Statistical assessment for spatio-temporal water quality in Angkor, Cambodia

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ABSTRACT

Comprehensive water quality monitoring was conducted to assess the water quality conditions and to determine the impact of urban infrastructure on ambient water quality in Angkor, Cambodia. During this study, surface water, groundwater, and sediment samples were collected for two distinctive seasons in 2006–2007 at 58 monitoring sites along and near the Siem Reap River, in Tole Sap Lake (TSL), and West Baray, the primary water resources in this region. To assess the seasonal and spatial variability of 27 water quality parameters, multivariate analysis of variance, hierarchical cluster analysis, and the Kruskal-Wallis test were conducted using the obtained data. Differences and relationships between the surface water and groundwater were also investigated using t-test and correlation analysis, respectively. The results of these tests showed that the bacterial indicators need special attention as the urban infrastructure of the downtown area caused increased levels of these bacterial indicators in both surface water and groundwater. However, for most parameters, though surface water showed strong seasonal variations, groundwater presented relatively stable conditions between seasons ($p > 0.05$) with site-specific geochemical conditions. Sediment quality illustrated that pollution levels of 10 trace metals were the highest in TSL because of its unique characteristic (river with backward flow), but did not reflect any potential enrichment from urban development. Overall, the results reveal that while the urban infrastructure in this region has not significantly affected most of the water quality parameters, bacteria and coliphages are still a main concern due to their contributions in widespread waterborne diseases. Thus, careful mitigation plans for reducing each pollutant source are needed in the Angkor area.

Key words | Angkor, Siem Reap River, statistical analysis, Tole Sap Lake, water quality

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INTRODUCTION

Surface water quality is generally affected by numerous natural or anthropogenic sources under site-specific environmental frames and conditions. Once these sources are introduced to a waterbody, they undergo physical, chemical, and biological transport within or across the air, water, or soil media, frequently generating adverse effects (i.e., water pollution or toxicity) in their surrounding communities (Nedeau *et al.* 2003; WHO 2006; MacCausland & McTammany 2007). Then, these combined effects create short- and long-term variations in water quality based on meteorological conditions, thereby lessening the ability to construct sustainable water resource management plans.

Of great concern in the Kingdom of Cambodia is water quality impairment; Cambodia has of late recorded a high infant mortality rate (58.45 deaths per 1,000 live births, CIA 2007) and poor drinking water coverage (around 64% for a population of 14 million, WHO/UNICEF 2005). Recent