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Groundwater in the wetlands of the Okavango Delta, Botswana, and its contribution to the structure and function of the ecosystem

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Abstract

The Okavango Delta of northern Botswana is a large (40,000 km^2) alluvial fan located at the terminus of the Okavango River. The river discharges about 10 km^3 of water onto the fan each year, augmented by about 6 km^3 of rainfall, which sustains about 2500 km^2 of permanent wetland and up to 8000 km^2 of seasonal wetland. Interaction between this surface water and the groundwater strongly influences the structure and function of the wetland ecosystem. The climate is semi-arid, and only 2% of the water leaves as surface flow and probably very little as groundwater flow. The bulk of the water is lost to the atmosphere. The Okavango River also delivers about 170,000 tonnes of bedload sediment and about 360,000 tonnes of solutes to the Delta each year, most of which are deposited on the fan. Bedload is deposited in the proximal, permanent wetland, whilst much of the solute load is deposited in the seasonal wetland. Notwithstanding the high evapotranspirational loss, saline surface water is rare. Between 80 and 90% of the seasonal flood water infiltrates the ground, recharging the groundwater beneath the flood plains and the many islands on the flood plains. The remainder is lost by evaporation. This groundwater reservoir is transpired into the atmosphere by both aquatic vegetation on the flood plains and terrestrial vegetation on the islands, and the water table is steadily lowered following passage of the seasonal flood. Trees, which are almost exclusively confined to islands, are particularly important, as they lower the water table beneath islands relative to the surrounding wetlands. There is therefore a net flow of groundwater towards islands. Accumulation of dissolved salts in this groundwater leads to precipitation of solutes (mainly of silica and calcite) in the soils beneath island fringes and the islands grow by vertical expansion. Islands are thus an expression of the chemical sedimentation taking place on the fan. Sodium bicarbonate accumulates in the groundwater beneath island centres, and this impacts on the vegetation, leading ultimately to barren island interiors. Dense saline brine thus produced subsides under density-driven flow. This cycling of seasonal flood water through the groundwater reservoir thus plays a key role in creating and maintaining the biological and habitat diversity of the wetland, and inhibits the formation of saline surface water.

Keywords: Okavango Delta; Groundwater; Groundwater recharge; Transpiration; Salt accumulation

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1. Introduction

The Okavango Delta of northern Botswana (Fig. 1) is arguably the most pristine of Africa's large wetlands. The rivers, which feed the wetland are unregulated and therefore its natural hydrological regime is intact. The malarial mosquito and tsetse fly that are prevalent over much of the Delta have ensured that no large-scale human settlement occurred historically. Moreover, it is remote from population centres in the region and hence did not attract the serious attentions of colonial developers. The wetland has therefore escaped the impact of large-scale agricultural development. In recent years much of the Delta has been demarcated for conservation or regulated sport hunting, and it supports a thriving tourist industry. Notwithstanding the Delta's relative remoteness, it has been well documented: the United Nations, and the staff of the Departments of Water Affairs, Surveys and Mapping, and Wildlife

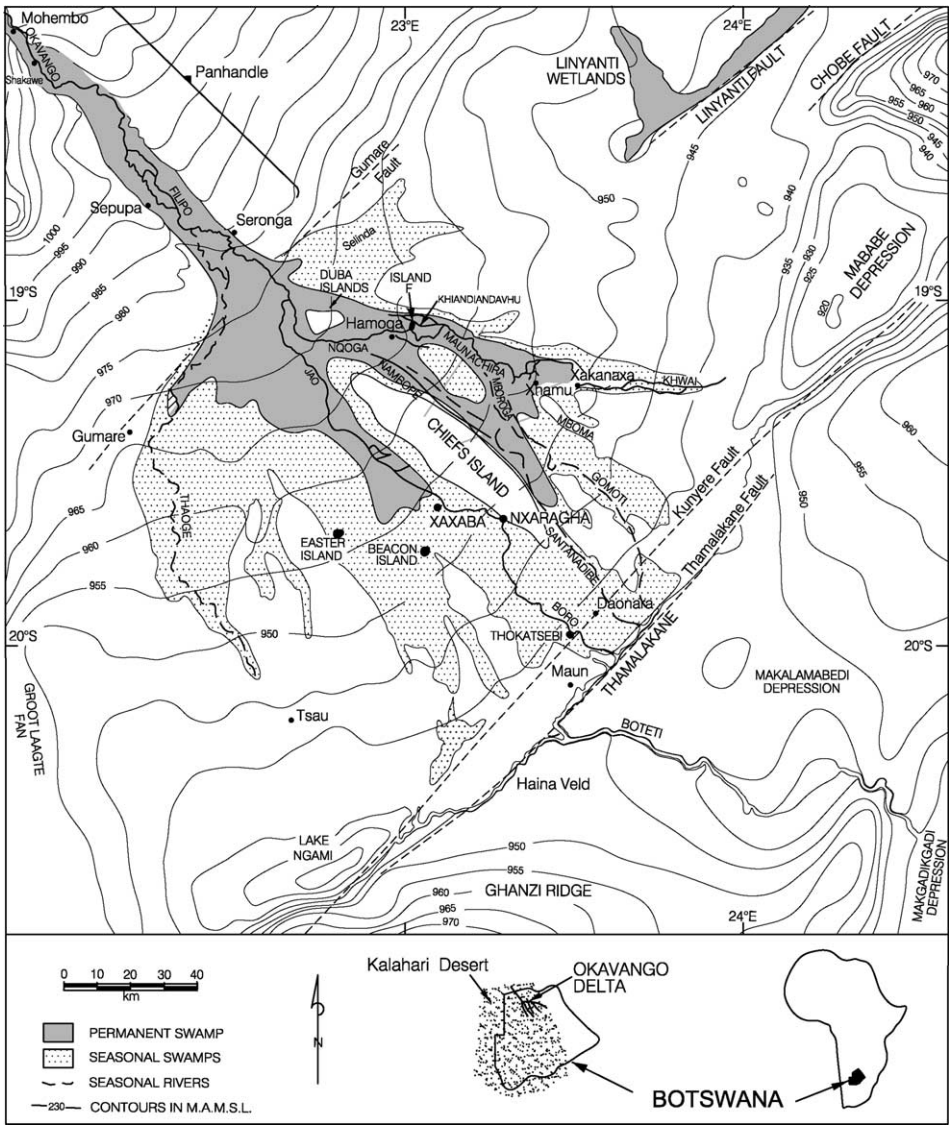

Fig. 1. Location of wetlands in, and the physiographic setting of, the Okavango Delta.