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Harmattan dust deposition and particle size in Ghana

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Abstract

In Ghana, a dust-laden Harmattan wind blows from the Sahara from November to March. Some of the dust is trapped in the vegetation, in the lakes and other inland waters, while the rest is blown further away into the Ivory Coast or into the Atlantic Ocean. Several methods have been used to trap the Harmattan dust, mainly bowls with or without water, but also plates or sheets of various materials have been used. This paper compares three different methods to trap the Harmattan dust and describes the differences in amount and particle size distribution of dust trapped in various agroecological zones. The investigation shows that bowls with water trap more dust than plastic mats with 1.5 cm straw which again trap more dust than wooden plates. The bowl values can be used as a measure of the total Harmattan dust deposition, the mat values can be used as a measure of how much Harmattan dust is retained by vegetation, while the plates provide a measure of how much dust is retained on vegetation free areas. The amount of Harmattan dust captured is largest in the north, the amount of dust retained differs significantly from year to year, and a severe Harmattan in the north is not necessary coincident with severe Harmattan in the south. The dust particle size becomes finer towards the south and with increasing amounts of organic matter, and the particle size distribution shows that the major part of the dust trapped is long-term suspended material with a significant input of local dust. The dust particle size is coarser on the mats than in the bowls due to re-suspension from the mats. The presence of diatoms in the samples from Bawku indicates that a substantial part of the dust originates from former lakes in the Sahara. The amount of dust retained in the north gives a deposition rate of about 15 mm per 1000 years. This may explain why loess layers have not developed in Ghana.
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1. Introduction

In West Africa along the Gulf of Guinea, one of the most prominent atmospheric phenomena is the seasonal presence of a dry dust-laden wind, the Harmattan, blowing from the Sahara Desert. In Ghana, the Harmattan wind is active from November to March, when a north-eastern airflow from the Sahara replaces the south-westerly monsoon winds. During that period, storm activities in the Bilma and Faya Largeau area in the Chad basin raise large amounts of dust into the atmosphere, which is then carried southwest by the predominant winds (Kalu, 1979; McTainsh, 1980; McTainsh and Walker, 1982; Cox et al., 1982; d'Almieda, 1986; Afeti and Resch, 2000). As the inter-tropical convergence zone (ITCZ) from December to February is located in the Atlantic Ocean but close to the coast of the Gulf of Guinea, most of the dust will probably settle over land, because particles are captured by collision with rough, moist or electrically charged surfaces, the particles may become charged and form aggregates, which settle back on the ground, there is a reduction in wind velocity or the dust is washed out of the atmosphere (Pye, 1987).

Few investigations have been carried out in Ghana on the Harmattan dust. Afeti and Resch (2000) measured, over a 3-year period at Kumasi in Southern Ghana, the particle size, number and mass concentration in the air by means of a Pacific-Scientific Hiac/Royco 5250A. The conclusion was that the average mass concentration of suspended dust during the Harmattan period reached a value of 134 $\mu g/m^3$, and the corresponding aerosol diameter was 1.16 μm. Their investigation did not determine how much dust had settled on the land surface and how much was blown over the Atlantic Ocean.

Tiessen et al. (1991) investigated some soils in northern Ghana and compared their chemistry with the chemistry of the Harmattan dust captured on plastic sheeting or in funnels between 1 and 5 m above the ground. Some sampling sites were located far away from roads to avoid input of local dust. Others were located close to roads. The general conclusion was that, at sheltered sites far away from the roads, the captured dust is predominantly pure Harmattan dust with a distinct chemical composition very different from that of the local soils. Furthermore, it was stated, that the high base saturation in the soils, calculated as the sum of exchangeable Ca+Mg+K divided by eCEC value, is attributable to a high input of bases from the Harmattan dust, and that the amount of Harmattan dust trapped in the funnels at Nyankpala in the vicinity of Tamale was 15 g/cm^2.

In publications on Harmattan dust, dust samples were collected in many ways, but mostly in different types of containers or funnels, some dry others filled with water or liquid paraffin (McTainsh and Walker, 1982; Tiessen et al., 1991; McTainsh et al., 1997; Adetunji et al., 2001) or on different types of plates (Møberg et al., 1991; Tiessen et al., 1991). The question is which sampling technique gives the most accurate measure of the amount of dust settling on the landscape. Stoorvogel et al. (1997) used a canopy drip method to show that in the tropical rain forest in the Taï National Park in the Ivory Coast, the Harmattan dust deposition was twice as high as the dust captured in a wet basin. This proves that the dust samplers should also reflect the land surface cover as much as possible. Thus, in order to measure the amount of dust settled on the landscape, it is important to use samplers which as much as possible mirror the vegetation cover.

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