J. Tsai, H. Y. Tsai, S. H. Lin, C. K. Wu, C. Y. Huang, T. C. Yao*. 2021. Residential greenness and birth outcomes: evaluating the mediation and interaction effects of particulate air pollution. Ecotoxicology and Environmental Safety 211: 111915 **(IF=7.1; JIF%=93.1%)**.

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Association between exposure to air pollution and kidney function decline

Jia-Ling Wu[1], Yu-Tzu Chang[2], Pei-Chen Lee[1], Ya-Yun Cheng[3,4,5], Tsung Yu[1], Pei-Yi Wong[6], Chih-Da Wu[7,8,9,10,11], Pei-Shih Chen[12] and Chung-Yi Li[1,13,14]

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Wu, J. L., Y. T. Chang, P. C. Lee, Y. Y. Cheng, T. Yu, P. Y. Wong, **C. D. Wu**, P. S. Chen, C. Y. Li*. 2025. Association between exposure to air pollution and kidney function decline. Nephrology Dialysis Transplantation gfaf143, https://doi.org/10.1093/ndt/gfaf143 **(IF=5.6; JIF%=91.9%)**.

Environmental Health and Preventive Medicine

Environmental Health and Preventive Medicine (2024) 29:7
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RESEARCH ARTICLE

Non-linear association between long-term air pollution exposure and risk of metabolic dysfunction-associated steatotic liver disease

Wei-Chun Cheng[1,2,3], Pei-Yi Wong[4], Chih-Da Wu[5,6,7], Pin-Nan Cheng[2], Pei-Chen Lee[1] and Chung-Yi Li[1,8,9]*

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Cheng, W. C., P. Y. Wong, **C. D. Wu**, P. N. Cheng, P. C. Lee, C. Y. Li*. 2024. Non-linear association between long-term air pollution exposure and risk of metabolic dysfunction-associated steatotic liver disease. Environmental Health and Preventive Medicine 29: 7-19 **(IF=4.7; JIF%=79.7%).**

AIR POLLUTION vs Brain Aging

Environment International 190 (2024) 108876

Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

Full length article

Yearly change in air pollution and brain aging among older adults: A community-based study in Taiwan

Table 2
Association of reduction slopes in air pollutants on cognitive performance (n = 431).

	Cognitive function	[1]Model 1 Unadjusted			[2]Model 2 Adjusted		
		B(SE)	Correlation coefficient	P-value	B(SE)	Partial correlation coefficient	P-value
$PM_{2.5}$	Attention	**−0.62 (0.11)**	**−0.26**	**<0.01**	**−0.18 (0.09)**	**−0.1**	**0.047**
	Memory	**−0.35 (0.14)**	**−0.12**	**0.01**	0.07 (0.16)	0.02	0.66
	Executive	**−0.29 (0.1)**	**−0.13**	**<0.01**	−0.24 (0.13)	−0.09	0.06
O_3	Attention	−0.25 (0.23)	−0.05	0.28	0.21 (0.15)	0.07	0.15
	Memory	−0.28 (0.28)	−0.05	0.32	0.07 (0.26)	0.01	0.8
	Executive	0.18 (0.21)	0.04	0.39	0.33 (0.21)	0.08	0.12
NO_2	Attention	**−1.22 (0.17)**	**−0.33**	**<0.01**	**−0.42 (0.2)**	**−0.1**	**0.03**
	Memory	**−0.8 (0.21)**	**−0.18**	**<0.01**	−0.48 (0.35)	−0.07	0.17
	Executive	**−0.42 (0.16)**	**−0.13**	**<0.01**	−0.45 (0.29)	−0.08	0.11
PM_{10}	Attention	**−0.59 (0.1)**	**−0.28**	**<0.01**	**−0.23 (0.07)**	**−0.16**	**<0.01**
	Memory	**−0.43 (0.12)**	**−0.17**	**<0.01**	−0.16 (0.12)	−0.06	0.19
	Executive	**−0.28 (0.09)**	**−0.14**	**<0.01**	**−0.23 (0.1)**	**−0.11**	**0.03**

Lin, Y. C., K. C. Fan, **C. D. Wu**, W. C. Pan, J. C. Chen, Y. P. Chao, Y. J. Lai, Y. L. Chiu, Y. F. Chuang*.2024. Yearly Change in Air Pollution Reduction and Brain Aging among Older Adults: a Community-based Study in Taiwan. Environment International 190: 108876 **(IF=11.8; JIF%=94%).**

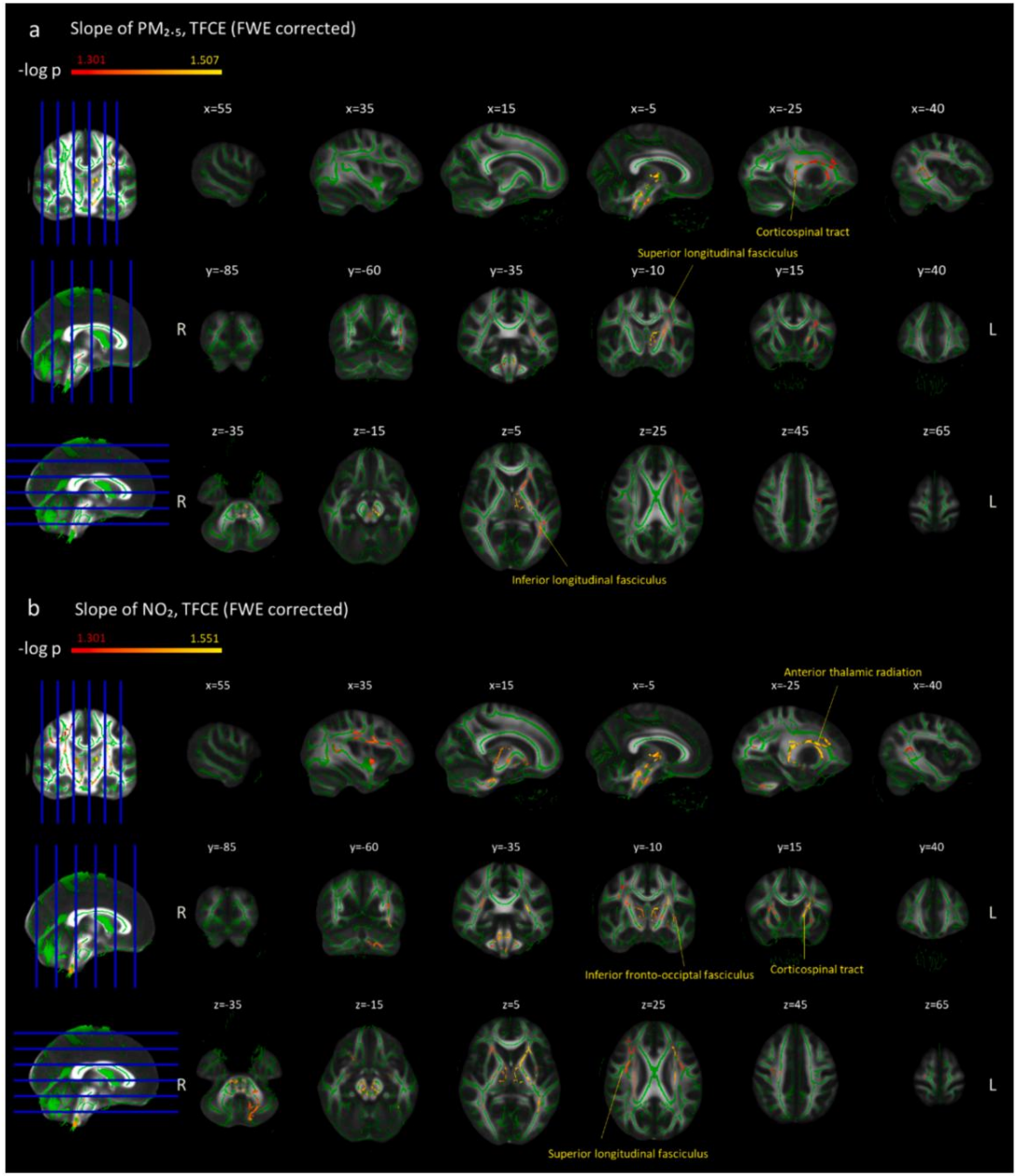

Fig. 3. Association between slopes of $PM_{2.5}$ and slopes of NO_2 with fractional anisotropy (FA) using tract-based spatial statistics (TBSS) analysis Voxels (red-yellow, $p < 0.05$, family-wise error corrected) highlight areas where greater reduction of air pollution significantly correlates with higher FA, accounting for age, sex, education years, and baseline air pollutant levels. These voxels are overlaid onto the mean FA skeleton (green) aligned with the MNI152 template (gray). (a) Slope of $PM_{2.5}$ (b) Slope of NO_2. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

AIR POLLUTION vs Metabolic Syndrome

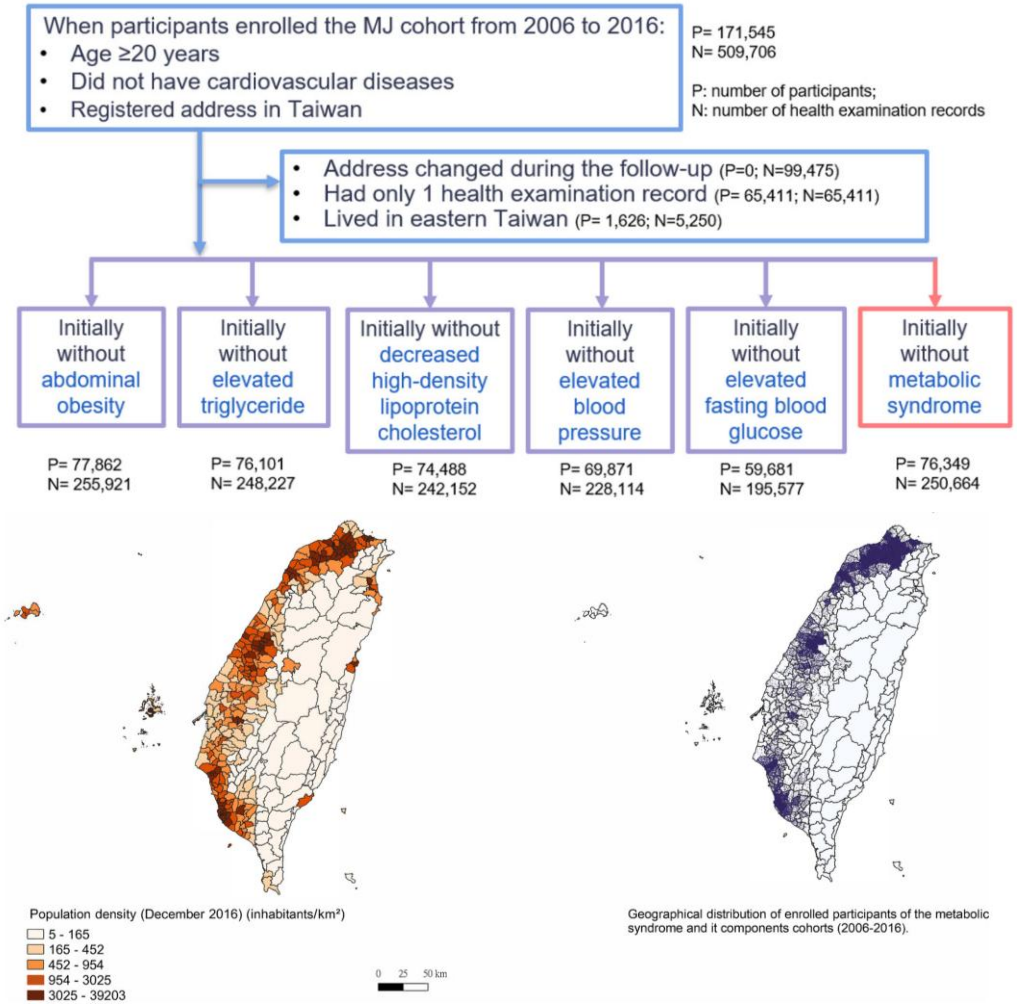

Figure 2. Geographical distributions of population density in Taiwan ($N = 23{,}539{,}816$), and the participants of the metabolic syndrome and its components cohorts ($N = 93{,}771$). The area of Taiwan is ~36,000 km^2,[44] with a population of 23.5 million people.[45] (A) Population density. (B) General distribution of enrolled participants; each dot represents one participant. The small, outlined areas represent townships. This figure was created using the QGIS Desktop software (version 3.22; Open Source Geospatial Foundation).

Table 3. Associations [aHR (95% CI)] of $PM_{2.5}$ and NO_2 with metabolic syndrome and its components among participants of the MJ Health Research cohort in Taiwan between 2006 and 2016.

	Model 1[a]		Model 2[b]		Model 3[c]	
MetS and its components	$PM_{2.5}$	NO_2	$PM_{2.5}$	NO_2	$PM_{2.5}$	NO_2
Development of abdominal obesity in the no abdominal obesity cohort	($n = 76{,}960$; $e = 8{,}555$) 1.15 (1.01, 1.12)	1.06 (0.99, 1.12)	($n = 70{,}729$; $e = 7{,}705$) 1.08 (1.02, 1.15)	1.01 (0.95, 1.07)	($n = 70{,}589$; $e = 7{,}698$) 1.07 (1.01, 1.14)	0.97 (0.92, 1.03)
Development of reduced HDL-C in the normal HDL-C cohort	($n = 75{,}210$; $e = 12{,}542$) 1.16 (1.10, 1.22)	1.03 (0.99, 1.08)	($n = 68{,}733$; $e = 11{,}373$) 1.17 (1.11, 1.23)	1.02 (0.97, 1.07)	($n = 68{,}727$; $e = 11{,}372$) 1.17 (1.11, 1.23)	0.99 (0.94, 1.03)
Development of elevated TG in the normal TG cohort	($n = 73{,}707$; $e = 7{,}210$) 1.10 (1.02, 1.18)	1.01 (0.95, 1.07)	($n = 67{,}592$; $e = 6{,}490$) 1.12 (1.04, 1.20)	1.00 (0.94, 1.07)	($n = 67{,}587$; $e = 6{,}489$) 1.09 (1.02, 1.17)	0.94 (0.88, 1.01)
Development of elevated BP in the normal BP cohort	($n = 69{,}075$; $e = 12{,}965$) 1.18 (1.12, 1.24)	1.03 (0.98, 1.08)	($n = 63{,}514$; $e = 11{,}772$) 1.18 (1.12, 1.24)	1.01 (0.97, 1.06)	($n = 63{,}510$; $e = 11{,}771$) 1.15 (1.09, 1.21)	1.04 (0.99, 1.10)
Development of elevated FBG in the normal FBG cohort	($n = 59{,}681$; $e = 20{,}549$) 1.11 (1.06, 1.15)	1.07 (1.03, 1.11)	($n = 54{,}274$; $e = 18{,}615$) 1.11 (1.06, 1.16)	1.06 (1.02, 1.10)	($n = 54{,}269$; $e = 18{,}614$) 1.15 (1.10, 1.20)	1.03 (0.99, 1.07)
Development of MetS based on the number of MetS components exhibited at baseline	($n = 75{,}596$; $e = 9{,}818$)		($n = 69{,}460$; $e = 8{,}850$)		($n = 69{,}456$; $e = 8{,}848$)	
0	($n = 34{,}285$; $e = 897$) 0.99 (0.89, 1.11)	0.87 (0.75, 1.01)	($n = 31{,}788$; $e = 824$) 0.99 (0.89, 1.11)	0.87 (0.75, 1.01)	($n = 31{,}787$; $e = 824$) 0.99 (0.89, 1.12)	0.88 (0.76, 1.03)
1	($n = 25{,}277$; $e = 3{,}175$) 1.12 (1.04, 1.20)	1.02 (0.94, 1.11)	($n = 23{,}137$; $e = 2{,}858$) 1.12 (1.04, 1.21)	1.02 (0.94, 1.11)	($n = 23{,}134$; $e = 2{,}856$) 1.12 (1.04, 1.20)	1.01 (0.93, 1.10)
2	($n = 16{,}034$; $e = 5{,}746$) 1.12 (1.05, 1.19)	1.13 (1.06, 1.21)	($n = 14{,}535$; $e = 5{,}168$) 1.12 (1.05, 1.19)	1.14 (1.06, 1.21)	($n = 14{,}535$; $e = 5{,}168$) 1.14 (1.07, 1.22)	1.10 (1.03, 1.18)

Chen, Y. C, W. S. Chin, S. C. Pan, **C. D. Wu**. Y. L. L. Guo. 2023. Long-Term Exposure to Air Pollution and the Occurrence of Metabolic Syndrome and Its Components. Environmental Health Perspectives 131, https://doi.org/10.1289/EHP10611 **(IF=11; JIF%=97.3%).**

AIR POLLUTION vs Parkinson's Disease

Movement disorders

OPEN ACCESS

Original research

Long-term exposure to multiple air pollutants and risk of Parkinson's disease: a population-based multipollutant model study

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► Additional supplemental material is published online only. To view, please visit the journal online (https://doi.org/10.1136/jnnp-2024-334825).

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ABSTRACT

Background Recent evidence suggests brain-first Parkinson's disease (PD) may start from the olfactory system, indicating potential inhalational exposure to causal agents. We investigated the impact of long-term exposure to various air pollutants on PD incidence using both single- and multi-pollutant models to account for interactions between pollutants.

Methods This retrospective population study used data from Taiwan's National Health Insurance Research Database (2006 and 2018) and included individuals aged 40–65 without PD. Personal exposure levels to various air pollutants, including $PM_{2.5}$, PM_{10}, NO_2, O_3, SO_2 and CO, were calculated using the hybrid Kriging/land-use regression method. Cox regression models were used to analyse the association between pollutants and PD incidence, adjusting for covariates.

Results A total of 5 113 322 individuals without PD (mean age 50.1±6.9 years, 47.3% men) were followed for an average of 11.2±2.4 years, during which 20 694 incident cases of PD were identified. In the single-pollutant model, exposure to $PM_{2.5}$ (HR 2.65 (95% CI 2.59 to 2.72)), PM_{10} (HR 3.13 (3.04 to 3.22)), NO_2 (HR 1.74 (1.68 to 1.80)) and SO_2 (HR 1.68 (1.65 to 1.71)) was associated with an increased risk of PD. These associations remained robust in the multipollutant model. A positive association between exposure to O_3 and an increased risk of PD (HR 1.29 (1.25–1.33)) was

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Exposure to air pollutants is inconsistently associate with an increased risk of Parkinson's disease (PD). Few studies have considered the potential interaction between each air pollutant.

WHAT THIS STUDY ADDS

⇒ In the present study, we comprehensively analysed the effects of six major components of air pollution (PM2.5, PM10, NO2, CO, SO2 and O3) using a large population cohort under longitudinal long-term follow-up. By using multipollutant models to consider interaction effects between pollutants and accounting for temperature and humidity as covariates related to global warming, this study uncovered significant associations between long-term exposure to air pollutants (PM2.5, PM10, NO2, SO2 and O3) and increased risks of PD.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Our results emphasise the need for health policies to mitigate the detrimental effects of air pollution on PD, especially on vulnerable populations.

Table 2 The adjusted HR of PD for each IQR increment in air pollutant levels

		Two-pollutant model			
	Single pollutant model	Model 1 (adjusted for $PM_{2.5}$)	Model 2 (adjusted for NO_2)	Model 3 (adjusted for SO_2)	Multiple pollutants model*
Air pollutant	HR, 95% CI	HR, 95% CI	HR, 95% CI	HR, 95% CI	HR, 95% CI
$PM_{2.5}$	2.65 (2.59 to 2.72)	–	2.74 (2.67 to 2.80)	2.29 (2.23 to 2.35)	2.51 (2.45 to 2.58)
PM_{10}	3.13 (3.04 to 3.22)	1.76 (1.66 to 1.87)	3.07 (2.99 to 3.16)	2.65 (2.56 to 2.73)	1.25 (1.18 to 1.33)
CO	1.82 (1.75 to 1.89)	1.79 (1.72 to 1.86)	1.34 (1.26 to 1.42)	1.47 (1.42 to 1.54)	1.05 (0.99 to 1.11)
NO_2	1.74 (1.68 to 1.80)	1.97 (1.91 to 2.04)	–	1.29 (1.25 to 1.34)	1.76 (1.70 to 1.83)
SO_2	1.68 (1.65 to 1.71)	1.32 (1.29 to 1.34)	1.61 (1.58 to 1.64)	–	1.15 (1.13 to 1.18)
O_3	0.77 (0.75 to 0.79)	0.93 (0.90 to 0.95)	0.91 (0.89 to 0.94)	0.81 (0.79 to 0.83)	1.29 (1.25 to 1.33)

Single-pollutant model: adjusted for sex; age; degree of urbanisation; insured amount; diabetes mellitus; hypertension; viral hepatitis A, B or C; ambient temperature; and relative humidity.
Two-pollutant model: covariates including sex, age, degree of urbanisation, insured amount, diabetes mellitus, hypertension, viral hepatitis, ambient temperature and relative humidity were adjusted in all the models.
Model 1: adjusted for covariates and $PM_{2.5}$. Model 2: adjusted for covariates and NO_2. Model 3: adjusted for covariates and SO_2.
*Multiple-pollutant model: single-pollutant model plus co-pollutants. For $PM_{2.5}$, adjustments are made for NO_2 and SO_2. For NO_2, adjustments are made for $PM_{2.5}$ and SO_2. For SO_2, adjustments are made for $PM_{2.5}$ and NO_2. For PM_{10}, CO, and O_3, adjustments are made for $PM_{2.5}$, NO_2, and SO_2.
PD, Parkinson's disease.

Lin, C. H., S. C. Pan, **C. D. Wu**, H. S. Li, Y. L. Guo*. 2024. Long-term Exposure to Multiple Air Pollutants and Risk of Parkinson's Disease: A Population-based Multi-pollutant Model Study. Journal of Neurology Neurosurgery & Psychiatry doi: 10.1136/jnnp-2024-334825 **(IF=8.8; JIF%=97%)**.

AIR POLLUTION
vs GUT & NASAL MICROBIOTA

Ecotoxicology and Environmental Safety 291 (2025) 117793

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Ecotoxicology and Environmental Safety

journal homepage: www.elsevier.com/locate/ecoenv

Environmental exposures related to gut microbiota among children with asthma: a pioneer study in Taiwan

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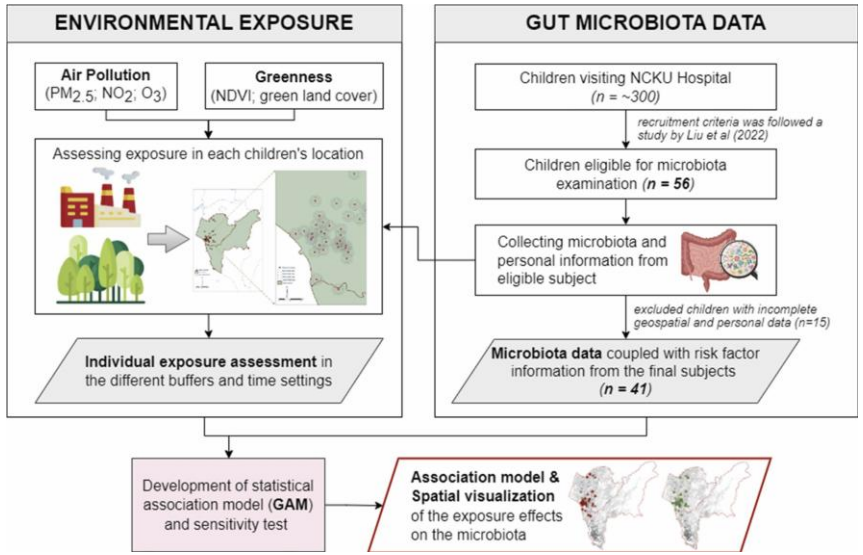

Asri, A. K., T. Liu, H. . Tsai, J. Y. Wang*, **C. D. Wu***. 2025. Environmental exposures related to gut microbiota among children with asthma: a pioneer study in Taiwan. Ecotoxicology and Environmental Safety 291: 117793 **(IF=6.2; JIF%=92%).**

Environmental Research 219 (2023) 115095

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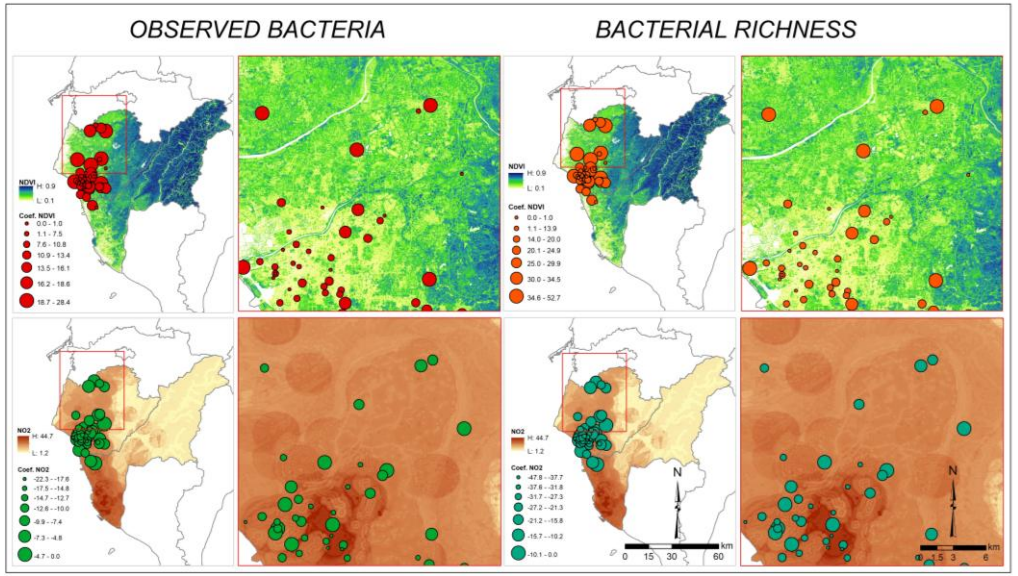
Residential greenness and air pollution's association with nasal microbiota among asthmatic children

Aji Kusumaning Asri [a], Tsunglin Liu [b], Hui-Ju Tsai [c], Hsiao-Yun Lee [d], Wen-Chi Pan [e], Chih-Da Wu [a,f,*,1], Jiu-Yao Wang [g,h,**,1]



Asri, A. K., T. Liu, H. J. Tsai, H. Y. Lee, W. C. Pan, **C. D. Wu***, J. Y. Wang*. 2023. Residential Greenness and Air Pollution Associated with Nasal Microbiota Among Asthmatic Children. Environmental Research 219:115095 **(IF=8.4; JIF%=90.2%).**

Surrounding Environment vs ESRD

MOST 105-2119-M-415-001 -

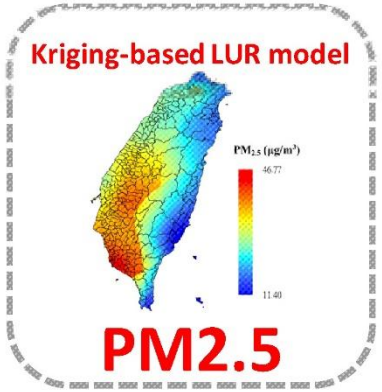
Longitudinal Health Insurance Database (LHID2000) (n=623,894)

Followed up from 2003 to 2012

Incident ESRD cases (n=1,945)

Subjects without ESRD (n=621,949)

Exposure Assessment



Cox proportional hazards models with a generalized estimating equation

$PM_{2.5}$ (per IQR=11.31 μg/m³)

Surrounding green spaces (per IQR=8.1%)

1.08

0.9

adjusted hazard ratio

Wu, C. D., Y. R. Chern, W. C. Pan, S. C. C. Lung, T. C. Yao, H. J. Tsai*, J. D. Spengler. 2020. Effects of Surrounding Environment on Incidence of End Stage Renal Disease. Science of the Total Environment 723: 137915 **(IF=6.6; JIF%=91.9%)**.

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Thanks for Listening :)

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