

Yu-Chun Wang Research Themes

Research Themes & Achievements | Dept. of Environmental Engineering, Chung Yuan Christian University

My research is unified by a single concern: the human-health impacts of, and adaptation to, global environmental change. Spanning environmental engineering, public health, atmospheric science and climate services, it draws on population-based health-insurance and vital-statistics data for Taiwan's 23 million residents, combined with meteorological, air-quality, satellite and reanalysis data and IPCC climate-projection scenarios, and applies distributed lag non-linear models (DLNM), random-effects meta-analysis and Bayesian hierarchical models. Based on 77 journal articles and 60 funded projects, the work falls into five themes:

Theme 1 Extreme Temperature, Climate Change and Human Health

Key output ~29 journal articles; >40 climate-health projects - the core of my research program.

Taiwan is a subtropical, humid island with high air-conditioning penetration, where extreme temperatures produce strongly region-dependent health effects. I have systematically quantified the mortality and morbidity risks of ambient temperature for all-cause, circulatory, respiratory, renal, cerebrovascular and mental disorders, finding that cold-related excess health loss generally exceeds heat-related loss in Taiwan, that circulatory-disease mortality carries the highest cold-related risk, and that prolonged extreme-temperature events further elevate emergency-care demand.

I have compared single temperature measures with composite bio-meteorological indices, showing that metropolitan Taipei is better served by human-biometeorological indicators while daily mean temperature suffices in central and southern Taiwan; identified vulnerable sub-populations (the elderly and those with circulatory/renal comorbidity); and projected future impacts under IPCC RCP scenarios. Recent work extends to mental disorders (e.g., RR 1.18 for all mental disorders among men aged 65+ under extreme heat), hospitalization, and cross-national application to Indian cities such as Ahmedabad. These findings have informed adaptation and early-warning policy at Taiwan's Ministry of Health and Welfare, Ministry of Environment and Ministry of Labor.

Theme 2 Health Impacts and Risk Assessment of Air Pollution

Key output ~16 journal articles covering PM_{2.5} and its constituents, VOCs, ozone and Asian dust storms.

I have examined the acute effects of particulate matter (PM_{2.5}, PM₁₀) and its chemical constituents (nitrate, sulfate, organic and elemental carbon), VOCs, ozone and Asian dust storms on mortality, emergency-room visits and pre-hospital emergency medical services. Risk thresholds differ by health outcome, and specific constituents (e.g., elemental carbon) show stronger associations with emergency demand, supporting routine evaluation of PM composition in air-quality management. Attaining the WHO air-quality guideline (PM_{2.5} < 15 µg/m³) is estimated to prevent ~5,571 elderly deaths in Taiwan.

Long-term VOC monitoring around a petrochemical complex characterized source-specific pollutants and children's cancer/non-cancer risks. Recent nature-based work demonstrates that green-curtain systems and higher community green-view index measurably reduce PM_{2.5} exposure, and I have developed real-time air-pollution health-risk indicators to support regional control priorities.

Theme 3 Climate Variability and Infectious Diseases in the Asia-Pacific

Key output ~16 journal articles across Taiwan, Nepal, the Solomon Islands, Indonesia and India.

I analyze how meteorological variability and air quality shape diarrhea, gastroenteritis, enterovirus, conjunctivitis and influenza, incorporating large-scale signals such as the El Niño-Southern Oscillation (ENSO) and monsoon anomalies. Key results include: extreme low temperature raising all-infectious and viral diarrhea risk in Taiwan; in the Solomon Islands,

average temperature increasing dengue-like-illness risk (IRR 2.19) with La Niña sharply elevating it (IRR 4.54) and El Niño reducing it by 72.8-76.7%; and in Nepal, monsoon season raising under-5 diarrhea by 21% with stronger effects in mountain regions (IRR 1.51).

Because ENSO and monsoon dynamics are predictable at longer lead times than weather, these findings underpin seasonal-to-subseasonal early warning. Through the Belmont Forum AWARD-APR project, my team has translated this evidence into community-based adaptation and hygiene education across Southeast Asia and the Pacific.

Theme 4 Health Early-Warning Systems, Climate Services and Adaptation

Key output Practical translation across Central Weather Bureau, NHRI and industry collaborations.

I translate temperature-health and infectious-disease research from historical observation to real-time, seasonal and long-term climate prediction, building decision-relevant climate services. Deliverables include web-based warning prototypes for cardiopulmonary mortality and dengue in Taiwan, and the Solomon Islands Dengue-Like-Illness Early Warning System (SoSAFE). At the policy interface, I provide scientific evidence to government ministries, co-developed climate-health adaptation decision methods with the National Health Research Institutes, and supported Cathay Financial Holdings' climate-related financial disclosure (TCFD) through extreme-temperature health-risk scenario analysis.

Theme 5 Water Quality, Green Chemistry and Environmental Sustainability

Key output ~7 journal articles; >15 green-chemistry, carbon/net-zero and environmental-monitoring projects.

Extending my environmental-engineering expertise, this theme covers reservoir eutrophication, long-term river water-quality trends and source apportionment, occupational health risk of water reuse, and a systematic review of climate impacts on biochemical oxygen demand (BOD) in Asian rivers (aligned with SDG 6). I have also quantified future dioxin (PCDD/Fs) emissions from sugarcane burning in Indonesia (~309 pg TEQ/year). In education and governance, I have led multi-year green-chemistry public-education programs, assessed the health co-benefits of bioenergy replacing coal, and now embed the SDGs and net-zero transition into institutional decision-making and University Social Responsibility (USR) as Chief Sustainability Officer.

Closing

Across these five themes, my research follows a consistent arc - environmental exposure, health risk, adaptation action - moving from local quantification of temperature and air-pollution effects, to regional climate-sensitive infectious diseases, to operational warning systems and policy, and back to water resources and institutional sustainability. The work combines originality (methodological integration and regional comparison), rigor (population-scale data and statistical modeling) and policy impact (cross-ministerial and cross-national application).

Effect sizes (relative risks/incidence-rate ratios with 95% CIs) are drawn from the cited journal articles; full references appear in the publication list and CV.