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Integrating farmers' perspectives and scientific knowledge to manage transboundary river basins sustainably: A case study of the Sio Malaba Malakisi river basin

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Background

Land Under Pressure: The Case for Conservation in the SMMRB

Soil erosion threatens food security, ecosystem stability, and livelihoods, impacting 70% of the population in Sub-Saharan Africa who rely on smallholder farming [1].

Population growth increases land pressure, causing land use changes and degradation [2;3].

A key outcome of degradation is the loss of fertile topsoil, which further degrades water quality [4;5].

Soil and Water Conservation Practices (SWCPs) like terracing are widely promoted to combat erosion [6;7]. but adoption and effectiveness remain inconsistent, especially in data scarce transboundary basins..

The SMMRB, shared between Kenya and Uganda, highlights this challenge.

Survey of 200 farmers:

> 60% report visible soil erosion.

> 92% observe a decline in soil fertility [8].

> These findings highlight the need for spatially informed, locally relevant conservation strategies.

This study uses the Universal Soil Loss Equation (USLE), focusing on the P factor, which quantifies the effectiveness of conservation practices [10].

P factor estimation is often oversimplified using global values due to data limitations [11; 12].

This study, integrates detailed farmer reported SWCP data and geospatial analysis to:

> Predict spatially continuous P-factor maps

> Quantify current erosion risk

> Model a Best Management Practice (BMP) scenario based on local adoption potential and proximity based knowledge exchange within the basin

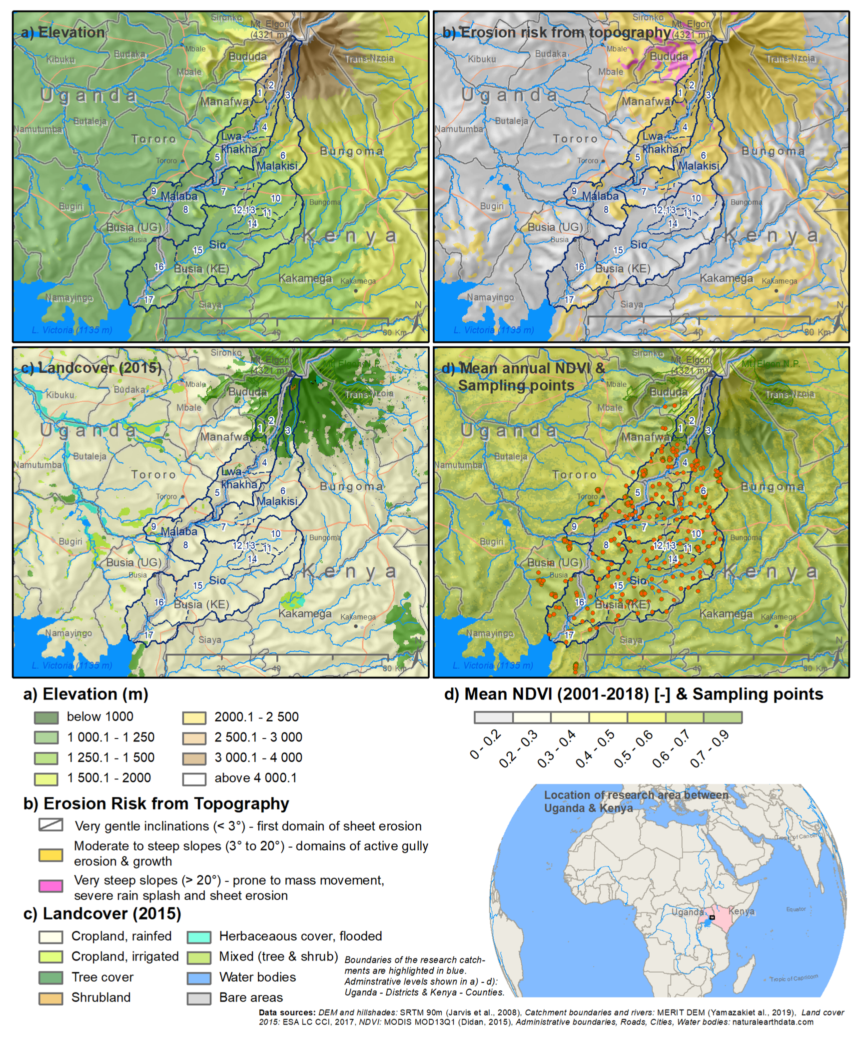
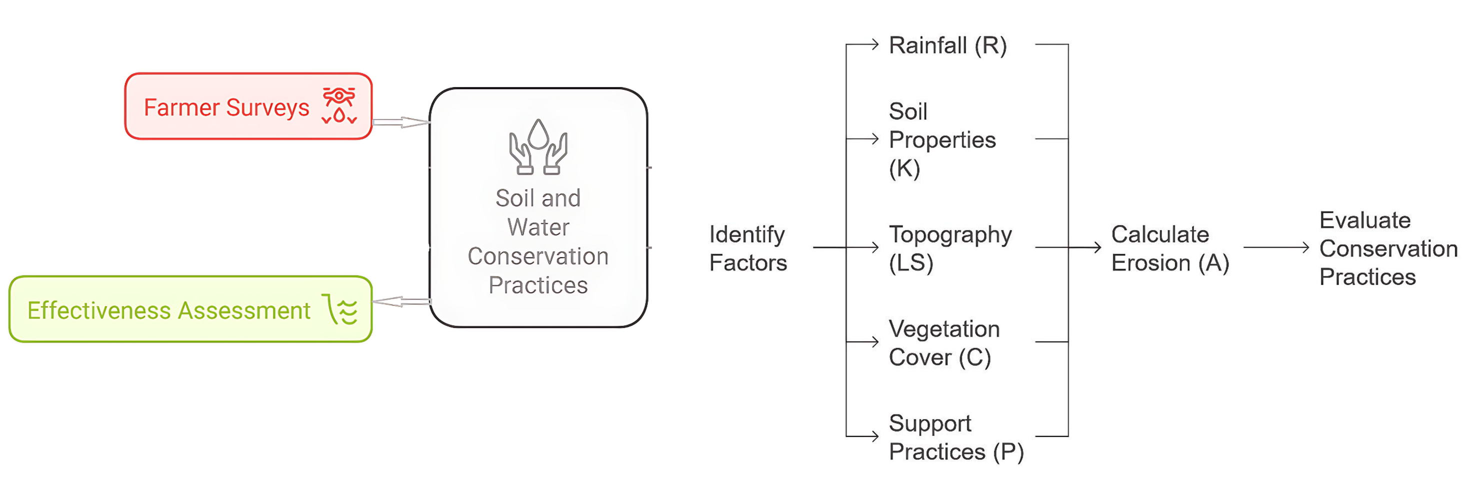
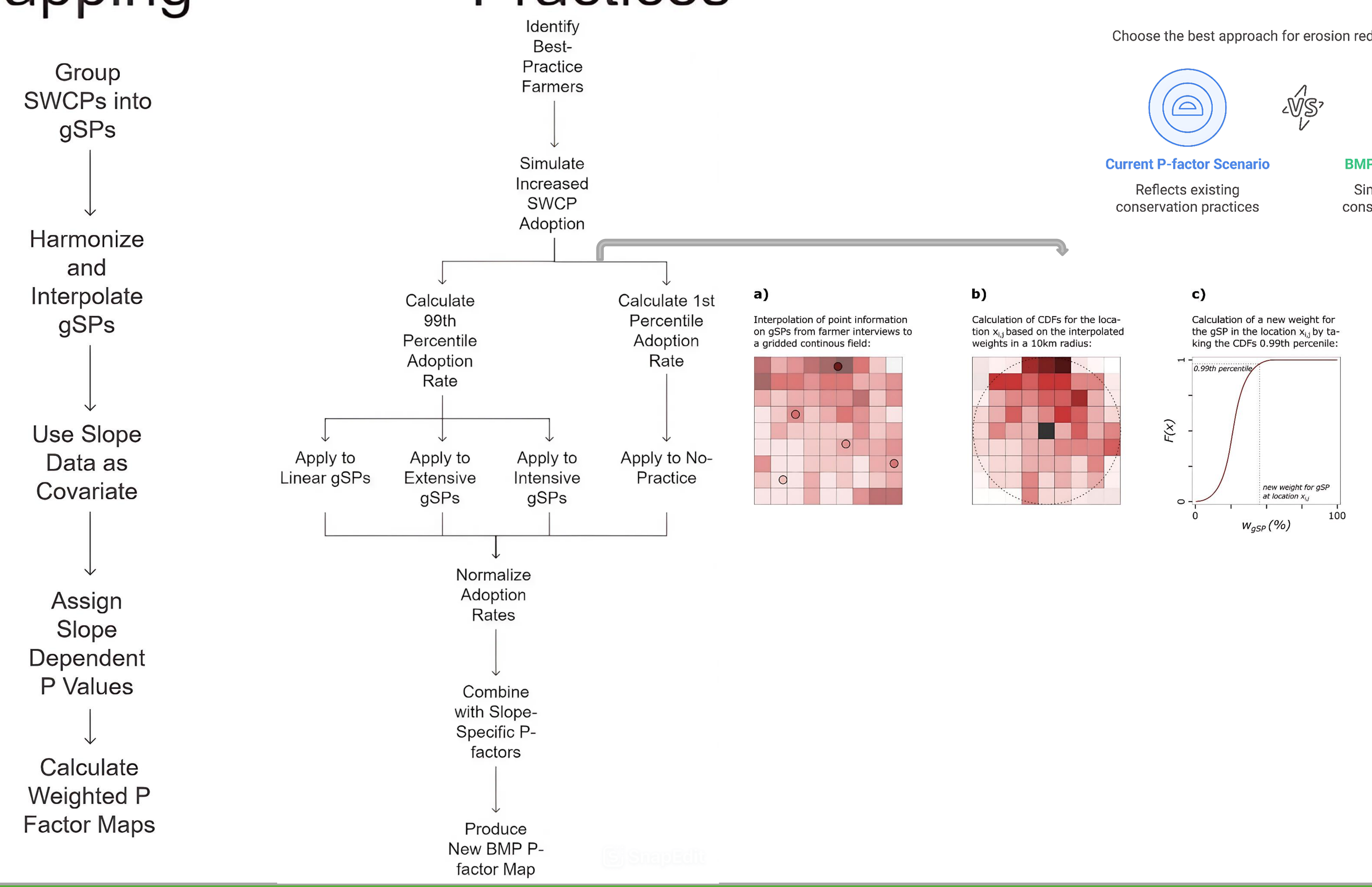


Figure 1: Sio Malaba Malakisi River Basin

Materials & Methods

Farmer Surveys and SWCP Data → Soil Erosion Estimation Using USLE → Spatial P Factor Mapping → Modeling Best Management Practices → Scenario Comparison





Study Area The Sio Malaba Malakisi River Basin (SMMRB) is a transboundary catchment spanning 3,022 km² across Kenya (78%) and Uganda (22%), stretching from Mt. Elgon to Lake Victoria. Home to ~4 million people, 80% of whom are reliant on agriculture—the basin faces severe soil erosion risks due to steep slopes, high population density, and poverty. These factors make the SMMRB a critical site for evaluating the effectiveness of soil and water conservation practices (SWCPs).

Results & Discussion

SWC Adoption Regional Gaps & Potential

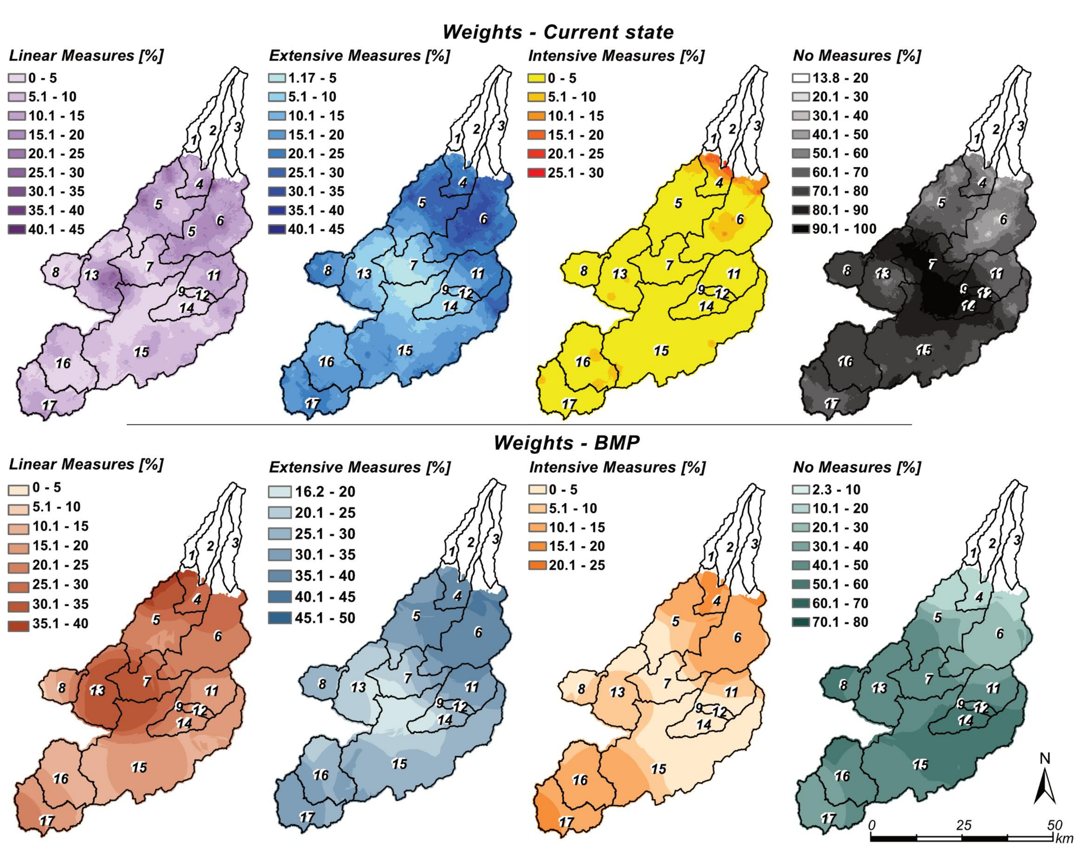


Figure 2: Comparison of P factor Weights Before and After BMP Adoption

> Under current conditions, 76% of the basin lacks SWCPs.

> The BMP scenario based on regional knowledge sharing and adoption of "best practice" techniques reduces this to 44%

> With significant gains in linear and extensive practices.

Support Practices improves the P factor

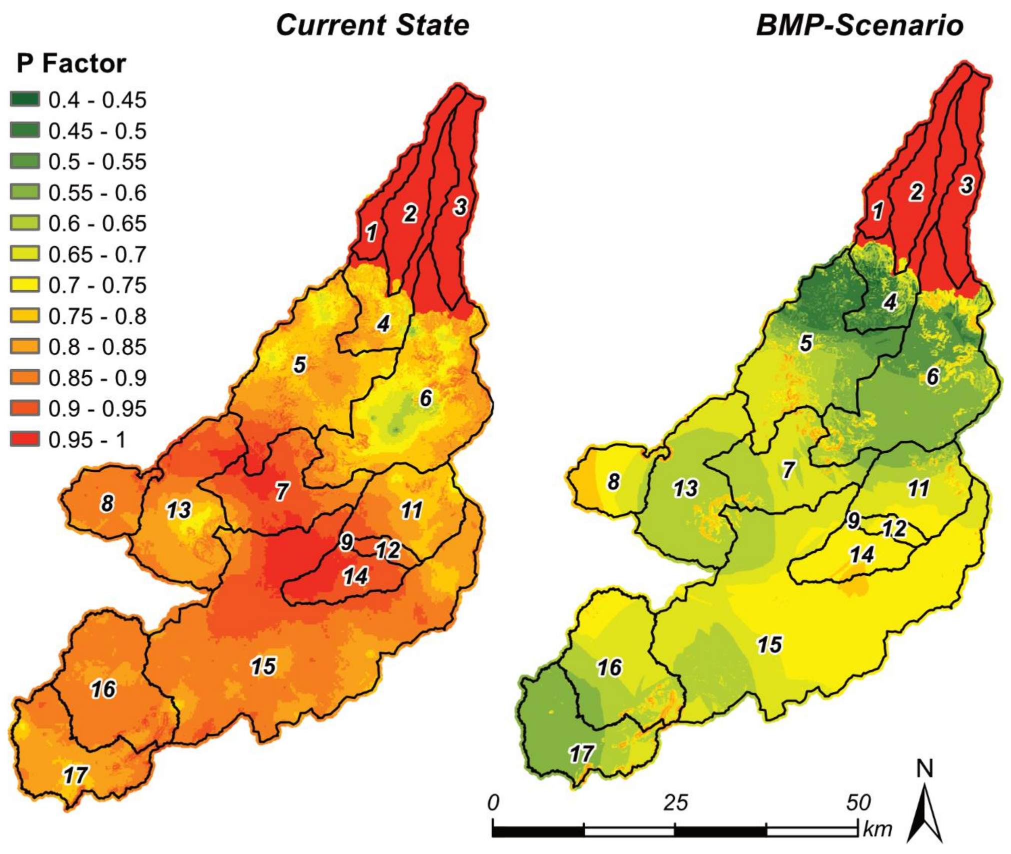


Figure 3: P-Factor Maps – Current vs BMP

> The average P-factor improves from 0.85 to 0.66 under the BMP scenario

> Suggesting widespread erosion risk reduction.

> Steep sub-basins near Mt. Elgon benefit most from increased terracing, showing the value of slope sensitive interventions.

Support Practices Reduce Erosion Risk

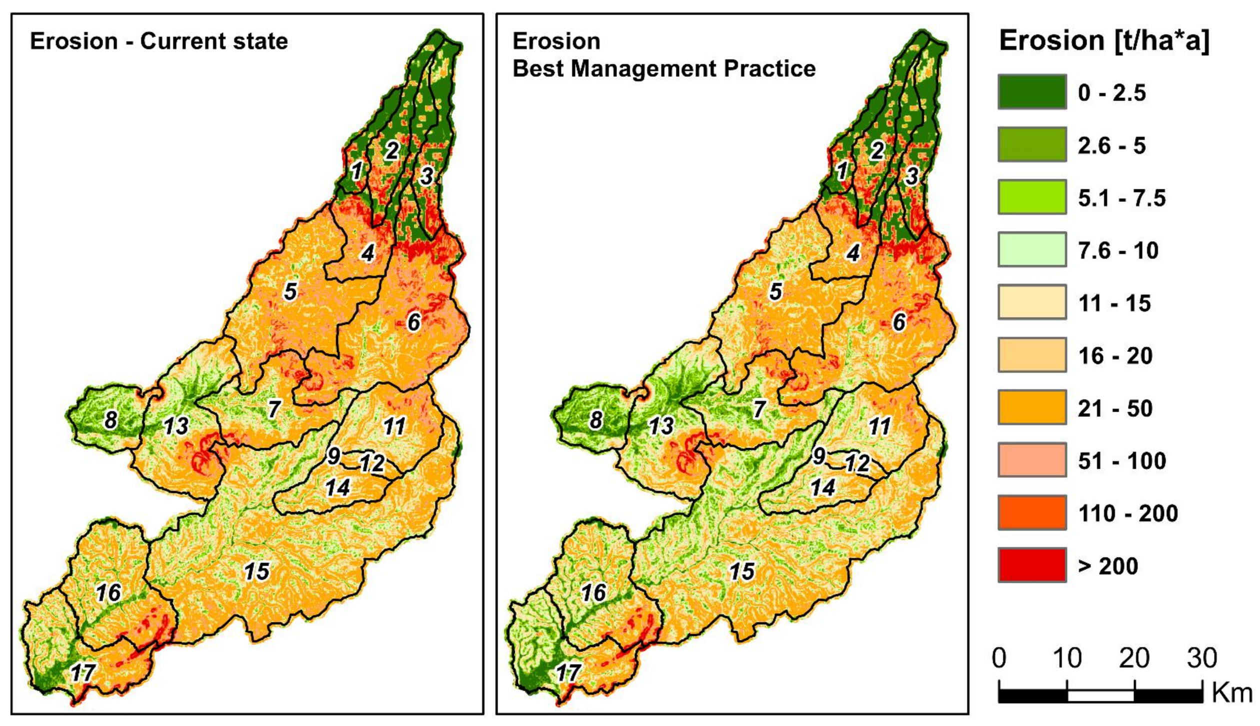


Figure 4: Soil Erosion Estimation Maps

Current State

> Average soil erosion: 40.7 t/ha/year

> Range of erosion across the basin: 0 to >200 t/ha/year

> Severe erosion (>50 t/ha/year) affects significant areas of the basin.

After BMP

> Average soil erosion under BMP scenario: 26.6 t/ha/year.

> 25% reduction in areas with severe erosion; Increased adoption of best-practice SWCPs leads to a significant reduction in erosion risk

Conclusion & Recommendation

This study demonstrates that scaling farmer-informed practices through data-driven, spatially targeted approaches offers a replicable and sustainable model for erosion control in data-scarce, transboundary regions. By reducing soil erosion by 25% and improving P-factor values, contributing to improved food security and farmer livelihoods. The results are consistent with successful models in the Lake Victoria Basin, where targeted conservation practices reduced erosion by up to 30%. However, the true potential of this model lies in its adaptability to regions with diverse agricultural practices and climatic conditions, offering a scalable solution for global erosion control. This study shows the importance of participatory science in shaping sustainable land management and policy action, and provides a pathway for scaling these practices across other transboundary river basins.

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References

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