Universität Basel

Research Project

South African cropland dust emission risks: physical thresholds, environmental and socio-economic impacts

Third-party funded project

Project title South African cropland dust emission risks: physical thresholds, environmental and socio-economic impacts
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Southern African dust sources have been well documented, feature some of the world's dustiest regions, and disperse dust throughout the subcontinent and beyond. The west coast of South Africa produces dust from coastal pans, river valleys, and deltas in both the Namib and Northern Cape regions. Further East, mine tailings in and around Johannesburg (Gauteng province) are among the most studied dust sources in South Africa due to systematic monitoring efforts and immediate impact on nearby urban air quality. However, few studies have drawn attention to dust originating from South Africa's extensive farmland. These areas appear to be most productive in early summer at the onset of the rainy season as part of cold pool outflows from convective storms over the Free State and Northern Cape. Such ground level events have often been reported by the media, but have gone unmonitored due to their association with cloud and rain events. These associations are different from most other dust events that produce elongated plumes during the clear winter months, particularly in Namibia and Botswana, and disperse throughout the region. Nevertheless, the use of Meteosat MSG clearly suggests that southern African events are not infrequent and not insignificant in extent.

Exposed agricultural lands are thus important dust sources in South Africa, and the supply of fine dust material may be even more pronounced during drought cycles. Such events represent a loss of soil mass at the site of origin, but also impact ecosystem services further afield and, potentially, contribute to climate change. Microbial and chemical contaminants transported by dust from cropland add to the public health concerns with dust originating from farms and reaching urban areas. The research questions of this four-year project thus are: (i) what are the environmental thresholds for generation of dust (wind, soil moisture soil crust) in relation to farmland management? and, (ii) to what extent do farmland dust sources impact ecosystem services, public health, and potentially climate?

This research aims to fill this knowledge gap by using a holistic and interdisciplinary approach spanning geomorphology, land management, and microbiomics. A Swiss - South African partnership of four institutions (University of Basel, Agricultural Research Council, University of Cape Town, and University of Pretoria), which encompasses the necessary expertise, has been formed to conduct this research. The objectives of the project are (i) to identify the spatial and temporal pattern of dust emissions from agricultural land in South Africa, (ii) to determine the environmental boundary conditions for dust emission on South African cropland identified as dust sources, (iii) to identify the impact of land management practices on dust emission and ecosystem services losses, (iv) to identify microbiomics air contamination due to dust, and (iv) to synthetize the above information and produce holistic knowledge on dispersal, impact of dust and thresholds to inform policy in farming systems. Activities and methods will be divided in five interconnected work packages (one WP per objective), using remote sensing of Meteosat and

MODIS satellite imagery to identify and quantify dust sources emitted from farmland (WP1), using a rain and wind tunnel simulator to determine crust formation and dust physical boundaries (WP2), using leaf area index and interviews to identify biophysical and management attributes (WP3), using dust samples to determine microbial population phytogenetics, including impacts of the transport of microorganisms, whether suspended in aqueous aerosols or adsorbed to mineral (dust) particles (WP4), and usingă the results of WP1-4 for a synthesis leading to publish holistic scientific contributions on South African cropland dust emissions, identify farmland management best practices, and inform policy.

Dust emission is a growing issue affecting soil mass losses, ecosystem services, public health, and climate change. Understanding dust emission dynamics originating from farming in drylands is crucial not only to prepare and respond to the aforementioned impacts, but also to secure food production in the best possible conditions using marginal lands, a resource becoming increasingly important for food security of a warming planet.

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