

Introduction

Heavy metals in waterways are detrimental to the environment and can affect river ecologies, fish migration, agriculture, and human health ([Tchounwou *et al.*, 2012](#)). Heavy metal pollution has affected ASEAN in recent years because many ASEAN countries have developed chemical and mining industries that produce wastewater containing heavy metals. The wastewater being directly released into waterways without suitable treatment directly threatens human health and causes cancer ([McGee & Greenberg, 1992](#); [Graeme & Pollack, 1998](#)). Around 30,000 people in the ASEAN area suffer from heavy metal pollution every year ([Graeme & Pollack, 1998](#); [World Health Organization, 2010](#)), and the fishery industry has also been affected by heavy metal pollution ([Sowana *et al.*, 2011](#)). Direct economic losses due to heavy metal pollution are estimated to be as high as 1.5 million United States dollars (USD) per year in ASEAN countries ([Owlad *et al.*, 2009](#)). Some pollution occurs on national borders, creating transboundary issues ([Hart *et al.*, 2001](#)). For example, according to a technical paper produced by the Mekong River Commission (MRC), transboundary pollutants from the Khorat Plateau in Thailand directly affect Pakse in Laos ([Edwin *et al.*, 2007](#)).

Consequentially, it is essential that ASEAN countries work together to tackle heavy metal pollution and transboundary issues. Currently, four countries (Cambodia, Laos, Thailand, and Vietnam) in the lower Mekong basin are members of the MRC, an organisation that monitors water quality. However, many ASEAN countries do not have effective policies regarding heavy metal pollution. Some ASEAN countries are also reluctant to respond to transboundary heavy metal pollution, as they do not want to interfere in each other's internal issues. The current ASEAN approach (including that of the MRC) cannot reduce heavy metal concentration effectively regarding water treatment. In this paper, network governance theory will be used to analyse environmental problems. This paper proposes that traditional state-centric governance is gradually supplemented by voluntary governance, a move that may help to solve environmental pollution problem in some areas.

Heavy metal pollution and transboundary issues in ASEAN countries

Heavy metals are generally defined as metals that have high densities and cause water contamination and environmental problems. Heavy metals in the natural environment mainly include cobalt, nickel, arsenic, cadmium, chromium, copper, iron, mercury, manganese, lead, and zinc ([Hawkes, 1997](#)). One major source of heavy metals in ASEAN countries was

chemical and mining factories. Without proper wastewater treatment during chemical and mining processes, heavy metals will be released into waterways, and people who drink water that contains a high concentration of heavy metals will suffer from cancer and brain damage ([Graeme & Pollack, 1998](#); [Owlad et al., 2009](#)). Such environmental problems are common in many developing countries in Asia, such as China and India. However, due to recent economic growth, ASEAN countries are increasingly witnessing heavy metal pollution ([Hart et al., 2001](#)). [Nguyen et al. \(2016\)](#) studied pollution and found that heavy metal concentrations had reached serious levels in the Red River (see [Figure 1](#)) in Vietnam. [Berg et al. \(2001\)](#) found an average arsenic concentration of 159 µg/L in the Red River, which exceeded the World Health Organization's (WHO's) provisional guideline value of 10 µg/L. Cheevaporn and Menasveta reported that high concentrations of heavy metals (arsenic, cadmium, chromium, copper, iron, mercury, manganese, lead, and zinc) had directly led to habitat degradation in the Gulf of Thailand. The authors stated in a paper that heavy metal problems would become more severe if preventive measures were not taken promptly ([Cheevaporn & Menasveta, 2003](#)). The research mentioned above clearly reflects the serious impact that heavy metal pollution has on ASEAN countries. A schematic illustration of the Mekong River and three sample points (Vientiane in Laos, Prek Kdam in Cambodia, and Chau Doc in Vietnam). The figure is copied from Natural Earth (with permission) and has been replotted by the author.

In some cases, chemical or mining companies near national borders have released wastewater that has not been properly treated, leading to transboundary issues. Transboundary issues may lead to further environmental deterioration because (1) the source of pollution is sometimes in one country and the victims in another, and (2) environmental law enforcement is much more difficult. This paper examines heavy metal pollution and transboundary issues in the Mekong River (a large river that passes through Myanmar, Laos, Thailand, Cambodia, and Vietnam; Yunnan Key Laboratory for International Rivers and Transboundary Ecology Security reported that the release of heavy metals (chromium, lead, nickel, and zinc) from Myanmar in the upper Mekong might directly affect water quality in Laos, Vietnam, Thailand, and Cambodia in the lower Mekong basin ([Fu et al., 2012](#)). A technical report released by the MRC stated that the concentration of arsenic was high in the upstream of the Mekong River, which had the potential to negatively affect the ecology of the area and human health in the downstream of the Mekong River ([Hart et al., 2001](#)). The concentration of mercury was high at one sample point (Prek Kdam,

Cambodia), but the mercury had not been detected at the other two sample points. Different heavy metals could have different behaviours (higher mobility versus lower mobility) that might cause various transboundary issues.

Network governance theory to water pollution

[Listen](#)

Network governance theory involves the creation of synergy between various competencies and sources of knowledge to deal with complicated problems ([Jones et al., 1997](#)). Network governance can be applied to study the ecological, social, and political challenges involved in environmental issues. Due to the complexity of both the heavy metal problem and transboundary issues, scientists, practitioners, and policymakers use network governance to evaluate environmental policy and also to help people to understand individual roles within a network ([Bixler et al., 2016](#)). Network governance is used to increase the efficiency, or reduce the agency, of different organisations as the efficiency can be improved through distributed knowledge acquisition and decentralised problem-solving, and the effectiveness can be enhanced by the emergence of collective solutions to regional problems in different self-regulated organisations ([Poole, 2014](#)).

In traditional theory, there are four classic modes of governance: (1) state-centric (hierarchical) governance, (2) multi-partner governance, (3) market governance, and (4) voluntary governance (self-governance) ([Lowndes & Skelcher, 1998](#)). Nowadays, ASEAN countries use traditional state-centric governance to solve most environmental problems ([Figure 2](#)). In brief, after a pollution event occurs, a research institute will report the problem to the government. To deal with the problem, the government will design a new policy and implement it. In this process, non-governmental organisations (NGOs) play the role of advocate/assistant to state government. Business associations might also invest/provide funding for some environmental projects. Finally, the environmental problem is solved.