Science of the Total Environment 407 (2009) 3482–3493

Contents lists available at ScienceDirect

Science of the Total Environment

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

Characteristics of wet and dry weather heavy metal discharges in the Yeongsan Watershed, Korea

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ARTICLE INFO

Article history:
Received 5 September 2008
Received in revised form 29 December 2008
Accepted 10 February 2009
Available online 6 March 2009

Keywords:
Heavy metals
Urban runoff
Surface water quality
Non-point source
Wet weather flow
Dry weather flow

ABSTRACT

A comprehensive water quality monitoring program was conducted in the Yeongsan (YS) River, Korea from 2005 to present to investigate wet and dry weather pollutant discharge in an attempt to establish point and non-point pollution management strategies. As part of this monitoring program, 11 heavy metal species were measured during dry and wet weather conditions in the YS River, where Gwangju City (GJ), a subcatchment of the YS River, was further monitored to clarify the responsibility of different metal species discharged into the mainstream. Monthly grab water samples showed that greater amounts of metals along the YS River were discharged during the wet summer months due largely to storm runoff. In addition, further monitoring results revealed that GJ, a highly urbanized area, was a significant contributor of the heavy metals being discharged into the YS River during both wet and dry weather. The most abundant metal species discharged from GJ were manganese, aluminum and iron with different contributions of wet and dry weather flows to the total discharge load. Wet weather flow was a significant contributor to the annual dissolved metal loads, accounting for 44–93% of the annual load depending on the metal species, with the exception of chromium and cadmium (9% and 27%, respectively). Mostly, metal loads during wet weather were shown to be proportional to the rainfall depth and antecedent dry period. A substantial fraction of metals were also associated with solids, suggesting that sedimentation might be an appropriate management practice for reducing the metal load generated in GJ. Overall, although dissolved metal concentrations in YS River were at an acceptable level for aquatic community protection, continual metal discharge throughout the year was considered to be a potential problem in the long-term due to gradual water quality degradation as well as continuous metal accumulation in the system.

1. Introduction

As point sources have been successfully controlled over the past several decades, non-point sources have become the leading cause of impaired receiving waterbodies. Non-point source pollution is caused by a variety of natural and anthropogenic pollutants that are delivered into receiving waterways and waterbodies by means of overland flow, percolation or return flow, and urban runoff during both wet and dry weather.

Managing dry and wet weather urban runoff has been of primary concern for many municipalities as a means of improving receiving water quality and to meet water quality regulations (Moilleron et al., 2001; McPherson et al., 2005). Dry weather urban runoff occurs without measurable precipitation, resulting from groundwater inflow, permitted discharge, and human activities including car washing, irrigation, street washing, and construction activities involving water use. On the other hand, wet weather urban runoff ("urban storm runoff") occurs during storm events and is typically responsible for a greater amount of pollutant discharge due to an increase in flow energy that mobilizes pollutants deposited on the urban catchment surface. As such, urban storm runoff has been recognized as a prime cause of non-point source discharge such as heavy metals, polycyclic aromatic hydrocarbons, nutrients, and other toxic compounds of anthropogenic origins (US EPA, 1995; Characklis and Wiesner, 1997).

Of great concern have been high concentrations of heavy metals in urban runoff (Barrett et al., 1998; Furumai et al., 2002; Kayhanian et al., 2003; McPherson et al., 2005). Although trace amounts of heavy metals can naturally occur, short and long-term exposure to elevated concentrations of heavy metals may damage human health and aquatic life. Heavy metals lack transformation or decay mechanisms (Chapra, 1997), and thus can accumulate in environmental media (e.g., sediment layers) or tissues of living organisms through the food chain; as a result, they become a potential pollutant source and deteriorate

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doi:10.1016/j.scitotenv.2009.02.021