Journal of Hazardous Materials 165 (2009) 317–324

Contents lists available at ScienceDirect

Journal of Hazardous Materials

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

Water quality in the upper Han River basin, China: The impacts of land use/land cover in riparian buffer zone

Siyue Li[a], Sheng Gu[a], Xiang Tan[a,b], Quanfa Zhang[a,*]

[a] Laboratory of Aquatic Botany and Watershed Ecology, Wuhan Botanical Garden, the Chinese Academy of Sciences, Wuhan 430074, China
[b] Graduate School of the Chinese Academy of Sciences, Beijing 100049, China

ARTICLE INFO

Article history:
Received 10 July 2008
Received in revised form
15 September 2008
Accepted 29 September 2008
Available online 11 October 2008

Keywords:
Water quality
Riparian
Land use and land cover
Han River
Physico-chemicals

ABSTRACT

Vegetated riparian zones adjacent to rivers and streams, can greatly mitigate nutrients, sediment from surface through deposition, absorption and denitrification, yet, human activities primarily land use practices have dramatically reduced the capacity. In this study, 42 sampling sites were selected in the riverine network throughout the upper Han River basin (approximately 95,200 km^2) of China. A total of 252 water samples were collected during the time period of 2005–2006 and analyzed for physico-chemical variables and major ions. Correlation analysis, principal components analysis and stepwise least squares multiple regression were used to determine the spatio-temporal variability of water quality variables and in particular their correlations with land use/land cover in the 100 m riparian zone along the stream network. The basin in general has a better water quality in the dry season than the rainy season, indicated by the primary pollutants including COD_{Mn} and nitrogen. Major ion compositions display large spatial and seasonal differences and are significantly related to land use and land cover in the riparian zone, while riparian landscape could not explain most of the water quality variability in *T*, pH, turbidity, SPM and COD_{Mn}. The research could provide help develop sustainable land use practice of the riparian zone for water conservation in the basin.

1. Introduction

Surface waters are controlled by both the natural processes, i.e. precipitation inputs, erosion, weathering, and the anthropogenic activities via point sources, such as industrial effluents and wastewater treatment facilities, and diffuse, such as runoffs from urban area and farming land [1–4]. Studies demonstrate that surface water quality has deteriorated noticeably in many countries in the past decades due to poor land use practices (e.g. [1,5]), indicating by the strong relationships between declining water quality and increasing agricultural development at catchment scale [1,6]. Therefore, researchers have been paying more attentions to the effect of land use on water quality, in particular the key contributors of agricultural activities to nutrients and suspended particulate matter [1,6,7]. Other findings note that urban land development greatly influence water quality as well [2,8].

Riparian buffers, especially undisturbed vegetated riparian zones situated adjacent to river and streams, can greatly mitigate nutrients, sediment from surface and groundwater flow through the processes of deposition, absorption and denitrification [9,10]. Past findings highlight the importance of the riparian zones for water quality (e.g. [11,12]), while its extent and the scale of the influences on water physicochemistry are still under debate [2,7,13]. For instance, Sliva and Williams [2] and Hunsaker and Levine [13] find that land use and land cover at catchment level are a better indicator of water quality than those in the buffer zones, while other studies show the opposite [7].

The upper Han River is the water source area of China's South-to-North Water Transfer Project which will transfer water to North China including Beijing and Tianjin for domestic, industrial and irrigational usages [14]. Studies have reported increasing nitrogen concentration and heavy metal contaminations in the Han River [3,5,14,15]. Diffuse pollutants due to land use practices have been increasingly becoming the key contributors to the declining water quality, and pollution prevention requires a better understanding of water quality and the impact by land use and land cover in the basin. Previous study has demonstrated the relationships between water quality and basin-wide land use and land cover [16]. This study presents the spatio-temporal variability of physico-chemicals and particularly the impacts of land use in riparian zone on water quality in order to develop sustainable land use practice for water conservation in the basin and ultimately for the interbasin water transfer project.

* Corresponding author. Tel.: +86 27 87510702; fax: +86 27 87510251.
E-mail address: qzhang@wbgcas.cn (Q. Zhang).

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doi:10.1016/j.jhazmat.2008.09.123

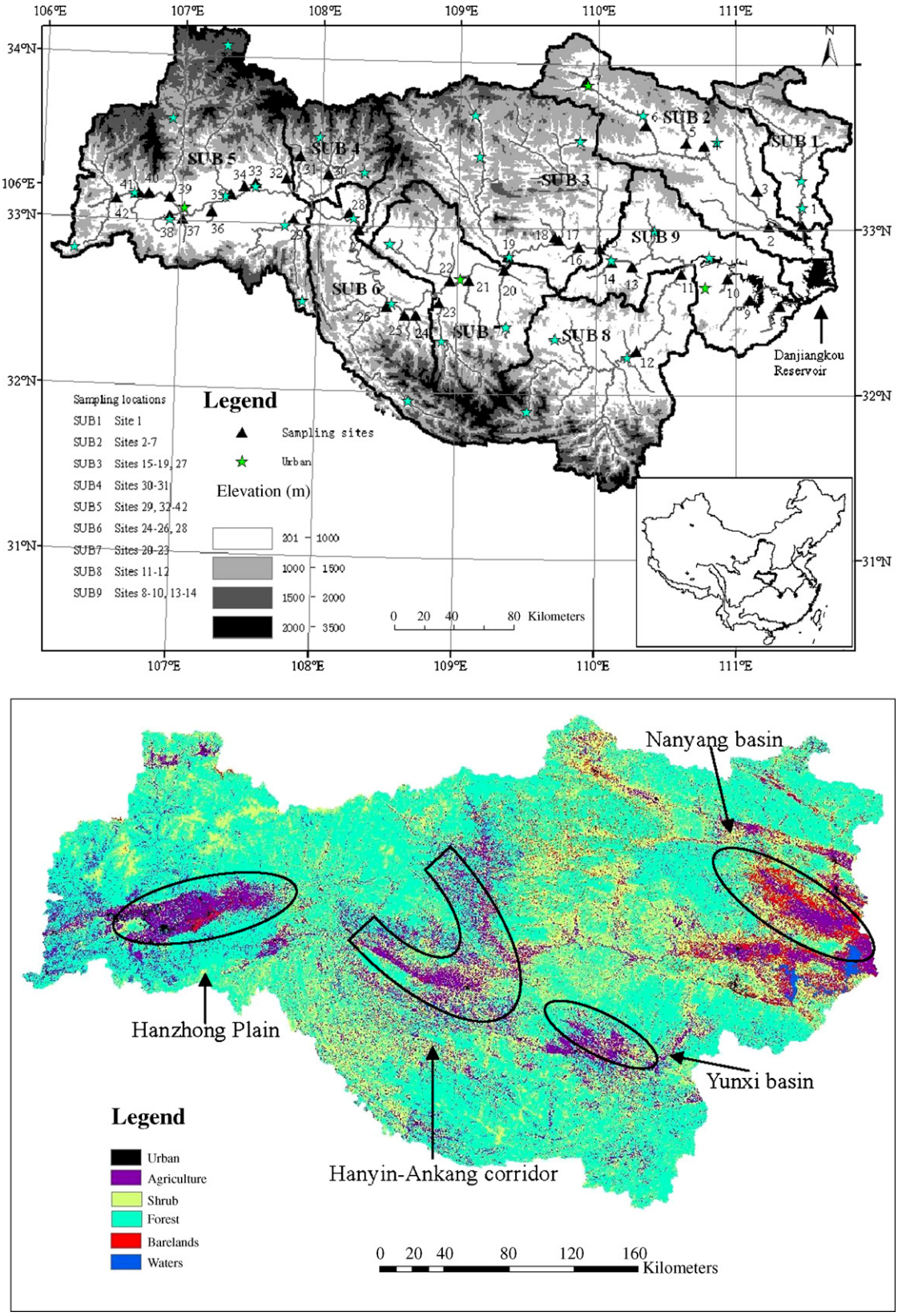

Fig. 1. The upper Han River basin showing the water sampling sites, DEM, drainage system and LULC, China (SUB1, Laoguan River; SUB2, Dan River; SUB3, the South of the Qinling Mountain; SUB4, Ziwu River; SUB5, Hanzhong Plain; SUB6, the North of the Daba Mountains; SUB7, Ankang Plain; SUB8, Du River; SUB9, Danjiangkou Reservoir; [16]).