IWMI
International Water Management Institute

Project Brief

Flowing Insights: Unleashing Remote Sensing Data and Water Accounting for Informed Water Management in the Volta Basin

Summary

The Problem: *The full potential of the water resources of the Volta for hydropower, irrigation, fisheries, and more is not being fully harnessed for poverty alleviation and economic development. Yet environmental degradation is occurring. Improved water management is vital, but limited data on water poses a challenge.*

The approach: *The Digital Innovation for Water Secure Africa (DIWASA) initiative of the International Water Management Institute is motivated to address water data scarcity issues through the water accounting plus (WA+) framework. The Water Accounting Plus (WA+) is a tool that tracks water inflows, outflows, return flows, and storage, providing an in-depth understanding of water availability, distribution, utilization, and household pollution within the Volta Basin. Remote sensing products are used as inputs, thereby overcoming data scarcity challenges.*

What do we learn from the Volta Basin WA+ study (2010-2019)?

- *The Volta Basin received a generous annual net inflow of 384.4 km³, predominantly through precipitation. There is, however, high seasonality, with much of the basin's precipitation occurring in the wet season (May to September).*
- *Groundwater reserves are being tapped at an average rate of 14.6 km3/year. This is likely during the dry season when many small tributaries in the basin dry up.*
- *Protected areas are pivotal in maintaining natural hydrological processes and preserving water quality. They account for 45 km3 of evapotranspiration.*
- *About 42% (19.6 km3) of exploitable water (45.9 km3) resources are untapped and available to be used. This presents opportunities for new development for poverty alleviation, increased water conservation (through reduced groundwater exploitation), or more water reserved for environmental flows.*
- *Water that cannot be recovered due to pollution is about 25% of the basin outflows showing that more investment in water purification is needed in the basin, along with efforts to curb pollution.account for 45 km3 of evapotranspiration.*
- *There is a trade-off between environmental flows and other water uses and any increase in water use can impact the environment negatively. The reserved flows now meet dry season low flow environmental requirements but if high flows are desired, more of the exploitable water will have to be reserved for this.*

The Volta Basin is home to over 20 million people in West Africa. Covering a vast area of approximately 400,000 km², this vibrant ecosystem is made up of a network of rivers that not only shape the region's diverse landscape but also nurture the socio-cultural and economic fabric of six riparian nations: Burkina Faso, Ghana, Ivory Coast, Mali, Togo, and Benin.

Man watering crops in the Volta Basin, using watering cans for more efficient use of water (*photo*: IWMI).

Challenges in the Volta Basin

Environmental and water challenges in the Volta Basin arise from a mix of physical and governance-related issues. The climatic conditions of the basin vary significantly from north to south, marked by an increasing density of vegetation and precipitation. Accordingly, the priorities of the riparian nations differ - while irrigation dominates water use upstream in the relatively dry north in Burkina Faso, hydropower production dominates other water uses downstream in Ghana, which lies in the wetter south.

Unfortunately, environmental threats to water quality and availability are prevalent due to illegal small-scale mining, invasive aquatic species, erosion and river sedimentation. There is also high dependence on groundwater, with little oversight. Changes in water quantity and quality in the Volta tributaries tie closely to socioeconomic fortunes. These changes are further exacerbated by the impacts of climate change, which has resulted in more severe but less predictable water shortages, protracted drying of rivers, and frequent flooding. Existing in-situ measurements are unable to fully capture this dynamic picture of the basin and this is where Water accounting (WA+) using remote sensing data come in.

The Water Accounting Plus (WA+) model

The Water Accounting Plus (WA+) framework is an open-source framework that uses publicly available remote sensing data for tracking water inflows, outflows, return flows, and storage, providing an in-depth understanding of water availability, distribution, and utilization (Karimi et al. 2013). This is a modified version of a simplistic water accounting framework (Molden and Shaktivadivel, 1999).

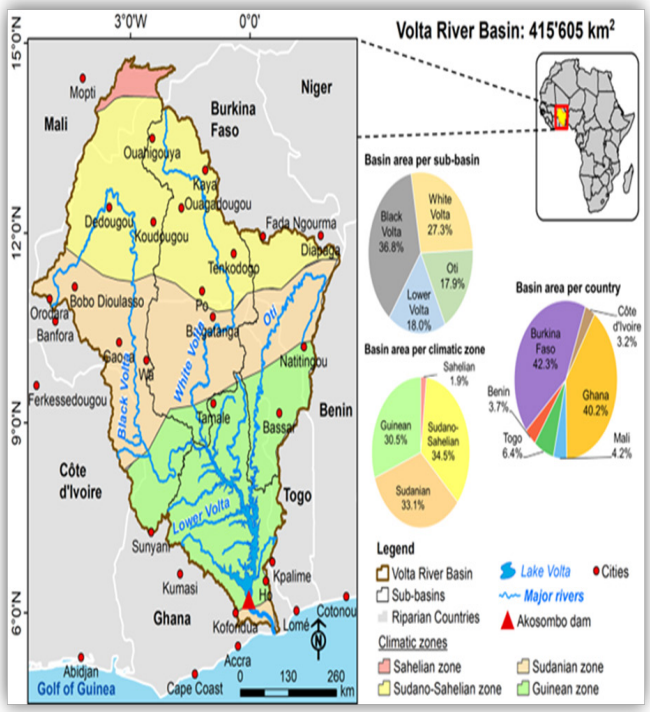

Figure 1. The Volta Basin The Volta basin (source: Dembele et al., 2023).

Flooding in Ghana caused by excess spillage of the Bagre Dam in Burkina Faso (top left); Water pollution due to land degredation of the White Volta (top right); Chemical pollution of the black Volta River due to illegal mining (bottom left); Drying of small reservoir due to climate change (bottom right) (*photo*: IWMI).

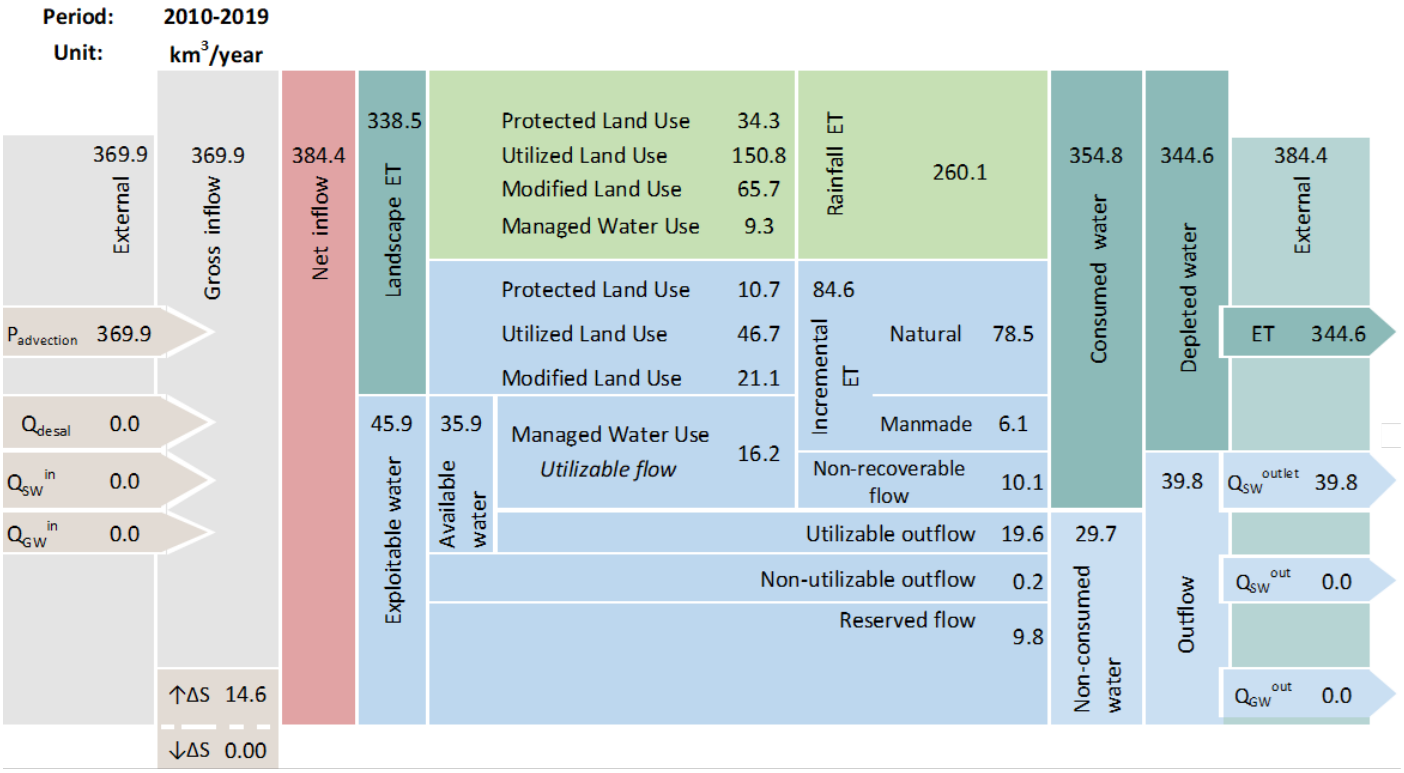

Figure 2. Resource base sheet summarizing major water accounting indicators for the Volta Basin, 2010-2019.

What Water Accounting Plus (WA+) of Volta from 2010 to 2019 shows

On average, from 2010 to 2019, the Volta Basin received a generous annual net inflow of 384.4 km³, predominantly through precipitation. A positive storage change indicates groundwater reserves are being tapped at an average rate of 14.6 km³/year. This is likely during the dry season when many small tributaries dry up.

Legally protected and managed zones, such as national parks and wetlands, accounted for about 45 km³/year of water use. Of these, about 25% of water is consumed from shallow groundwater sources (blue water ET). Also, water use from areas like forests, grasslands, and wetlands consume up to 197.5 km³ (Utilized Lane Use), even though their management isn't strictly controlled. However, the protected areas and natural landscapes are pivotal in maintaining natural hydrological processes and preserving water quality.

Though relatively small, annual irrigation water use of 6.1 km³ play a significant role in maintaining food security in the basin. The Modified Land Use areas - where human activities like rainfed agriculture, urban development, and infrastructure construction alter the natural hydrological processes - account for a sizable chunk (86.8 km³) of the basin's water balance.

Water that cannot be recovered due to pollution is about 25% of the basin outflows showing that more investment in water purification is needed in the basin, along with efforts to curb pollution. The basin's utilizable water resources, amounting to around 19.6 km³, present significant opportunities for new/future developments, water conservation or increased reserved flows. Also, proper planning and management of the utilizable flows (19.6 km³) can reduce the dependence on groundwater resources during dry season. With careful planning and sustainable practices, these utilizable flows can be used to bolster the region's socio-economic progress without compromising the ecosystem's health. However, the development of new projects in the basin should not be done at the expense of environmental flows. For now, the reserved flow constitutes 9.8 km³ of the total water accounting. This reserved flows now meets dry season low flow environmental requirements but if higher flows are desired, more of the exploitable water will have to be reserved for this.

These findings underscore the utility of WA+ as a robust tool for expeditious water resource estimation at a basin level, especially within regions grappling with limited data availability. The water accounting framework and remote sensing datasets offer an invaluable insights into water resources, bolstering decision-making processes in data-scarce territories.

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Contacts

Abdulkarim Seid, Project Leader (DIWASA) and Country Representative, IWMI-Ethiopia (a.seid@cgiar.org)

Naga Velpuri, Senior Researcher - Water Accounting and Productivity, IWMI, Sri Lanka (n.velpuri@cgiar.org)
Afua Owusu, Post Doctoral Fellow, IWMI-Ghana (a.owusu@cgiar.org)
Komlavi Akpoti, Post Doctoral Fellow, IWMI-Ghana (k.akpoti@cgiar.org)

IWMI Ghana

PMB CT 112 Cantonments,
Accra, Ghana
Tel: +233 302 784753/4 or +233 544 088 277
Fax: +233 302 784752
Email: iwmi-ghana@cgiar.org

International Water Management Institute

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International Water Management Institute (IWMI)

Headquarters
127 Sunil Mawatha, Pelawatte,
Battaramulla, Sri Lanka

Mailing address:
P. O. Box 2075, Colombo, Sri Lanka
Tel: +94 11 2880000
Fax: +94 11 2786854
Email: iwmi@cgiar.org
www.iwmi.org

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