Environmental Pollution 187 (2014) 202–205

Contents lists available at ScienceDirect

Environmental Pollution

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

Commentary

Respiratory disease and particulate air pollution in Santiago Chile: Contribution of erosion particles from fine sediments

Pablo A. Garcia-Chevesich [a,b], Sergio Alvarado [c,f], Daniel G. Neary [g], Rodrigo Valdes [b,e], Juan Valdes [b], Juan José Aguirre [a], Marcelo Mena [d], Roberto Pizarro [e,*], Paola Jofré [a], Mauricio Vera [e], Claudio Olivares [e]

[a] Instituto Forestal, Santiago, Chile
[b] Department of Hydrology and Water Resources, University of Arizona, 1133 E. James E. Rogers Way, PO Box 210011, Tucson, AZ 85721-0011, USA
[c] División de Epidemiología, Escuela de Salud Pública, Facultad de Medicina, Universidad de Chile, Santiago, Chile
[d] Universidad Andrés Bello, Santiago, Chile
[e] Facultad de Ingeniería Forestal, Universidad de Talca, Talca, Chile
[f] Facultad de Ciencias de la Salud, Universidad de Tarapacá, Arica, Chile
[g] USDA Forest Service, Rocky Mountain Research Station, Flagstaff, AZ, USA

A R T I C L E I N F O

Article history:
Received 24 December 2013
Accepted 31 December 2013

Keywords:
PM10
Air pollution
Santiago
Erosion
Sedimentation

A B S T R A C T

Air pollution in Santiago is a serious problem every winter, causing thousands of cases of breathing problems within the population. With more than 6 million people and almost two million vehicles, this large city receives rainfall only during winters. Depending on the frequency of storms, statistics show that every time it rains, air quality improves for a couple of days, followed by extreme levels of air pollution. Current regulations focus mostly on PM10 and PM2.5, due to its strong influence on respiratory diseases. Though more than 50% of the ambient PM10s in Santiago is represented by soil particles, most of the efforts have been focused on the remaining 50%, i.e. particulate material originating from fossil and wood fuel combustion, among others. This document emphasizes the need for the creation of erosion/sediment control regulations in Chile, to decrease respiratory diseases on Chilean polluted cities.
© 2014 Elsevier Ltd. All rights reserved.

1. Introduction

Santiago, Chile, one of the cities with the most serious air pollution problems in the world is geographically located surrounded by mountain ranges, leaving the country's capital with no proper air drainage (Rutllant and Garreaud, 1995). As most Chilean cities, Santiago has thermal inversions during winter months (April–August) that make atmospheric conditions highly vulnerable, preventing polluting particles in the air to be dispersed (Garreaud et al., 2002).

Among the most relevant air pollution sources on Chilean cities are vehicles, manufacturing industries, and residential wood combustion. All of them increase their contribution to air pollution, depending on the amount of fuel consumption (Romero et al., 2010). However, fugitive emissions of coarse particulate material are mainly produced due to suspended dust from eroded areas and fields and stream alluvial deposits (Mena-Carrasco et al., 2012; Feng et al., 2011; Garcia-Chevesich, 2008).

Particles in the air disperse or decrease significantly only when precipitation occurs or fronts bring in relatively clear cold air masses, temporally improving air quality. However, this situation continues for a couple of days and air pollution then comes back to pre-rain levels, or even worse. When such phenomena reaches critical levels necessitating environmental alerts, pre-emergencies, or emergencies, hospitals often become overloaded with the increase of respiratory problems among the local population. According to the Chilean Environmental National Commission (Conama) (Comision Nacional del Medio Ambiente (CONAMA), 2009), an average of 20,000 people suffer air pollution-related problems each year in Santiago, causing more than 700 deaths during winter seasons (O'Ryan and Larraguibel, 2000; Jorquera and Barraza, 2012).

According to the country's Environmental Report (Informe País) and many other studies around the world, the most relevant air polluting variable in terms of the population health is PM10s, i.e. particulate material smaller than 10 μ in diameter (Universidad de Chile, 2008; Samet et al., 2000). This important parameter has been documented on an hourly base and at different locations within and around the Santiago basin since the year 1998 due to increasing

* Corresponding author.
E-mail addresses: pablogarciach@gmail.com (P.A. Garcia-Chevesich), rpizarro@utalca.cl (R. Pizarro).

0269-7491/$ – see front matter © 2014 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.envpol.2013.12.028

fossil fuel and wood combustion. On the other hand, worldwide research suggests that wind erosion of soils and sediments is another source that generates particulate material harmful for human health (Hagen, 2004). In fact, fugitive dust is an actual concern in the United States, since PM10s and PM2.5s are regulated by the Environmental Protection Agency (EPA) and are considered important air pollutants (Samet et al., 2000; Feng et al., 2011). Furthermore, wind erosion of soils and sediments, and fugitive dust emissions contribute not only to desertification and loss of soil productivity, but also to the worsening of air quality and visibility (Feng et al., 2011).

2. Santiago's current problems

Despite the situation mentioned above, the Atmospheric Decontamination and Prevention Plan (ADPP) for Santiago, created in 1998, has incorporated countless regulations and norms to decrease air pollution in the capital. Table 1 shows the main efforts generated by the ADPP. The focus of the ADPP has not significantly changed since its creation, considering the fact that the Government continues to focus on improving vehicle and industry emissions. However, little has been done to decrease the major component of PM10: soil (sediment) particles (O'Ryan and Larraguibel, 2000; Universidad de Chile, 2008; Sharratt and Edgar, 2011). In fact, even though Jorquera and Barraza (Jorquera and Barraza, 2012) measured smaller quantities of soil in PM2.5 samples, O'Ryan and Larraguibel (O'Ryan and Larraguibel, 2000) reported that more than 50% of PM10s are represented by soil particles.

Fine sediment: Small diameter soil particles are detached from their origins (i.e. construction sites, agricultural fields, and dirt roads, among others) and transported by water and wind during storm events, to the paved streets of Santiago. Later on, a few days after the rain, when sediments are completely dry, air turbulence produced by vehicles and wind lift again the sediment particles into the air, dangerously increasing PM10 concentrations making the city's air quality worse. This process might also explain why air quality improves when rainfall occurs frequently, since this way sediments remain humid and, as a consequence, wind erosion is not possible. Additionally, it is important to add that soil particles are bipolar, i.e. they have the capacity to transport other chemical compounds, such as SOx, CO, pesticide residues, and fungal spores etc., commonly found on PM10s (Garcia-Chevesich, 2008).

Table 1
High-impact activities to decrease Santiago's air pollution levels, by the year 2001 (Source: Informe País 2008).

Source focus	Main activities
Buses	Removal of 2700 buses with inappropriate air pollution technology Incorporation of 1000 buses with low emissions Post-treatment systems
Large trucks	Removal of trucks with inappropriate air pollution technology Norms EURO III and EPA98 Post-treatment systems
Inappropriate vehicles	Norms TIER I and EURO III
Dust control	Street vacuuming Road pavement
Fuel improvements	Diesel quality 300 and 50 μg m^3 Better home-use fuel qualities
Fire management	Prescribed burn restrictions
New industry regulations	CO emission norms SOx emission norms Program to reduce SOx in major emissions
Compensation and emission permits	Industry's NOx emission limit PM10 emission limits for industrial processes Emission compensation for industry and transportation

Fungal Spores: The pathogenic role of invasive fungal infections (IFIs) related to dust exposure has increased during the past two decades. The most important include Coccidioidomycosis, Histoplasmosis, Paracoccidioidomycosis, and a variety of Opportunistic Mycoses (Colombo et al., 2011; Sifuentes-Osornio et al., 2012). Although endemic mycoses are a frequent health problem in Latin American countries, clinical and epidemiological data remain scarce and fragmentary. Medical scientists have begun to investigate more deeply into the mechanisms of these diseases and their relationship with susceptible populations. Working habits (e.g. agriculture, livestock activities, construction, urban dust sources, etc.) and leisure activities have been the focus of attention by public health officials along with individuals with immunosuppression, as a number of outbreaks of endemic mycoses have been traced to exposure to microorganisms in their natural habitat, soil and dust.

Coccidioidomycosis is an endemic IFI caused by species of Coccidioides. This disease is probably the best understood of the IFIs since it has been well-studied in the USA. It is highly prevalent in arid and semi-arid regions (<600 mm of annual rainfall) with high temperatures. The deserts of the Southwest USA is a type region for Coccidioides species. The natural habitat of the species is 5 cm–30 cm below the surface of alkaline soils. Weather conditions are usually extreme, ranging between 0 °C and 45 °C. The two distinct species are endemic in different regions: *C. immitis* in the San Joaquin Valley in California and *C. posadasii* in Arizona, Texas, Mexico, Central America, and South America. Endemic areas in Latin America include the Sonoran and Chihuahuan deserts of northern Mexico, the Motagua River valley in Guatemala, the Comaya valley in Honduras, the Sierras Pampeanas in Argentina, the Magdalena, Guajira, and Cesar provinces in Colombia, the area of the Great Chaco in Paraguay, and several regions in Venezuela and Brazil.

Increased incidence has recently been reported in Argentina and the United States, mainly owing to migration and new residential construction in high-risk areas. Pulmonary outbreaks usually have been associated with earthquakes, military encampments, agriculture, construction sites, and archeologic excavations The role of urban dusts originating from erosion is poorly documented. In Catamarca, Argentina, the incidence rates grew by 350% from 2006 to 2009. Most cases in the United States and Mexico occur in individuals younger than 5 or older than 55 years while the higher occurrences in South America involve those 25–35 years of age.

Despite knowledge of the above processes, the only activities to reduce soil particles (50% of PM10s) in Santiago have been street vacuuming and street paving (Table 1). Nothing has been done in terms of attacking the problem from its origin, i.e. to control sediment production on sites where vegetation has been removed.

3. International experience

Many countries have implemented the incorporation of sediments among their measurable parameters to control fugitive dust emissions, in order to protect the public health. This fact has improved the efficiency of air quality standards of a number of countries. According to the World's Health Organization (World Health Organization, 2005), an organization involved with environmental regulations of more than 200 countries, the recommended standard for PM10 concentrations is 50 μg m (Romero et al., 2010). However, most countries establish their own limits on air quality, mainly because PM10 and its composition might be a function of local climates, (i.e. annual precipitation, which determines natural plant cover) and natural sediment yields from watersheds. According to Langbein and Schumm (Langbein and

Download English Version:

https://daneshyari.com/en/article/6318332

Download Persian Version:

https://daneshyari.com/article/6318332

Daneshyari.com