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Assessment of Soil Fluorine Spatial Distribution around Brick Kilns Using GIS Application

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Abstract

Soil fluorine is naturally occurring micronutrient and also considered as essential element for health of humans and animals. But higher concentration of soil fluorine leads to water pollution and cause damages to plants. Brick kilns are one of main source of Fluorine emission in form of Hydrogen Fluoride which accumulate in the surrounding soil. So it is need to identify soil fluorine pollution hotspots necessary for improved and better management. ArcGIS is very useful application for analyzing spatial variation and mapping of pollution. In present study cluster and outlier analysis based on Local Moran Index was used to know the geo-statistically significant hotspots area. For interpolation and prediction, Inverse Distance Weighting method was used to analyze the spatial distribution patter of fluorine in soil around brick kilns.

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Keywords: Moran I; hotspots; spatial variation; cluster outliers; pollution.

1. Introduction

Thousands of poorly regulated brick kilns are working in rural areas of South Asian countries. In fact South Asia has history of 4000 years for brick baking which is a date back to an ancient time. Pakistan is developing country in South Asia famous as home of famous Indus valley civilization which is well known for invented baked bricks by using firewood that ultimately caused extensive deforestation, resulting in to decline of the Indus valley civilization

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[1]. Whereas brick kilns are part of informal sector in Pakistan. Though existing number is not accurately known due to lack of research based data. But some organizations have estimated and compiled some statistics from pre-determined sources [2]. The main reason for the increasing number of existing brick kilns is increasing demand for brick supply due to the rapid growth rate of population and urbanization in Pakistan. It has also been reported that not only Pakistan but all other South Asian countries have poorly regulated brick kilns along peri-urban agricultural areas, which may be a growing but unrecognized environmental problem in the regions of Asia [3]. In Pakistan the volume of the brick industry has been estimated through market sources according to which there are about 12000 brick kilns operational throughout Pakistan. These include Clamps, Moveable Chimney Bulls Trench Kilns (MCBTK) and predominantly the Bull's Trench Kiln (BTK), all of these types are energy intensive as compared to the alternate kiln technologies offered as Hoffman Kiln (only one reported), Vertical Shaft Brick Kilns (VSBK, only three are reported), and only one Modified Bull's Trench Kiln (Indian version) has been reported [1]. In soil and rocks Fluoride is a very common constituent with 650 mg/l in the continental crust and 300 mg/l in the soil [4]. The emission of fluoride compounds from these kilns majorly affects the surrounding agricultural crops and orchards [3, 5-9]. These compounds alter plants' metabolic pathways, cause foliar lesions, reduction in growth, and lead to various ecosystem damages. Fluoride concentration of around 10-1000 times lower than other major pollutants can affect the sensitive species [10]. Geographic information system (GIS) is a computer based application used for modeling and analysis of data by using technique of inverse distance weighted (IDW) method [3]. This is very helpful for mapping pollutant area and their possible sources [11]. In order to get a better view of spatial distribution pollutants, GIS tool is very beneficial by applying on dataset in order to obtain spatial interpolation maps [12]. For brick making specific clay is use commonly known as "Pothwar clay" that has deposited over thousands of years covered Pothwar Plateau [13].

The aim of the present study was to investigate the spatial distribution of soil fluorine around brick kilns through geostatistical application by using ArcGIS 10.2.

2. Materials and methods

Site selection: Study site was Photohar area of Rawalpindi city located between 33° 37' 33.8052" N and 73° 4' 17.1912" E, which is covered with "Photohar clay" used for brick making. Brick kilns were still operational at this site even though this area has been urbanized (Fig. 1). People living around kilns also cultivate crops on their small fields.

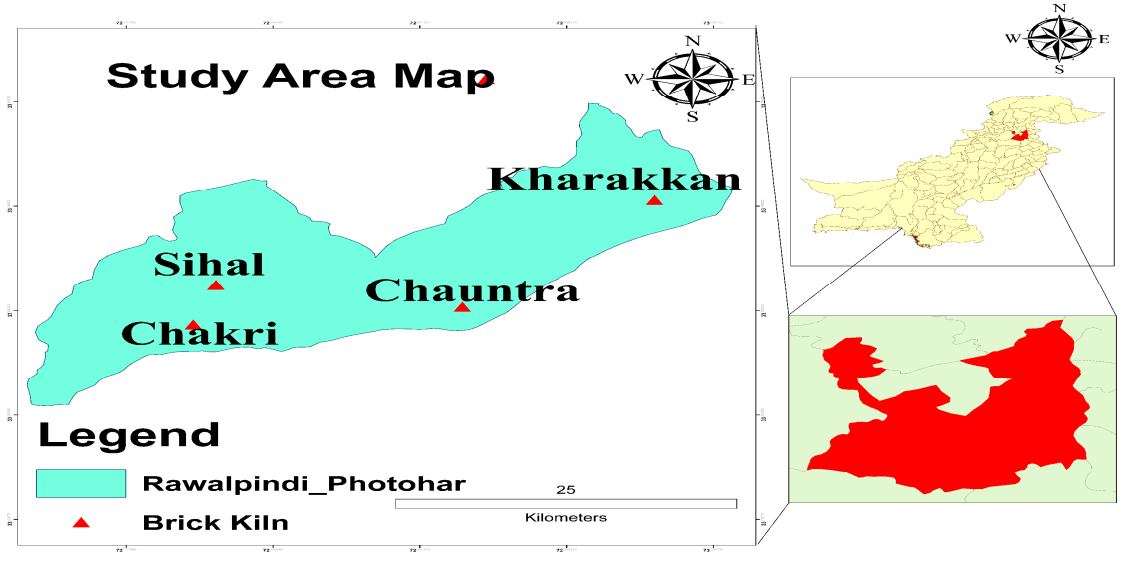

Fig. 1. Study area Map.