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# Urban Climate and Air Pollution in Ouagadougou, Burkina Faso

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## ABSTRACT

Africa has recently been singled out by UN Habitat as the fastest urbanizing continent in the world. The most extreme case was found in the Sahelian city of Ouagadougou, Burkina Faso, where the population is expected to almost double over the next ten years. It is well known that the rapid growth of an urban area is among the most important anthropogenic impacts on the environment, and that it has a profound impact on both the urban climate and air quality. Few studies have been focused on cities in the Sahel region, and the lack of information may consequently hinder adaptation to the extreme urbanization rates of these often heavily polluted cities.

The main objective of this thesis was to study the nature of, and relationship between, urban climate and air pollution in Ouagadougou, Burkina Faso. Specific objectives were to; examine spatial variations in daily temperature and humidity patterns during early dry season with focus on effects of different land cover; to examine the influence of atmospheric stability on the intra-urban air temperature patterns, the urban wind field and on air pollution levels; and to examine spatial variations in air pollution levels. An additional objective was to document the status and potential development of synoptic meteorological stations in Burkina Faso. Empirical data used in analyses were collected during five field studies between 2003 and 2010. Meteorological and air pollution parameters were measured at fixed sites and through car traverses in areas of different land cover, activity, traffic density and road surface.

The most distinct features in thermal patterns found in Ouagadougou were strong intra-urban nocturnal cool islands in vegetated areas, caused by evening evaporative cooling by the vegetation. Extremely stable nocturnal atmospheric conditions were observed during 80 % of days examined in early dry season, during which spatial patterns in temperature and humidity as well as in air pollution were most pronounced. An intra-urban thermal breeze generating almost opposite wind directions within the city was found during all extremely stable nights. Air pollution situation in Ouagadougou were characterized by; important spatial variations, high pollution levels in general, and extreme levels of coarse particles, commonly exceeding WHO air quality guidelines in all areas. Important sources were re-suspension of road dust, transported dust, traffic and biomass burning. Documentation of meteorological stations show that observations were made by well trained staff following a strict set of procedures. However, many risk factors potentially affecting data quality were found, such as many manual steps in data handling and limited funding for maintenance of the instrument park.

In contrast to the many studies identifying urban built structure as most important land cover parameter for the nocturnal urban climate, vegetation was the dominating parameter in Ouagadougou. The strong influence of vegetation shown in this study should be carefully considered in all urban climate studies, especially in (semi) arid regions. In urban-rural comparisons, this is particularly important for the location of the rural area where vegetation often is dominant. The high frequency of extremely stable atmospheric conditions and the intra-urban thermal wind system show a very restricted ventilation of the urban air and limited dispersion of urban-derived pollutants. Large spatial differences in pollution levels found in the city are likely to create important differences in exposure situation within the population. When using data from synoptic meteorological stations in Burkina Faso, the many risk factors found should be considered. Findings presented in this thesis could used in order to increase comfort and health in urban planning, as well as in development of strategies for air pollution mitigation in this region, especially when considering the ongoing extremely rapid urban growth. The information of status and potential development of observational data may be valuable for more reliable predictions of future changes in climate in the region.

*Keywords: Sub-Saharan Africa, Sahel, (semi) arid, nocturnal cooling, urban vegetation, evening evaporative cooling, cooling rate, atmospheric stability, thermal wind, carbon monoxide, particulate matter, road dust, exposure differences.*