A short literature review on impact of cement dust deposition on soil and vegetation's around cement factory

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Abstract

A brief overview of historical background followed by the brief review of earlier investigations carried out on soil pollution from cement dust deposition and effects of pollutants on vegetations. Many studies have been made on the cement dust deposition on soil and effect of cement dust on plants and other natural components at different countries. The cement factories has been recognized to be playing a fundamental role in the producing environmental pollution hazards and imbalances of the environment attributes. Cement dust is a prospective phytotoxic pollutant in the vicinity of a cement plants and creates grave pollution problems causing massive damage to the ecosystem. In this article a short outline of different types of pollutants releasing from cement factory and their effects on soil, vegetations and other environmental components are presented, along with the reviews of studies of various investigators.

Introduction

The rapid industrial growth is causing massive environmental pollution problems. Industrial pollution is caused by the emission of varieties of industrial pollutants in the forms of liquids, gases and solids which affect the physical, chemical and biological conditions of the environment. Cement industry is the one of the 17 most pollutant industries listed by central pollution control board. Pollutants of the cement industry produced the adverse impact on air, water and soil. The three major types of environmental pollution by cement industries are air, water and soil pollution which are dangerous for plants and animals life. Main impacts of the activity of cement manufacturing industries on the environment are the broadcasts of particles and gases. During the last decades emission of these particles has been magnified alarmingly because of expansion of numbers of cement plant to meet the requirement of cement materials for construction of building. Dust particles can enter into soil as dry, humid or occult deposits and can undermine its physio-chemical properties. Sedimentation and deposition of dust particulates on plants and soils is probably the most important source of soil pollution and plant contamination with heavy metals, particularly near industrial zones.

Review on Impact of cement dust on Environmental attributes

A study was done in the SPM (suspended particulate matter) concentration in extensive air of cement factories and reported air pollution by cement dust and lime kiln, deteriorated air quality of approx 100m of area (Mehrotra *et al.* 2001).). Cement industry is a potential anthropogenic source of air pollution. It is a major contributor to dust, sulfur oxides (SO_x), nitrogen oxides (NO_x) and carbon monoxide (CO) in metropolitan areas. Furthermore, it contributes about 5% of the global CO_2, the famous green house gas (Ian and David, 2002).

The pollutant particles can enter into soil as dry, humid or occult deposits and can undermine its physicochemical properties (Laj and Sellegri, 2003). The emissions of cement industry reduce the air quality in areas within 3-4 km radius periphery of the factory. Such emissions can contribute to a wide range of health effects, especially lung and skin cancer, respiratory problems, brain damage, skin irritations, heart diseases, fatigue, headache and nausea. Failing eyesight due fumes is also common in the different working processes of cement area near the factory. (World Development Indicators, 2004). Kiln operations in cement factory and burning of wastes releases cadmium (Cd) into the environment. Cadmium exhaust emitted from processes in form of fugitive emissions or through flue gas system. The major sources of chromium emission to the atmosphere are coal and oil combustion during cement production investigated by Gbadebo, (2007). The pollutants generated during cement manufacturing process contain primarily of alkaline particulates. The main impacts of the cement activity on the environment are the broadcasts of dusts and gases. The industry releases huge amounts of cement dust into the atmosphere which settle on the surrounding areas forming a hard crust and causes various adverse impacts. A huge volume substances released during the production of cement are carbon dioxide, particulate matter (dust), oxides of nitrogen, and sulphur dioxide. Cement dust contains heavy metals like nickel, cobalt, lead, chromium, mercury pollutants hazardous to the biotic environment, with adverse impact for vegetation, human and animal health and ecosystems (Baby *et al*., 2008).

The outcomes demonstrated that PM10 and PM2.5 have surpassed the Jordanian 24 hour standard of 120 µg/m3 during 20 days out of 50 days establish the entire inspecting period. According to an estimation the submicron molecule number focuses in the urban/rural air of Amman–Jordan throughout the spring of 2009 and found that during the morning times of heavy traffic the number fixations were as high as 120 × 103 and 75 ×103 1/cm3 at the urban and rural locales during week after week workdays (Hussein et al. 2010). Cement industry contributes almost 5% of total carbon dioxide released to atmosphere worldwide, which enhanced global warming. PM10 is particulate matter with an aerodynamic diameter up to 10µm, i.e., fine and coarse fraction combined. The diameter of dust particles of PM10 is larger than PM 2.5 i.e. fine dust particles. (Qudais, 2011; Lei et al. 2011). The combustion of coal and tyre are used in cement industry to generate heat energy at 3 C and remaining residue to enhance the strength of the cement. Combustion experiments were conducted using Nelson reactor under controlled conditions in presence of air and nitrogen gas (INOX). The temperature range was varied from 300-1300C. At the maximum temperature around 1300C, the effluent of combustion of both (coal and tyre) fuels was practically devoid (Patil K. et al. 2012). 210 large cement plants account for a have an estimated production capacity of over 350 million tonnes, while over 350 mini cement plants with installed capacity of nearly 11.10 million tonnes, as of 2016. Every industry has both negative and also positive impact on environment and living beings associated with it, negative in terms of associated harmful emissions and positive, in terms of socio-economic development (Ggeorghe and Ion, 2011; Yousefi, 2013). A study was done to estimate the Zn, Pb, Cr and Ni levels in the soil (Frederick, 2014). while another study estimate that the plants of the cement production site posed a potential health hazard to animals that grazed the area and human through consumption of forage and agronomic crops cultivated around the factory by peasant farmers , (Salami, 2014).

A biomonitoring study was conducted in Ravena, Albany County, New York on 185 participants living within 0.7 to 9.9 km from a cement plant. The study was conducted to address community concerns about the probable health impact from the metal emissions of the cement plant. Concentrations of aluminium, arsenic, cadmium, lead, mercury and selenium were measured in blood and mercury in hair samples of the participants. The outcomes were comparable to the general US population and regional population. The researcher concluded that metal exposures to the surrounding community were minimal, and it was unlikely that residents in the vicinity of the cement plant had elevated health risks as a result of exposure to metals (Dong et al., 2015).

Review on impact of cement dust on soil health

An investigation on the changes in some characteristics of the soil due to dust emitted from the cement factories. The comparative analysis showed that the pollution caused an increase of 2.66% in pH, 22.00% in lime, 15.93% in exchangeable cations, and 7.86% in electrical conductivity. These changes resulted in decrease of organic matter content, decrease in field capacity and decrease in wilting point in soil of the polluted areas (Bayhan *et al.* 2002). A studied on the impact of ceramic dust on the soil quality before and after the cultivation by rosemary (*Rosemarinus officinalis* L.) and soybean (*Glycine max* L. CV. Crawford) singly or in competition. It was noticed that ceramic dust may mediate both the synthesis and decomposition of soil organic matter and therefore influence cation exchange capacity; the soil N, P, and S reserve; soil acidity and toxicity; and soil water-holding capacity, An assessment of the impact of cement dust pollution on soil nitrogen status near a cement factory and compared with non-polluted soil, then improve its characteristics (Ali *et al.* 2003). In order to understand the impact of cement dust pollution on the nitrogen status, soil nitrogen, inorganic fractions and soil biochemical processes were examined. A major decrease in total nitrogen content, nitrogen fractions like nitrite and nitrate with significant increase in soil ammonia content were observed in polluted soil near the factory area. Further, the mineralization of peptone nitrogen and oxidation of ammonia nitrogen were significantly decreased in two polluted soils, indicating decreased carbon and nitrogen source for the microbial and plant growth (Shanthi *et al.* 2004). Developing countries are confronted with the huge challenge of controlling the land pollution, specially in the rapidly growing urban centers. land pollution is an major problem in industrial areas which may have an bad effect on the nutrient composition of surrounding upper surface of soils (Cachier *et al.,* 2005). The impact of alkaline dust pollution released from a cement factory on the soil microbial biomass carbon was investigated by using the chloroform fumigation-extraction (CFE) method. Microbial biomass C (C mic) values ranged in the soil of polluted area was from 157.82 to 1201.51 μg g-1 and from 726.70 to 1529.14 μg g-1 in the soil of control area. Soils polluted with alkaline cement dust resulted in significant reductions in C mic levels compared to control soils. Microbial biomass C correlated negatively with CaCO3 content (r = -0.52, P < 0.05) and positively with soil organic C (r = 0.67, P < 0.01). Mean C mic: C org ratio was 2.55 and 3.09 in the polluted soils and control soils, respectively. The decrease in this ratio was an indication of soil degradation in the polluted soils. A significant decrease in the C mic: C org ratio in cement dust-polluted soils also showed that this parameter could serve as a good indicator of soil health (Kara and Bolat, 2006). The relatively high soils content Al, Zn, Cu, Fe, Pb, Cr and Cd were related to anthropogenic sources of cement factory. The pH of soil was moderately to slightly acid (mean 5.8%), total Nitrogen content was low (mean 0.04), and available phosphorus (P) was high (mean 87.43 mg/Kg), organic matter content was moderate (mean 2.54%) ,exchangeable calcium content was moderate to high (3.02 - 7.44 cmol/kg) in the surface soil. Most samples resulted low magnesium content (mean 0.25 cmol/kg), medium concentration of exchangeable potassium (mean 0.27 - 1.38 cmol/kg) and effective cation exchange capacity (ECEC) had low to medium (2.50 – 15.17 cmol/kg) values around Calabar cement company (Ioniobong, 2008). The usual gaseous emissions from cement manufacturing factories to air includes carbon oxides (CO and CO_2), nitrogen oxide (NOx), sulphur dioxide (SO_2), and dust (Pregger and Friedrich, 2009). In a study on dust emitted from cement industries in Oman has shown higher amount of REE and heavy metals in soils within a radius of 0.5 to 2 km around the cement factory (Semhi *et al.* 2010).

A study was carried out particularly to discriminate the effect of cement dust deposition on soil and over the vegetation and its consequent effects on groundnut crop. Calcium, Iron, magnesium, phosphorus, potassium that are prominent in cement dust were found to be higher in concentration in the polluted soil. pH of the soil increased due to the effect of cement dust when compared to control soil (Rajasubramanian *et al*, 2011). An investigation was carried out to study the assessment on effect of cement dust on soil health and reported that many soil properties like pH, electrical conductivity, and calcium carbonate content increased significantly due to effect of cement dust pollution. Similarly the content of calcium, potassium and magnesium increased in the area around cement plant. The cation exchange capacity of the soil also increased from 40.5 to 50.2 meq 100 g^{-1} soil at 5000 m and 50 m distance respectively. The phosphorus content normally decreases from 17.1 kg ha^{-1} at 5000 m to 11.3 kg ha^{-1} at 50 m distance. Whereas the other major and micronutrients like Nitrogen, iron, copper, zinc, manganese and boron observed decreasing trend but the results were statistically non-significant. The content of heavy metal like lead and cadmium increased from 2.08 and 0.030 mg kg^{-1} at 5000 m to 3.63 and 0.055 mg kg^{-1} soil at 50 m distance respectively (Khamparia *et al*. (2012).

The geochemical result of soils showed that most of the metals have values above the USEPA standard except V, Cr, Ni, and Ba, due to the effect of cement factory. Contamination factor and degree (Cdeg) revealed extreme contamination of Mn and Zn. Inter elemental analysis showed a strong correlation between Cr-As ('r' = 0.872) and Ga-v ('r' = 0.936), which reflects the same anthropogenic source. Mean concentration 7.96 g Kg^{-1}, Zn, 0.33 g Kg^{-1} Cu, 215.30 g Kg^{-1} Fe, 80.79 g Kg^{-1} Mn, 2.05 g Kg-^{1} Ni, and 26.91 g Kg^{-1} Co was found around Ashaka cement factory, Nigeria (Wufem *et al*. 2014). A studied was carried out to the assessment of heavy metal contamination of soil and cassava plants near the area of a cement factory in north central, Nigeria and the results showed that mean Cd contents in the soil and control soil samples were 1.22 ± 0.34 and 0.78 ± 0.16 µg/ g respectively, the mean values for Cu, Ni, Pb and Zn concentrations in the soil samples were 3.42 ± 0.70, 0.07 ± 0.02, 8.40 ± 2.48 and 0.04 ± 0.01µg/ g, respectively while for the control sites, the mean values were 0.72 ± 0.09, 0.02 ± 0.07, 0.91 ± 0.04 and 0.02 ± 0.01, respectively (Adejoh, 2016). The assessment of nutrients of tropical soils around a mega cement factory in southwest Nigeria and indicated total organic nitrogen, total organic carbon and heavy metals decreased with increasing distance from the cement factory while there was increase in the amount of soil potassium and soil phosphorous, the results also showed inverse correlation between most of these heavy metals, the pH, and the activities of the soil nutrients are indicative that pollution caused by cement production exhibit a significant effect on soil nutrients and this may invariably affect the quality and condition of the soil of the area (Oludoye & Ogunyebi, 2017).

Review on Cement dust deposition and its impacts on vegetations

A study made on periodic effect of cement dust pollution on the growth of plant species, found encrustation, dust deposition on leaves changes chlorophyll content concentration and also changes their growth rate, and chlorophyll 'a' is more effected by dust than chlorophyll 'b', (Mohammad and Shafig 2001)The decrease in seeds germination with increasing concentrations may be due to toxic effects of metals present in the cement dust which interrupt with the normal synthesis of metabolic products, thus directly affecting the cell division and cell elongation (Singh and Srivastava, 2002). The impact of ceramic dust on the soil properties before and after the cultivation by soybean (*Glycine max* L. CV. Crawford) and rosemary (*Rosemarinus officinalis* L.) separately or in competition. It was observed that ceramic dust may mediate both the synthesis and decomposition of soil organic matter and that is why affect cation exchange capacity, soil acidity and toxicity, soil water-holding capacity, the soil N, S, and P reserve, and then improve its characteristics (Ali *et al.* 2003). 'Malabar Cement Factory', which is situated at Walayar, the foothills of Western ghats, Kerala was chosen for study. The cement kiln emitted from the cement factory get deposits at the rate of 2.43 g/m the vegetation around the factory area. The dust contains large amount of particulate and gaseous pollutants, which can create some physiological and biochemical changes in the leaves of the plants. The continuous deposition of cement dust on the surface of the leaves of the plants decline the chlorophyll content and also acts as a barrier for the photosynthesis process to take place. The dust deposition also result a subsequent reduction of carbohydrates, starch, proteins and amino acids in those leaves when compared to that of with normal leaves. Since the physiological and biochemical characteristics are affected, the productivity of plant gets badly affected (Murugessan, at al. 2004) Dust of Cement-Kiln affects growth of plant mostly by the formation of crusts on different parts like leaves, twigs and flowers. The crusts are formed because some portion of the settling dust contain calcium silicates, which are typical of the clinker (burned limestone) from which cement is made. When this dust is deposit and hydrated on the surfaces of leaves, a gelatinous calcium silicate hydrate is formed, which later solidifies and crystallizes to a hard crust. Physiological misbalance such as reduced growth is finally due to the cumulative effects of the causal factors on the physiological processes is needed for the plant growth and its development (Schutzki and Cregg, 2007). Dust deposition affects stomatal movement, photosynthesis and productivity (Santosh and Tripathi, 2008). The Plants that are continuously exposed to environmental pollutants absorb, accumulate and integrate these pollutants into their systems. It has reported that depending on their sensitivity level, plants show noticeable changes which would comprise accumulation of certain metabolites or alteration in the biochemical processes (Agbaire and Esiefarienrhe, 2009). The leaf dust catching capacities of 14 basic urban greening plants and their associations with surface micro-morphology. Among the all selected plant species, leaf dust catching capacities ranged from 0.23 g m^{-2} (*Trifolium repens*) to 4.51 g m^{-2} (*Pittosporum tobira*). This research concluded that plants with higher dust catching capacities and with leaf micro-morphological properties for example, epidermal cell, sunken stomata and wax can be prescribed for presenting as urban greening plants species, concluded by Wang et al. (2011). Properties of both particles and the vegetation are important to decide their interactions, and subsequently the effectiveness of particle removal to atmosphere Dust capturing capacity of vegetations is depends on their surface geometry, phyllotaxy and characteristics such as cuticle,hair, height and canopy of tree (Prajapati 2012). Element contents in some plant specimens those existed in both 0-100m (high concentration of dust) and 2 km (non- polluted) areas were compared. S, P, K and Cl contents were found to be in high amount in the plants growing in areas 0-100m from the cement factory, compared to same plants grow at 2 km far from the factory, reported by Mutlu *et al.* (2013). A work done on dust pollution from cement industry discharge huge amount of metals and dioxins, changes soil chemical composition and harming land scarps. The vegetation experienced more harms and decreased yield depends on the rate of photosynthesis and just as the amount of chlorophyll content during the dry than wet season Karstensen (2008) and Abril (2014). Cadmium and Mercury are considered as a heavy toxic metal and important pollutant factor for environmental, which are the foremost source of pollution and generate the most hazardous pollutants by the growth of cement industry & cement factories. Whenever the concentration of pollutants exceeds a certain limit, in addition to the human and animals health, it can be contaminated for plants too. This toxicity is connected with the plant growth reduction and then the yield of plant will be reduced and in more extreme conditions leads to death.(Arfaeinia, H. at al. 2016).

Conclusion

Many studies have been made on the cement dust deposition on soil and effect of cement dust on plants and other natural components at different countries. The cement factories has been recognized to be playing a fundamental role in the producing environmental pollution hazards and imbalances of the environment attributes. It has been calculated, that the cement factories are one of the major source of soil pollution that affects the physical and chemical properties of soil in the vicinity of cement plant due to cement dust deposition. It is also concluded that the contamination or degradation of soil due to cement dust deposition influence germination, growth and yield of plants. The most important point of absorb is that we must be concerned with the environment and at least, we would be able to reduce the rate of pollution by the cement industry.

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