WATER RESEARCH COMMISSION

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TECHNICAL BRIEF

Wetlands

Water use of the dominant vegetation types of the Eastern Shores Area, Maputaland

A WRC-funded study investigated evapotranspiration from the Nkazana Swamp forest and the Mfabeni Mire.

Background

Internationally, our understanding of total evaporation (ET) and the related physical processes are not well characterised for many wetland types. Despite the numerous methods available to quantify wetland ET, it remains insufficiently characterised due to the diversity and complexity of wetland types.

In addition, no single model or measurement technique can be universally applied. This leaves wetland ecologists and hydrologists with some uncertainty regarding the most appropriate methods for estimating wetland ET in water balance studies or environmental water requirement assessments.

In South Africa, much of the focus on ET-related work in water research has been on alien vegetation due to its high water use and impact on the environment. There is a dearth of information on ET from natural vegetation and, in particular, indigenous trees. This is compounded by variable climate, and there is a poor understanding of how far previous research results can be extrapolated to other climatic regions.

During the course of two previous WRC projects there was a need to determine the water balance of the Eastern Shores area of the iSimangaliso Wetland Park. It was, however, apparent that there was little to no information on the actual ET from the different vegetation types of the area. Because ET is such a dominant component of the water balance, there was therefore a critical need to determine and better understand the ET of this vulnerable and protected area in order to improve the management of the system.

Study area

The study area was located in the Eastern Shores section of the iSimangaliso Wetland Park, which was declared South Africa's first UNESCO World Heritage Site in 1999. It lies adjacent to Lake St Lucia and within the St Lucia Ramsar Site designated in 1986. It is a premier tourist destination contributing to the economy of the surrounding communities and the town of St Lucia.

The Mfabeni Mire, the focus area of the project, is a subtropical freshwater wetland that falls within the Indian Ocean Coastal Belt Biome which is a mixed, seasonal grassland community. Quantification of the total evaporation for the Nkazana Swamp Forest and Mfabeni Mire was the primary consideration in this project due to the high water availability and therefore the potentially high ET from these areas.

For purposes of comparison, however, and in order to link the total evaporation of the Nkazana Swamp Forest and Mfabeni Mire to the hydrology of the area at a larger spatial scale it was considered necessary to determine the total evaporation from the most dominant vegetation types beyond those specifically stated in the project proposal but agreed upon at the inaugural reference group meeting.

Five sites were selected describing the dominant vegetation types in the area, namely a:

- Swamp Forest (Nkazana Swamp Forest)
- Reed Sedge Fen (referred to as the Fen site but also known as the Mfabeni Mire)
- Seasonally Inundated Grassland (referred to as Wet Grassland)
- Dune Forest
- Dry Grassland (on the Emboveni dune ridge)

Motivation for WRC project

The health and future conservation of Lake St Lucia is strongly dependent on the water level and the salinity of the water within the Lake, which is controlled in part by freshwater inflows. During droughts, the rivers to the west (Mkuze, Mzinene, Hluhluwe and Nyalazi) provide limited inflow into the lake.

Freshwater seepage from the groundwater mound of the Emboveni ridge on the Eastern Shores area into the Nkanzana and Tewate Rivers and other seepage zones along the shoreline become the most important contribution to the lake. This groundwater seepage from the Eastern Shores area has significant ecological importance and provides refuge sites where

localised freshwater inflows enable many species to survive during periods of high salinity, preventing extinction and loss of biodiversity.

For improved management of the system, accurate water balance studies were required, but were impossible without reliable estimates of ET. The solution was to apply the most appropriate and up-to-date methods to determine the long-term ET for this key strategic wetland, and to use these results to verify existing meteorologically-based models for future use. This would not only reduce uncertainty in the water balance study of the Mfabeni Mire, but also provide guidance in terms of seasonal ET rates over wetlands and lead to an improved understanding of the processes that define how the surface energy balance in wetlands is partitioned.

The project had the following objectives:

- Quantification of ET losses from Nkazana Swamp Forest
- Determination of seasonal trends in ET losses from the Mfabeni Mire in the Eastern Shores area
- Differentiating ET losses of the wetland system from those of their contributing catchment
- Calibration of empirical meteorological models to local conditions.

Methodology

From a micrometeorological perspective the five different sites required different measurement approaches due to different terrain and vegetation heights and structures. Two temporal scales of data collection were used (short term 10-14 day field campaigns and long-term monitoring). Scintillometry and eddy covariance techniques require frequent maintenance and were most effectively run for representative window periods – in this case August and November 2009, and March 2010.

Long-term measurements of sapflow using heat pulse velocity (HPV) systems, soil profile water content (time domain reflectometry and watermark sensors) and surface energy flux measurements (surface renewal) were installed for long-term monitoring as these were able to operate unattended for extended periods of up to six weeks.

Results

Despite their spatial proximity to each other (< 6 km), the average daily ET was variable between sites and across seasons. In all cases the average daily ET was lowest in August 2009 (winter) and highest in March 2010 (summer). The results between field campaigns were all significantly different except at the Dry Grassland and Dune Forest between November 2009 and March 2010 where confidence intervals (one standard error) for average daily ET values overlap, indicating that there was no significant difference in ET values between these data.

The Swamp Forest daily averages were highest for all three field campaigns followed by the Fen, Wet Grassland, Dry Grassland and Dune Forest sites.

The results showed that reference evaporation (ET_r) without specific crop factors was a poor indicator of the total evaporation at all of the sites, and that there was no consistent relationship with the measured ET. For example, the Swamp Forest ET (2.7 mm day^{-1}) was lower than ET_r in August 2009 (3.2 mm day^{-1}) but higher in November 2009 (3.8 mm day^{-1}) and March 2010 (4.5 mm day^{-1}). At the Fen site, however, the ET was lower than the ET_r during all three window periods.

The long-term measurements of climatic variables and ET at the Fen and Dry Grassland sites showed that intermittent cloud cover reduced the available energy. Despite plentiful water and a subtropical environment, wetlands and their surrounding landscapes are not necessarily the high water users they are frequently perceived to be. Even high windspeeds characteristic of the site did not raise the ET due to the low evaporative demand of the air.

The ET at the Dry Grassland and Dune Forest were shown to be limited by plant available water. The Dune Forest consists of mainly evergreen trees and even in winter after frontal rain the ET increased due to the plant available water increase. The tree roots are concentrated near the surface in order to optimise water uptake from the smallest of rainfall events. In contrast, the ET at the wetter sites, such as the Swamp Forest and Fen sites, is controlled by available energy although there was some plant senescence at the Fen site in winter.

This study clearly showed the invaluable contribution that can be gained from field-based measurements. Prior to this study, there was no ET information for the five dominant landscapes of the Eastern Shores area, which is now provided in this report. This will certainly assist in the future management of the iSimangaliso Wetland Park water resources to ensure the sustainability of the invaluable ecosystems.

It was also shown that the different vegetation types have significantly different water use. This implies that changes in land use brought about by climate change or management of the system (for example, by fire) will impact the water balance of the area. The implications of land use and climate change should therefore be a consideration in the management plans of the area.

Further reading:
To order the report, *Water use of the dominant natural vegetation types of the Eastern Shores Area, Maputaland* (**Report No. 1926/1/12**) contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za to download a free copy.