



# Environmental Pollution, Management, and Sustainable Development: Strategies for Vietnam and Other Developing Countries

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## Abstract

This editorial introduces the issue of selected papers that were presented at the third International Conference on Environmental Pollution, Restoration, and Management in Quy Nhon, Vietnam on 6–10 March 2017. While environmental problems caused by diverse municipal, industrial, and other economic development activities continue to increase in many Asian countries, public awareness about environmental management for public health and the environment remain at levels that favor accepting environmental degradation and impacts for tradeoffs with economic values. This special issue resulted from a conference that was organized to bringing scientists from developed and developing countries to Vietnam to share experiences, discuss environmental problems, and enhance future collaborations for research and training in support of better management plans for the environment and health. Papers published in this issue present original results from diverse research on current environmental management challenges in Vietnam and other Asian countries. The research areas include environmental contamination in groundwater and diet that affect human health, waste composting, and effects of wastewater effluent, which is one of the greatest challenges in most Asian countries. In addition, impacts of hazardous chemical emissions and related environmental management efforts, and sustainable development approaches are included.

## Introduction

World economic growth has expanded from western countries to the Asia-Pacific region in recent years. China, for example, with an average growth rate of about 10% has become the world's fastest growing economy over the past 20 years (IMF 2013). Vietnam, with an annual economic growth rate of  $\geq 5.2\%$ , is the leader in economic growth of the Association of Southeast Asian Nations (ASEAN) since a reform policy was implemented in 1986 (Warren 2016).

To improve the quality of modern life and develop the national economy, many Asian countries have favored exploitation of their natural resources with little consideration of consequences for public health and the environment. As a result, these countries are facing environmental challenges that ultimately will negatively affect their sustainable development in the future. Typical environmental problems include pollution due to industrial activities, habitat fragmentation, and degradation due to deforestation, rapid development of agriculture and aquaculture, and urbanization. These environmental problems have even become more serious with the effects of climate change and rapid human population growth, particularly in urban areas near coastal systems. In addition, public awareness about environmental management in many Asian countries are still at levels that are inadequate for the protection of natural habitats, environmental resources, and health. Unprogressive environmental ethics are making environmental problems continue to increase. Therefore, the need for proper management of natural resources and the development of appropriate fields of environmental sciences, such as environmental toxicology and risk assessment, remediation and sustainable technology becomes imperative.

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This special issue resulted from a unique conference that brought together scientists from developed and developing countries to Vietnam to share experiences, discuss environmental problems, and enhance future collaborations for research and training in support of better management plans for the environment and health. Topic areas included environmental pollution, toxicology, remediation and technology, public health, risk assessment and management, and sustainability. In addition to parallel sessions, short courses and workshops, a separate meeting with the Ministry of Natural Resources and Environment of Vietnam, including Minister Dr. Tran Hong Ha, to discuss current environmental problems in Vietnam and potential future collaborations for research and training. One of the important suggestions was to develop an Institute for Environmental Toxicology and Risk Assessment to conduct fundamental and applied research in support of better environmental management in Vietnam. The institute promises to be a central location to facilitate international collaborations, especially within and among Southeast Asian countries.

The papers published in this issue present the original results of research present on diverse topics at the conference. This editorial introduces the research in four topic categories: environmental contamination in groundwater and diet that is related to human health, waste composting, effects, and management, environmental impact assessment and management of emission of hazardous chemicals, and sustainable development in Vietnam.

## Environmental Contamination

We must increasingly recognize the pronounced health and environmental consequences of pollution, particularly in lower to middle income countries (Landrigan et al. 2018). In this special section, Gupta and Singh (2019) examine correlations between arsenic and iron concentrations in aquifers in Northeast India. Arsenic concentrations exceeded the World Health Organization guideline in both valleys sampled for the study but contamination was similar to other contaminated areas of south and eastern Asia. The authors suggest ways in which the data can be assimilated into spatial models to predict management practices for consumers to avoid groundwater contamination. Contaminated groundwater and surface water routinely intersect with food safety concerns. For example, Tran et al. (2019) report radionuclide concentrations in raw and cooked food items for the human population of the Red River Delta in Vietnam. The authors report that natural isotopes were the dominant source of radionuclides in Vietnamese food and cooking reduced overall concentrations of nuclides. Calculations of annual dose are included with the conclusion

that radionuclide exposure in the Red River Delta is comparable for these contaminants to previous reports from other countries.

## Solid Waste and Wastewater Management

Solid waste and wastewater management represents critically important environment and health considerations in Asia, which is predicted to become the top global producer of municipal solid waste by 2030 (UNEP 2015). Currently, sewage produced in Asia is largely untreated (68% in 2013; Sato et al. 2013). Composting is a sustainable practice that can transform sewage sludge from a waste material to a beneficial by-product. Nguyen and Shima (2019) describe a simplified aerobic process to compost municipal sewage sludge, identifying sludge physicochemical characteristics following composting authentic municipal sludges under two different temperature regimes (winter and summer). Their results confirmed that although the final chemical characteristics of each composted sludge varied by season, both composted sludges were equally effective at increasing plant biomass as a commercial plant fertilizer. The authors suggest monitoring certain physicochemical properties of sludges to assess compost maturity and efficacy as a fertilizer.

Pham et al. (2018) measured morphometric and biomarker responses of the common carp exposed to treated municipal sewage effluent, calculating an integrated biomarker response for a 360-d exposure. Polar organic chemical integrated samplers identified a complex mixture of pharmaceuticals and personal care products in the effluents that varied in concentration by season. The greatest impacts on fish health were measured early in the exposure, while biomarkers indicating endocrine disruption and oxidative stress were identified by the end of the exposure. The authors discuss relationships between biomarker data and fish health and implications of effluent treatment on maintaining healthy populations of fish and other organisms in receiving waters.

## Environmental Assessment and Management of Chemicals

Disaster risk reduction remains an important pursuit for countries in Southeast Asia and other developing regions. In this special section, Do and Ly (2019) developed a four-step evaluation process to characterize the impact of chemical emissions to local populations through identification of the hazards and worst-case scenario to simulation of the incident and assessment of the impact. The process uses several modeling techniques for

understanding the chemical movement at each step. The study then developed a hypothetical spill simulation to test the models. In a spill with *p*-xylene, concentrations could reach between levels 2 and 3 of the Protective Action Criteria for Chemicals and spread to >20 km, into highly populated areas, putting the most vulnerable members of society at further risk. Although further development of the model is suggested, this research suggests the model to be useful in developing cautionary information for local chemical companies.

Environmental management and impact assessment are two tools that work in conjunction with each other. Waxin et al. (2019) discussed the drivers for and challenges of environmental management system (EMS) implementation in an emerging economy of the Gulf Cooperation Council. They found variation in both drivers and challenges between public and private organizations, whereby both public and private use the EMS to comply with regulations and improve environmental performance, whereas public organizations focused more on their commitment to sustainability and private organizations stressed more on cost reduction, competitors, leadership commitment, and customers' demands. Challenges to implementation tended to be a lack of qualified human resources, practical challenges associated with implementation, a lack of regulations, a lack of support from management, and high costs. Therefore, this research suggested that an increase in environmental management education, upper management support and communication of the environmental policy, and harmonization of regulations at various levels would help organizations improve environmental performance in emerging Arab and Gulf economies.

## Sustainable Development in Vietnam

Vietnam is a country with over 4000 years of history, but a modern economy did not begin to emerge until 1986, when *Đổi Mới* (reform) was implemented. Since the reform and transition to a market-oriented economy, Vietnam began to develop rapidly, with an annual economic growth rate of 5.2% or more. With cheap labor cost, productive workers, strategic location, and large consumer market, Vietnam has become a favorable place for foreign investment. Presently, Vietnam is one of the fastest growing economies of the ASEAN. However, along with economic growth, Vietnam is facing environmental challenges that might negatively affect future development. Shultz and Peterson (2019) used the sustainable society index method to assess sustainable development in Vietnam under a macromarketing view. The results reveal that Vietnam scores well on several indexes, such as energy use, greenhouse gas emissions, and employment. However, the scores are poor for energy

savings and education. The authors also discuss the unsustainable use of water resources, which would lead to shortages for human consumption and supply for industrial development in the near future. This problem is even more serious to the Mekong Delta because of the rapid development of hydroelectricity in the upper Mekong River Basin, and agricultural practices and pollution in the Mekong Delta. Water flow is restricted, and saltwater intrusion and pollution threaten the freshwater ecosystem of the Mekong Delta in Vietnam—a condition not only harmful to Vietnam and to Vietnamese people, but to other countries and people around the world dependent upon its agricultural and aquaculture bounty. The results of the index also reveal how various forces, policies, and practices interact to degrade resources—water, energy, transportation systems, food supplies, air quality—which ultimately affect human health and well being. The overarching theme of the paper, to ensure that development in Vietnam is more sustainable, requires a stronger and coordinated management plan for natural resources and environment along with the policies and practices that affect them. Clearly, policy makers in the central government play a vital role in this regard, as do farmers, businesses, and consumers. Increased cooperation and constructive engagement of stakeholders, non-governmental organizations, governments, and private sectors in the management plan will enhance sustainable development of Vietnam.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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## References

- Do TTH, Ly TBT (2019) Development of a procedure for evaluating the impacts of the accidental emission of hazardous chemicals, case study in Ho Chi Minh City, Vietnam. *Environ Manage.* <https://doi.org/10.1007/s00267-017-0979-0>

- Gupta A, Singh EJ (2019) Arsenic-iron relationships in aquifers of North East India: Implications for public health and the environment. *Environ Manage*. <https://doi.org/10.1007/s00267-018-0999-4>
- International Monetary Fund (2013) Report for selected countries and subjects. [http://www.imf.org/external/pubs/ft/weo/2013/01/w/eodata/weorept.aspx?sy=1980&ey=2018&sort=country&ds=.&br=1&pr1.x=40&pr1.y=0&c=924&s=NGDP\\_RPCH%2CPPPPC&grp=0&a=](http://www.imf.org/external/pubs/ft/weo/2013/01/w/eodata/weorept.aspx?sy=1980&ey=2018&sort=country&ds=.&br=1&pr1.x=40&pr1.y=0&c=924&s=NGDP_RPCH%2CPPPPC&grp=0&a=). Accessed 19 Apr 2018
- Landrigan PL, Fuller R, Acosta NJR, Adeyi O, Arnold R, Basu NN, Baldé AB, Bertollini R, Bose-O'Reilly S, Boufford JI, Breyse PN, Chiles T, Mahidol C, Coll-Seck AM, Cropper ML, Coll-Seck J, Fuster V, Greenstone M, Haines A, Hanrahan D, Hunter D, Khare M, Krupnick A, Lanphear B, Lohani B, Martin K, Mathiasen KV, McTeer MA, Murray CJL, Ndahimananjara JD, Perera F, Potočnik J, Preker AS, Ramesh J, Rockström J, Salinas C, Samson LD, Sandilya K, Sly PD, Smith KR, Steiner A, Stewart RB, Suk WA, van Schayck OCP, Yadama GN, Yumkella K, Zhong M (2018) The Lancet commission on pollution and health *Lancet* 391:462–512. [https://doi.org/10.1016/S0140-6736\(17\)32345-0](https://doi.org/10.1016/S0140-6736(17)32345-0)
- Nguyen TB, Shima K (2019) Composting of sewage sludge with a simple aeration method and its utilization as a soil fertilizer. *Environ Manage*. <https://doi.org/10.1007/s00267-017-0963-8>
- Pham TG, Viktoriia B, Sidika, S, Heike SP, Rasmussen MK, Tomas R, Roman, G, Katerina, G, Ganna, F, Olga K, Oksana, G, Jan, T, Daniel C, Jitka K, Vladimir Z (2018) Effects of multi-component mixtures from sewage treatment plant effluent on Common carp (*Cyprinus carpio*) under fully realistic condition. *Environ Manage*. <https://doi.org/10.1007/s00267-017-0964-7>
- Shultz CJ, Peterson M (2019) A Macromarketing view of sustainable development in Vietnam. *Environ Manage*. <https://doi.org/10.1007/s00267-017-0971-8>
- Sato T, Qadir M, Yamamoto S, Endo T, Zahoor A (2013) Global, regional, and country level need for data on wastewater generation, treatment, and use. *Agric Water Manag* 130:1–13
- Tran TV, Luu TB, Dang DN, Nguyen HQ, Bui DC, Le VH (2019) Estimation of radionuclide concentrations and average annual committed effective dose due to ingestion for the population in the Red River Delta, Viet Nam. *Environ Manage*. <https://doi.org/10.1007/s00267-018-1007-8>
- UNEP (2015) *Global waste management outlook* (2015). UNEP Website. <http://web.unep.org/ourplanet/september-2015/unep-publications/global-waste-management-outlook>. Accessed 27 Jan 2019
- Warren J (2016) *Cultures of development: Vietnam, Brazil and the unsung vanguard of prosperity*. Routledge, London
- Waxin MF, Knuteson SL, Bartholomew A (2019) Drivers and challenges for implementing ISO 14001 environmental management systems in an emerging Gulf Arab country. *Environ Manage*. <https://doi.org/10.1007/s00267-017-0958-5>