J4.2 **URBAN CLIMATE AND AIR QUALITY IN TROPICAL CITIES**

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1. INTRODUCTION

The urban growths in developing countries require new ways of governance since it brings several concerns into focus. Regarding atmospheric properties, air quality imposes serious threats to the tropical urban environment. Health, marginal habitats and livelihoods of urban populations are at risk from pollution, heat stress and sea-level rise. In many of the African countries air pollution inventories are nearly non-existent, pollution is neither monitored nor controlled, and there are no long-term records of pollution levels and impacts (Fenger 1999).

In 2000 the Southern African Air Pollution and Urban Climate Network was formed in order to promote the importance of air quality and climate for the urban environment in Africa. At the moment the network include research groups from Botswana, Mozambique, Kenya, Tanzania, Burkina Faso and Sweden and the aim is to carry out standardised air pollution and meteorological measurements in the main cities in these countries. The present paper focuses on studies made in Gaborone, Botswana and Dar es Salaam, Tanzania. The capital of Burkina Faso, Ouagadougou, is a third city in which field work will be carried out (figure 1).

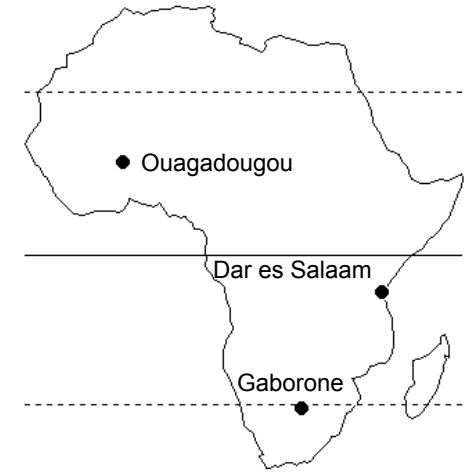

Fig 1. Location of the study areas.

2. RESULTS FROM THE STUDY AREAS

2.1 *Gaborone*

The capital of Botswana, Gaborone, is situated some 100 kilometres south of the tropic of Capricorn with an annual precipiation of 500 mm. The air quality in Gaborone, a city with roughly 200 000 inhabitants, has been studied in several projects (Moloi 2001). The air pollution situation is not alarming at the moment but it should be remembered that Gaborone is one of the fastest growing cities in Africa.

In a pilot study also the urban/rural temperature relationship as well as intra-urban temperature and humidity differences was studied with focus on variations due to building structure and land use. The results showed, in agreement with several other studies in tropical climates (Adebayo 1991, Ali 1999, Jauregui et al. 1992), a strong urban heat island during wintertime.

Analysis of NOAA NDVI imagery showed that the vegetation index fluctuates far more in rural areas than in the city itself on a seasonal basis. Dry grounds with leafless vegetation are more prone to loose heat than irrigated urban areas, thus increasing the UHI. The observed UHI is thought to be higher in winter and lower in summer because of this detected seasonal variation. Large differences in vegetation within the city also contributed to great temperature differences of up to 4 °C as a result of differing evapotranspiration (figure 2). However, the city as a whole does not act as a cold island at any time of the year.

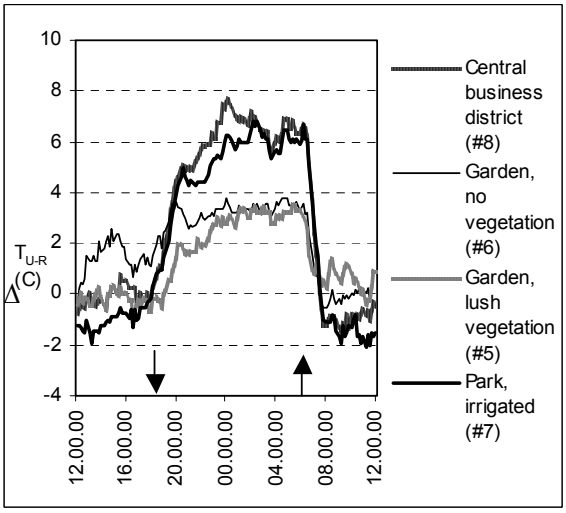

Fig 2. The progression of the UHI at different land uses during a 24 hour period in Gaborone measured by stationary temperature loggers. The weather was clear and calm throughout the period. The arrows indicate sun rise and sun set.

2.2 *Dar es Salaam*

Dar es Salaam, the major city of Tanzania is a coastal humid tropical city which is roughly ten times larger than Gaborone. The annual precipitation is 1000 mm. Dar es Salaam is heavily polluted although the wind pattern is an efficient source of dispersion. The aim of an ongoing study is to investigate the relationships between urban climate

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and the air quality of Dar es Salaam. This has been studied in May 2001 (wet seson) and October 2001 (dry season) in collaboration with Environmental Physics at Chalmers Uiversity of Technology in Göteborg, Sweden.

Measurements of particulate matter as well as SO_2 and NO_X were made at one urban location and at the airport some 15 km outside the city centre. The time resolution of the aerosol measurements was 12 hours, yielding night and day concentrations and sources of the pollutants with TDFXR analysis technique. This data was being processed at the time of writing.

The Dar es Salaam heat island is varying with season as well, but is more dependent of the wind pattern. In figure 3 the UHI for a urban station is plotted with the corresponding wind direction. All values between sun set and sun rise for a two week period in May and October respectively are showed. During May the sea breeze is absent as a consequence of the cloudy, wet season, yielding predominantly southern winds both day and night. October is however the season of a strong sea breeze. During easterly winds, which coincides with the sea breeze in direction, the UHI is weaker (figure 3).

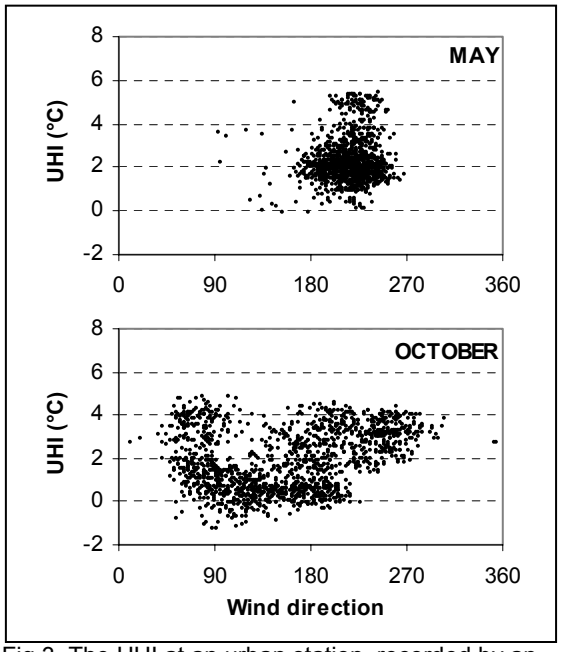

Fig 3. The UHI at an urban station, recorded by an stationary logger, plotted with wind dircection for May and October. All values are calculated from night time measurements.

2.3 *Ouagadougou*

Ouagadougou is a dry tropical city with an annual precipitation of 900 mm. The dry and wet seasons are well distinguished from each other. The Sahelian environment is dusty and the urban situation is worsened by widespread use of light motorcycles. At the time of writing 4 temperature loggers had been placed in Ouagadougou and its surroundings, awaiting an intense field work period in late 2002. Figure 4 shows the mean monthly minimum temperatue for the period 1992-2000. The dry season from November through April shows a higher value than the wet season. The resulting nocturnal UHI is in the range of 3 ºC when all days

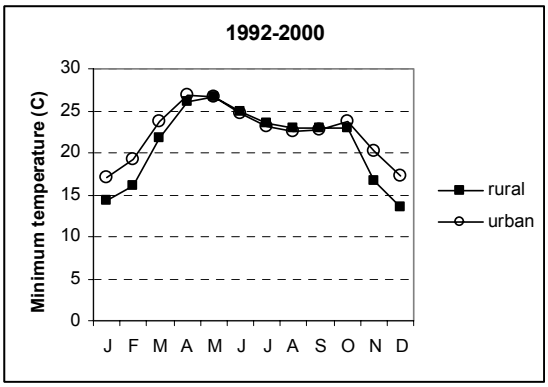

Fig 4. Mean monthly urban and rural minimum temperaure in the Ouagadougou area between 1992-2000.

are included.

3. ACKNOWLEGDEMENT

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