Assessment of Pollutant Loads of Runoff in Pretoria, South Africa

Josiah Adeyemo, Durban University of Technology, South Africa
Folasade Adeyemo, Durban University of Technology, South Africa
Fred Otieno, Durban University of Technology, South Africa

ABSTRACT

Pollutants in stormwater are detrimental to the receiving water bodies. The study of pollutants in stormwater is important to know the appropriate management techniques to remove these pollutants. This paper presents an explorative study of runoff in Pretoria, South Africa. Common pollutants in stormwater are studied to determine their correlation with total suspended solids found in four different sites in Pretoria. The metals are strongly correlated with total suspended solids. It is suggested that treatment of pollutants by treating or removing solids may be extended to other heavy metals and nutrients to improve stormwater quality. In this study, some contaminants are identified to be associated with traffic volume. In this paper, the authors suggest that efforts should be made nationally and internationally to redesign vehicular products to eliminate the traffic contaminants in stormwater.

Keywords: Ecological Technology, Heavy Metals, Pollutants, Total Suspended Solids, Water Quality

INTRODUCTION

Stormwater can be defined as all the water that falls on roofs, roads, driveway, parks or anywhere that runoff occurs following rainfall events. This water usually finds its way to creeks, rivulets, rivers and estuaries. Significant pollutant loads are collected and transported in stormwater. These pollutants cause poor quality of stormwater entering into drainage system. The sources of these pollutants are highly urbanized or commercial environments and tips and refuse collection areas through litters. The pollutants due to nutrients are found from detergents, fertilizers, decaying organic matter, sewage and biological wastes, dissolved or associated with particulate loads, animal faeces, sewage overflows, illegal or inadvertent cross connection between sewer and stormwater systems are another sources of pathogens. Sediments in stormwater are found due to erosion, construction/development sites, road/footpath wear and disturbance or loss of ground cover. Hydrocarbons and other organic contaminants

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are found due to vehicle wear and emissions, spills and illegal discharges, industry, sewage and atmospheric deposition.

Construction is performed yearly at hundreds of our highway and freeways sites. New roads are constructed while old ones are repaired. Roads are tarred while some roads are graded. All these activities contribute significantly to stormwater pollution. Moreover, construction works are also done by building new houses, office complexes and bridges. Because construction site activities differ significantly from highway/freeway activities, the stormwater runoff water quality characteristics are expected to differ as well. Sediment load from the active phase of construction was clearly the highest solids event mean concentration of 15,000 mg/L, seven times higher than any other phase of construction (Owens et al., 2000). Kayhanian et al. (2001) reported the findings on stormwater runoff from highway construction sites in California. In other study, fifteen highway construction sites were monitored to assess the water quality of stormwater runoff existing from the sites. The findings of this study suggest that caltran’s construction site runoff constituent concentration detected during the study are less than typical caltran’s and non-Caltran’s highway runoff constituent concentrations with the exception of total chromium, total nikel, total phosphorus, total suspended solid (TSS) and turbidity.

Heavy metals, e.g. lead (Pb), zinc (Zn), copper (Cu), cadmium (Cd), polycyclic aromatic hydrocarbons (PAH), mineral oil hydrocarbons (MOH) and readily soluble salts in runoff are partly regarded as hazardous to water (Pitt et al., 1994). The distribution or concentration of these pollutants depends on the characteristics of the surface, and the dry and wet atmospheric depositions (Förster, 1996, 1999). The concentration of TSS and turbidity are likely due to the disturbed soils present at most construction sites. Also, the origin of the high concentrations of total chromium, total nikel and total phosphorus concentration was unknown. Concentrations of these constituents varied between sites so it is possible site-specific soils and vegetative conditions may have contributed to the concentrations of these constituents. (Kayhanian et al., 2001)

Another group of typical urban pollutants are metals. The contaminants are heavy metals, including lead, copper, cadmium, zinc, mercury, and chromium. The sources of these contaminants are industrial activities and waste, illicit sewage connections, asphalt, automobile wear, exhaust and fluid leaks, atmospheric deposition, leaching of water supply and stormwater delivery systems. Metals can also be mobilized by other chemical changes such as a reduction in dissolved oxygen content. Metals may reach the water column directly, or may be discharged with sediment and subsequently be released into the water column. The effects are increased toxicity of runoff and accumulation (biomagnification) in the food chain. The most abundant heavy metals in stormwater are lead, zinc and copper, which together account for about 90% of the dissolved heavy metals and 90-98% of the total metal concentrations (Livingston, 1988). Metals (such as copper, cadmium, and zinc) can be present in a dissolved form as well as a particulate form. Consequently, very good removal efficiencies (60-95%) can be obtained in properly designed stormwater management practices (Livingston, 1988). Drapper et al. (1998, 1999, 2000a,b) reported the findings of a study of road runoff pollutants around Brisbane, Southeast Queensland. Data from road runoff samples was analysed in terms of traffic volume, pavement surface type and other site characteristics. The findings of this study suggest that areas of rapid deceleration, such as traffic lights and turning lanes, results in increased concentrations of Cu, Zn and Pb, possibly due to poor fuel consumption and rapid braking. It was also found that lead concentrations have a strong positive correlation to levels of total suspended solids (Drapper et al., 1999).

Drapper et al. (2000b) and Duncan (1999) reported a significant positive linear relationship between lead and zinc concentrations and traffic volume. While these findings support Makepeace et al.’s (1995) statement that most heavy metals, including copper, show a positive correlation with vehicular traffic intensity,
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