# Statistical Tool to Address the Influence of Urbanization in Groundwater Quality in Colombo District, Sri Lanka

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**ABSTRACT:** Management of groundwater quality is becoming a key feature of a sustainable future while implementing sustainable development goals which are given by United Nations. During past decades, rapid land-use changes, urbanization, and population expansion are highly influenced the groundwater quality. To provide policymakers and water managers with reliable information on groundwater quality is a challenge to achieving sustainable development goals in developing countries. Therefore, this study intended to assess the spatial variability of groundwater quality using selected physicochemical parameters at the 39 available groundwater wells during the southwest monsoon period. Spatial variability is explained in 13 Divisional Secretariat Division (DSD) levels in Colombo district due to easier interpretation and management purposes. Afterward, groundwater quality was related to urbanization using population density and built-up density in 13 DSD levels in Colombo district, Sri Lanka. PCA (Principal Component Analysis) shows that 08 DSD levels are urban and 05 DSD levels are rural. pH (3.22–6.73), COD (8.91–52.9 mg/L), $BOD_5$ (1.2–9.9 mg/L), and DO (2.17–5.05 mg/L) showed deviations from the given standards by local authorities in Sri Lanka. A significant relationship ($p < .05$) was found between urbanization and physicochemical parameters in regression analysis. The water quality index shows poor water quality indices in urban areas and *vice versa* in rural areas which is similar to the results obtained by statistical analysis. A sustainable urban development plan with continuous groundwater quality monitoring is necessary to protect groundwater resources in Sri Lanka.

**KEYWORDS:** Colombo district, urbanization, groundwater quality, PCA, sustainable development

**TYPE:** Original Research

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## Introduction

Spatial distribution of groundwater is higher than the surface water while temporal variability of groundwater is less than the surface water. Groundwater is less exposed to pollution than surface water. However, restoration or clean-up procedures are extremely difficult and expensive in case of pollution. Even though many natural and anthropogenic pollution triggering factors are available, they can be varied in different countries due to their geographical location and development status. There are many direct and indirect associations between urbanization and groundwater degradation because groundwater contamination in the urban environment is influenced by various numbers of potential contamination sources (Misra, 2011).

Domestic, commercial, and industrial wastes from urbanized areas are among the prime sources of pollution (Azzellino et al., 2019; Bougherira et al., 2014; Villholth & Rajasooriyar, 2010). On the other hand, increased agricultural use of fertilizers and pesticides are major threats to groundwater quality in rural areas (Elhatip et al., 2003; Hildebrandt et al., 2008; Jeyaruba & Thushyanthy, 2009). These pollutants can percolate into aquifers through seepage and contribute to polluting the groundwater (Kuruppuarachchi, 2012; WHO, 2011). Groundwater resources are widely used for domestic, agriculture, commercial, and industrial purposes, and hence, the demand for groundwater is steadily increasing in Sri Lanka (Herath, 2007; Rajasooriyar et al., 2013). Such large demands on groundwater have caused exploitation and at the same time, groundwater quality in the Colombo district is triggered by both natural and anthropogenic sources (Gunawardhana et al., 2002; Herath & Ratnayake, 2007; Mahagamage et al., 2015; Rathnasri & Manage, 2016). But the monitoring and management of groundwater resources have not been prioritized by the authorities.

Statistical tools are successfully utilized by researchers for analyzing spatial distribution of the physicochemical characteristics of groundwater over large areas. In addition, many studies have integrated statistical techniques and approaches to establishing strategies to manage groundwater resources (Arulbalaji & Gurugnanam, 2017; Gulgundi & Shetty, 2018).

Therefore, this study aims to assess the groundwater quality by analyzing the selected physicochemical parameters and correlating them with urbanization in the Colombo district.

## Methodology

### *Study area*

Rapidly urbanizing Colombo district in western province, Sri Lanka was selected as the study area (Figure 1a). It consists of 13 Divisional secretariats divisions (DSDs) and a total area extent of about 699 $km^2$. The total population is about 2,375,000 according to the 2015 statistics. Western part of the study area is exposed to the ocean and other directions of the study area are exposed to landmasses of Gampaha, Kegalle, Ratnapura, and Kalutara districts. Drainage network is drained off to the ocean (Figure 1a).