

# Agricultural Frontiers and River Basin Dynamics: Water Accounting of Cocoa-Driven Nature Loss

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African river basins are increasingly shaped by the complex interplay between agricultural expansion, land-use change, and water resource dynamics — a challenge that lies at the heart of socio-ecological sustainability across the continent. In Ghana, cocoa production has long driven deforestation and encroachment into protected areas, yet the resulting hydrological implications and unauthorized water consumption remain poorly quantified. This study, conducted under the Transforming Agrifood Systems in West and Central Africa (TAFS-WCA) initiative by CGIAR, addresses this gap by proposing a novel modeling framework that links land-use change to water accounting in the Pra Basin — Ghana's largest southwestern river basin, covering approximately 23,200 km<sup>2</sup> across five regions and representing a critical intersection of agricultural pressure and ecological sensitivity.

The framework integrates open-access Earth observation data, global geospatial datasets, and the Water Accounting Plus (WA+) framework to quantify water availability and consumption associated with cocoa production and protected-area encroachment over the period 2004–2020. Results show that the basin receives an average of 1,430 mm/year of rainfall, with 88% consumed as evapotranspiration, yielding a total water consumption of 29 km<sup>3</sup>/year. Cocoa production accounts for 30% of this total: monoculture cocoa dominates (84%), while agro-protected cocoa — representing encroachment into legally protected landscapes — contributes 14%, and shaded cocoa consumes only 2%. Within protected areas, agro-protected cocoa drives 24% of total water consumption, with 1.22 km<sup>3</sup>/year classified as unauthorized, highlighting a significant governance and socio-ecological challenge for African river basin management. Water productivity of cocoa is low and spatially variable, ranging from 0.019 to 0.061 kg/m<sup>3</sup> across regions.

These findings contribute to an emerging evidence base on the socio-ecological dimensions of water management in African river systems, demonstrating how commodity-driven land transformation translates into measurable hydrological impacts and biodiversity risks. By situating unauthorized water use within the broader dynamics of agricultural expansion and protected area governance, the study offers actionable insights for policymakers and basin authorities seeking to balance food security objectives with sustainable water and ecosystem management across West Africa.

**Keywords:** *water accounting; cocoa; deforestation; Pra Basin; Ghana*