American Journal of Water Resources, 2026, Vol. 14, No. 1, 8-16
Available online at http://pubs.sciepub.com/ajwr/14/1/2
Published by Science and Education Publishing
DOI:10.12691/ajwr-14-1-2

Assessing the Impacts of Historical and Future Extreme Precipitations on Reservoir Sedimentation Dynamics: Insights from the Niger River Basin in Northern Benin

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Received December 18, 2025; Revised January 20, 2026; Accepted January 27, 2026

Abstract This study assesses the relationship between extreme precipitations and reservoir sedimentation dynamics in the Beninese portion of the Niger River Basin. Historical daily rainfall data (1980-2020) and future climate projections (2021-2049) from the WRF regional climate model under the RCP 4.5 scenario were analyzed to assess trends in extreme rainfall using the Modified Mann-Kendall test and the Theil-Sen slope estimator. The impacts of changing heavy rainfall patterns on runoff and sediment yield were simulated using the Soil and Water Assessment Tool (SWAT), applied to the Sota catchment. The findings reveal mixed heavy rainfall trends across the study area, with a significant decrease projected under the RCP 4.5 scenario for several stations. The SWAT model showed satisfactory performance for streamflow simulation (NSE = 0.70 during calibration; 0.66 during validation). The historical mean sediment yield was estimated at 18.6 ton $ha^{-1}yr^{-1}$, exceeding commonly accepted sustainability thresholds. Spatial analysis revealed persistent sedimentation hotspots in the southwestern part of the catchment. Future simulations indicate an increase in runoff but a decline in sediment yield to 12.8 ton ha^{-1} yr^{-1} by 2049. This counterintuitive trend is attributed to a projected shift toward less erosive rainfall regimes coupled with temperature-driven changes in soil surface processes. While providing valuable insights into climate-sediment interactions, these projections are subject to uncertainties from the lack of measured sediment data, the use of a single climate scenario, and the assumption of static land use. Overall, the study highlights the sensitivity of reservoir sedimentation to changes in extreme rainfall and provides a scientific basis for improving sediment management strategies in small dams under future climate change.

Keywords: *heavy rainfall trends, sediment yield, small dams, WRF-GFDL model, hydrological Modeling, Sota catchment*

Cite This Article: Djigbo Félicien BADOU, Audrey Merveille ADANGO, and Chaim Vivien DOTO, “Assessing the Impacts of Historical and Future Extreme Precipitations on Reservoir Sedimentation Dynamics: Insights from the Niger River Basin in Northern Benin.” *American Journal of Water Resources*, vol. 14, no. 1 (2026): 8-16. doi: 10.12691/ajwr-14-1-2.

1. Introduction

Climate change is projected to disrupt hydrological regimes and exacerbate uncertainty in global water supplies, with vulnerable regions like West Africa being particularly affected [1]. To enhance water security, reservoirs have been constructed worldwide to regulate water for hydropower, irrigation, flood control, and domestic supply [2,3,4]. However, the long-term functionality of these vital infrastructures is threatened by reservoir sedimentation.

In West Africa, where small dams are critical for agricultural production, pastoral activities, aquaculture, and domestic water supply, this threat is acute. In the Sahelo-Sudanian region, sedimentation processes are strongly influenced by climate variability, particularly shifts in extreme precipitations, which accelerate soil erosion and sediment delivery to reservoirs [5]. An observed intensification of heavy rainfall events across parts of sub-Saharan Africa [6,7,8] signals a potential acceleration of catchment degradation and sediment yields. Nevertheless, the specific contribution of extreme precipitations to sedimentation dynamics remains poorly documented in many basins.

This knowledge gap is pronounced in the Niger River Basin of northern Benin, which hosts approximately 87% of the country's small reservoirs [9]. Existing local studies have either quantified sedimentation rates [10,11] or analyzed sediment contamination [12]. Recent hydrological assessments have focused on long-term rainfall trends or water quality [13,14,15] but have not explicitly examine how extreme precipitation patterns modulate sediment yield and reservoir infilling. As a result, a significant knowledge gap persists regarding the sensitivity of reservoir sedimentation processes to climate-induced changes in rainfall extremes. Furthermore, the temporal evolution of sediment accumulation under future climate scenarios remains unquantified, limiting adaptive management capacity.

This study addresses these gaps by examining the relationship between extreme rainfall patterns and reservoir sedimentation dynamics in northern Benin. We employ historical climate data and Weather Research and Forecasting (WRF) model projections to analyze trends in daily precipitation extremes for the period 1981-2049. Subsequently, we use the Soil and Water Assessment Tool (SWAT) to simulate resulting streamflow and sediment yield, evaluating how projected changes in rainfall intensity may alter sedimentation rates in the Sota catchment, a representative area with multiple small reservoirs.

Our work provides a process-based assessment of how catchment-scale sediment export responds to current and future rainfall extremes. Specifically, it contributes to regional hydrological research by: (i) quantifying historical and projected trends in extreme rainfalls; (ii) evaluating the implications of these trends for catchment sediment yield; and (iii) identifying potential hotspots of future reservoir sedimentation risk. The findings are designed to inform sustainable management and resilience planning for small dam infrastructure in this climate-vulnerable region.

2. Materials and Methods

2.1. Research Area

The study area encompasses the Beninese portion of the Niger River Basin, which is geographically defined by the longitudes 1°50'-3°45'W and the latitudinal range of 10°0'-12°30', covering a total area of 39,726 km^2 (Figure 1) [16]. The region features a Sudano-Sahelian climate in the north and a Sudanese climate in the south. It is characterized by a unimodal rainfall regime, with a single rainy season from April to October followed by a dry season from November to March [18]. The mean annual precipitation is approximately 936 mm [19], while daily maximum wind speeds can reach 9.5 m s^{-1} per day [16]. The mean minimum and mean maximum temperatures are 21.5°C and 34.6°C, respectively. According to the Comprehensive Data Repository of the Benin Water Directorate of 2019, the area contains 73 dams, accounting for 87% of the country's small dams [17].

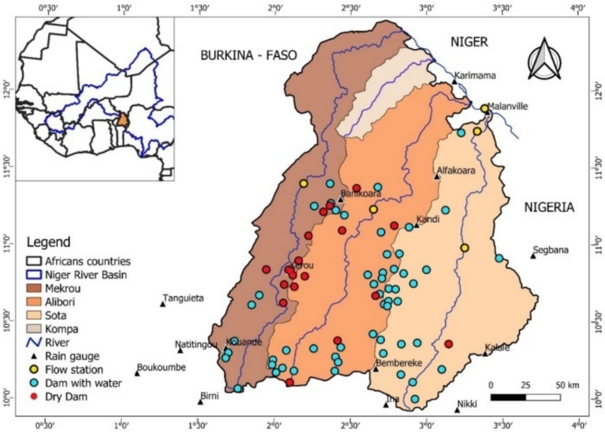

Figure 1. Map of the Niger River Basin in Benin showing the locations of rain gauges, hydrometric stations, and dams, classified by water presence status during the inventory of November-December 2019.

2.2. Data

The data used in this study are presented in Table 1. The climatic stations employed in this study, along with the associated percentage of missing data, are presented in Table 2.

Table 1. Data used in the study

Type of data	Characteristics	Purpose	Source
Historical climate data	Rainfall series of 18 rains gauges (1980 - 2020)	Determination of historical heavy rainfall trends Climate input for the SWAT model	Benin Meteorological Agency and MERRA-2 reanalysis/NASA^a
	Temperature, sunshine duration, wind speed, relative humidity (1980-2020)		
Future climate data (RCM datasets)	WRF-Had GEM2 WRF-GFDL (Spatial resolution: 12 km)	Determination of future heavy rainfall trends Climate input for the SWAT model	WASCAL/KIT/IMK-IFU
Hydrological data	Runoff series of two gauging stations (1980-2020)	Calibration and validation of the SWAT model	DGEau Benin
Topographic data	Digital Elevation Model resolution: 30 x 30 m	Defining HRU boundaries Extraction of terrain characteristics	ASTER
Soil map	Soil characteristics: texture, bulk density, organic material content, saturated water conductivity	Defining HRU boundaries	FAO/UNESCO Soil Map of the World
Landuse and land cover data	LULC map of 2020 resolution: 10 x 10 m	HRU boundary identification, root system depth, leaf area density, reflectivity, interception coefficient	WorldCover/European Space Agency

[a] MERRA-2 reanalysis daily maximum and minimum temperatures downloaded from the NASA POWER project for the period 1990-2020 were used to complement ground data.

Table 2. Climatic stations in northern Benin (1980-2020)

Name	Longitude (°)	Latitude (°)	Missing data (%)
Alfakoara	3.07	11.45	4
Banikoara	2.43	11.30	1
Bembereke	2.67	10.20	1
Birni	1.52	9.99	18
Boukoumbe	1.10	10.17	17
Djougou	1.67	9.70	5
Ina	2.70	9.97	12
Kalale	3.39	10.30	3
Kandi	2.93	11.13	0
Karimama	3.18	12.07	8
Kerou	2.10	10.83	35
Kouande	1.68	10.33	5
Malanville	3.40	11.87	3
Natitingou	1.38	10.32	0
Nikki	3.20	9.93	21
Parakou	2.60	9.35	0
Segbana	3.70	10.93	28
Tanguieta	1.27	10.62	8

The data from the stations at Kerou, Nikki, and Segbana were excluded from subsequent analysis due to extensive missing data (>20%), a threshold chosen to minimize potential bias [18].

To address data gaps and given the limited number of rain gauges in the study area, the inverse distance weighting (IDW) method, a deterministic spatial interpolation technique (Equation 1), was selected [16].

$$\hat{z}(u)=\sum_{j}\left(w_j . z\left(u_j\right)\right) \qquad (1)$$

with $w=\frac{1}{d\left(u,u_j\right)^p}\cdot\frac{1}{C}$, $C=\sum_j\frac{1}{d\left(u,u_j\right)^p}$ and $\sum_j w_j=1$

where $\hat{z}(u)$ is the interpolated value at location j, w_j the weight of the observed value at the location j, $z\left(u_j\right)$ the observed value at station j, $d\left(u,u_j\right)$ the distance to station j, and p the weighting power of the inverse distance (between 1 and 3; 2 was taken in this study).

Table 3 lists the gauging stations used in the study.

Table 3. Gauging stations in the research area

Runoff Stations	Longitude (°)	Latitude (°)	Period
Couberi	3.33	11.74	1953-2020
Gbasse	3.25	10.98	1952-2006

2.3. Methods

This study assesses trends in historical and projected heavy rainfall and models their impact on dam sedimentation. Figure 2 gives an overview of the methodology applied.

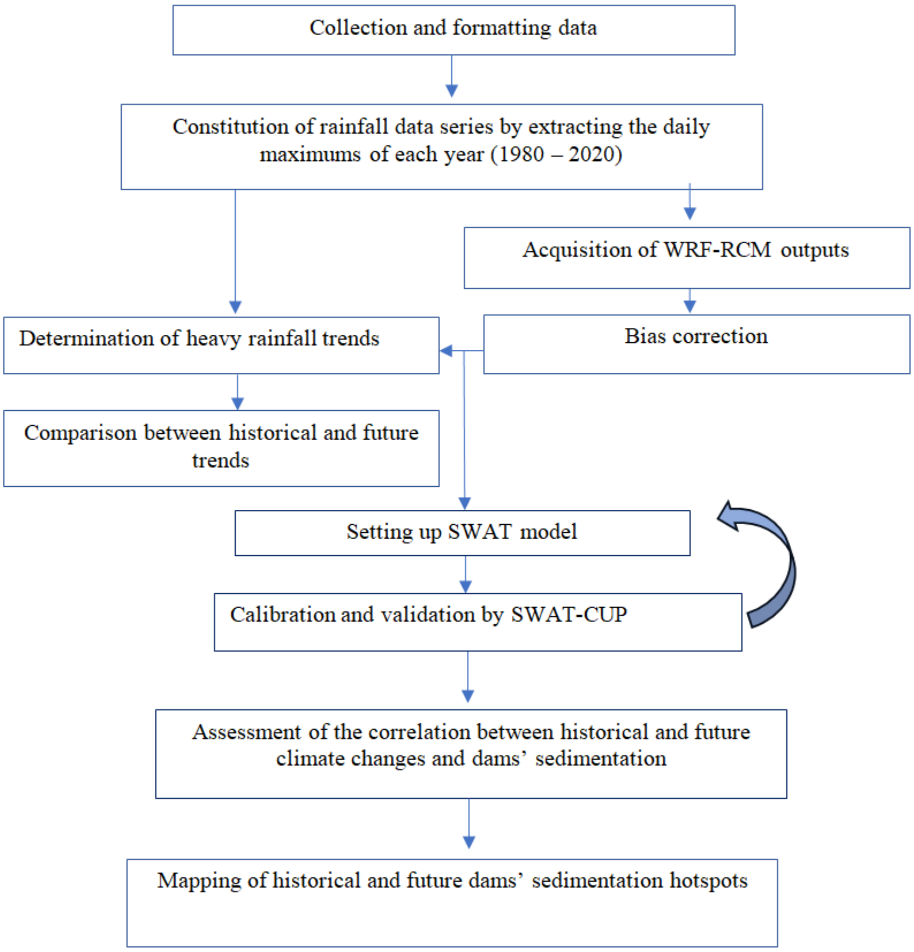

Figure 2. Overall flowchart of the methodology used in this study

2.3.1. Trends Detection in Heavy Rainfall Series

The historical rainfall time series comprised annual maximum daily precipitation data from 15 rain gauges (1980-2020). Future rainfall projections were acquired from WASCAL/KIT/IMK-IFU (https://www.pangaea.de) for the Regional Climate Models (RCMs) WRF-GFDL and WRF-hadGEM2 under the RCP 4.5 scenario for the 2021-2049 period. These RCM datasets, at a 12 km resolution, were bias-corrected using the linear scaling method within the Climate Model Data for Hydrologic Modeling (CmHyd, version 10.2) software [19].

The performance of the bias correction was evaluated using three metrics: the coefficient of determination (R^2, Equation 2), the percent bias (PBIAS, Equation 3), and the Nash-Sutcliffe efficiency (NSE) coefficient (Equation 4) [20], to compare raw and bias-corrected model outputs against observed data.

$$R^2 = \left[\frac{\sum_{i=1}^{N} (O_i - \bar{O})(P_i -)}{\left[\sum_{i=1}^{N} (O_i - \bar{O})^2 \right]^{0.5} \times \left[\sum_{i=1}^{N} (P_i - \bar{P})^2 \right]^{0.5}} \right]^2 \quad (2)$$

$$PBIAS = \frac{\sum_{i=1}^{n} (O_i - P_i)}{\sum_{i=1}^{n} (O_i - \bar{O})} \times 100 \quad (3)$$

$$NSE = 1 - \frac{\sum_{i=1}^{n} (O_i - P_i)^2}{\sum_{i=1}^{n} (O_i - \bar{O})^2} \quad (4)$$

where O_i is the observed value and P_i is the simulated or biased-corrected value.

Subsequently, the Modified Mann-Kendall test [21] and Theil-Sen slope estimator [22] were employed to detect trends and quantify their magnitudes in annual maximum precipitation series for both the historical and future periods. This analysis enabled a comparative assessment of projected changes in the frequency and magnitude of heavy rainfall events for the future period (2021-2049) relative to the historical baseline (1980-2020).

2.3.2. Assessment of the Correlation between Heavy Rainfall and Dam Sedimentation

The Soil and Water Assessment Tool (SWAT, version 2012) was employed to assess the impact of heavy rainfall patterns on dam sedimentation. The model simulates the hydrological cycle based on the following water-balance equation [23].

$$SW_t = SW_0 + \sum_{i+1}^{t} (Rday - Qsurf - E\alpha - Wseep - Qgw) \quad (5)$$

where SW_t is the soil water content (mm), SW_0 is the water available to plants (mm), R_{day} is the daily precipitation (mm), Q_{surf} is the surface runoff (mm), E_α is the evapotranspiration (mm), W_{seep} is the percolation (mm), Q_{gw} is the low flow (mm) and t is the time (days).

Surface runoff was estimated using the Soil Conservation Service (SCS) curve number equation while the sediment yield was calculated for each hydrologic response unit (HRU) using the Modified Universal Soil Loss Equation (MUSLE) [24].

$$sed = 11.8 * (Q_{surf} * q_{peak} * Area_{hru})^{0.56} * K_{USLE} * C_{USLE} * P_{USLE} * LS_{USLE} * CFRG \quad (6)$$

where sed is the sediment yield on a given day (tons), Q_{surf} is the surface runoff volume (mm /ha), q_{peak} is the peak runoff rate (m^3/s), $Area_{hru}$ is the area of the HRU (ha), K_{USLE} is the USLE soil erodability factor (), C_{USLE} is the USLE cover and management factor (-), P_{USLE} is the USLE support practice factor (-), LS_{USLE} is the USLE topographic factor and CFRG is the coarse fragment factor (-).

For the Sota catchment, the model was configured using ArcGIS 10.7 interface. The catchment was delineated and subdivided into sub-catchments using the ASTER DEM and dams were integrated into the model based on their respective sub-catchment locations. A sensitivity analysis was performed using the SWAT Calibration and Uncertainty Procedures (SWAT-CUP) tool [25]. A five-year (1990-1994) served as warmup period. The sequential uncertainty fitting (SUFI-2) approach was used for model calibration (1995-2015) and validation (2016-2020), with performance metrics computed using the R-based Hydrological Goodness-of-Fit package. Model performance was evaluated using the coefficient of determination (R^2), percent bias (PBIAS), and the Nash-Sutcliffe efficiency (NSE), consistent with the approach of [26].

Owing to the unavailability of measured sediment flux data, the calibrated and validated SWAT model was used to quantify streamflow and sediment yield for the historical (1980-2020) and future (2021-2049) periods, following the methodology of [27]. Future climate projections from the WRF models served as inputs to simulate future streamflow and sediment yield.

3. Results and Discussion

3.1. Trend in Historical Heavy Rainfall Series

The trends in heavy rainfall over Northern Benin and their magnitude are presented in Table 4.

Table 4. Trends in historical heavy rainfall data

Station	Long (°)	Lat (°)	mMann-Kendall trend	Theil-Sen slope (mm yr^{-1})	Year of Break
Alfakoara*	3.07	11.45	+	0.20	1983
Banikoara	2.43	11.3	Na		
Bembereke	2.67	10.2	Na		
Birni*	1.52	9.99	-	- 0.19	2005
Boukoumbé	1.1	10.17	Na		
Djougou*	1.67	9.7	-	- 0.42	2006
Ina	2.7	9.97	+	0.30	2008
Kalalé	3.39	10.3	Na		
Kandi*	2.93	11.13	+	0.20	1997
Karimama	3.18	12.07	Na		
Kouandé	1.68	10.33	Na		
Malanville	3.4	11.87	-	-0.06	1984
Natitingou*	1.38	10.32	+	0.37	2006
Parakou	2.6	9.35	-	-0.29	1997
Tanguiéta	1.27	10.62	Na		

+ means increasing trend, – signifies decreasing trend, na means no trends and * means a trend is significant at α = 0.05

Of the 15 rainfall stations, only five (Alfakoara, Birni, Djougou, Kandi, and Natitingou) showed statistically significant trends ($p\text{-value} < 0.05$). No clear spatial pattern or consistent direction in trends was detected. The heterogeneity in trends among stations within the same climatic zone is attributable to factors such as the percentage of missing data (See Table 2), and the high climatic variability in the West African region during the past decades [3,28].

3.2. Trends in Future Heavy Rainfall

3.2.1. Comparison of Raw and Bias-corrected Rainfall Data

The performance of the raw and bias-corrected outputs from the two RCMs, WRF-HadGEM2 and WRF-GFDL, and their ensemble mean is presented in Table 5.

Table 5. Performance evaluation of the regional climate models for projected precipitation using standard statistical metrics.

	Raw GFDL	Raw HadGEM2	Ensemble mean	Corrected GFDL	Corrected HadGEM 2	Ensemble mean
PBIAS (%)	3.3	22.1	12.7	10.5	101.7	56.1
NSE	0.97	0.86	0.95	0.93	-2.75	-0.18
R^2	0.97	0.96	0.98	0.96	0.62	0.77
KGE	0.95	0.68	0.84	0.82	-0.73	0.09

A comparison with observed data revealed that the raw WRF-GFDL model demonstrated superior performance in capturing precipitation dynamics over the study area compared to its bias-corrected counterpart and the ensemble mean. Consequently, the raw WRF-GFDL output was selected for subsequent analysis. This finding is consistent with a previous study in northern Nigeria, a region with a similar Sudano-Sahelian climate, which also reported a tendency for the HadGEM2-ES model to overestimate precipitation [29].

3.2.2. Trends in Heavy Rainfall from the WRF-GDFL Model

Projections from the GFDL-WRF model indicate a statistically significant shift in heavy rainfall patterns at 67% of the stations in the future compared to the historical baseline, with 60% of these stations exhibiting a decreasing trend (Figure 3).

These results are consistent with the findings of [30] , who also projected declining extreme rainfall indices for several stations in Benin's Ouémé catchment by mid-century under the RCP 4.5 scenario. In contrast, a study by [31] projected an increase of 1.5 in the annual maximum daily rainfall over the Kolkata Metropolitan Area (India) by the end of the century (2071-2100) under the same RCP4.5 scenario. This discrepancy underscores the substantial geographical variability in climate change projections. Furthermore, [31] suggest that while the RCP 4.5 scenario typically projects moderate changes, localized intensification of extremes can occur due to the interplay between global warming and regional climatic dynamics.

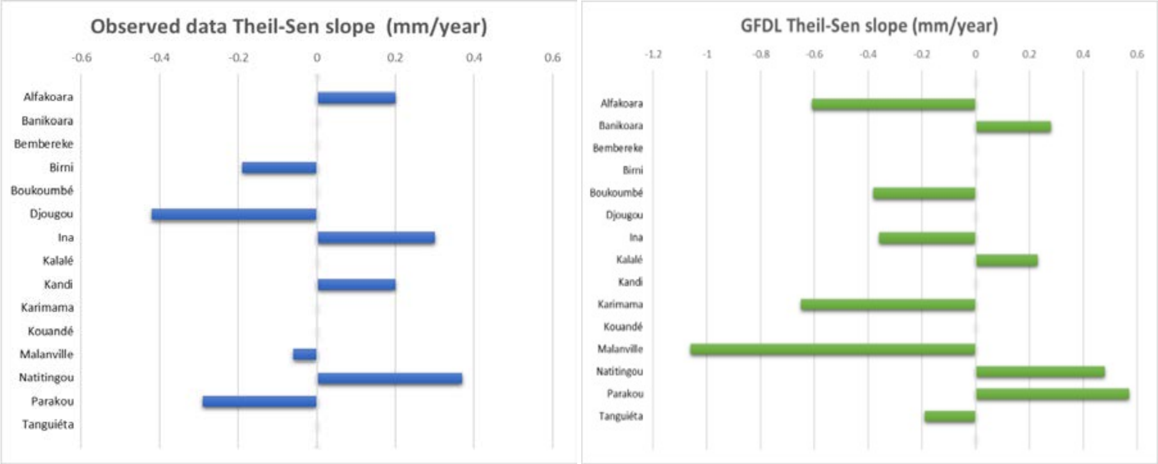

Figure 3. Theil-Sen slope of heavy rainfall in northern Benin for the observed data (1980- 2020) and the GFDL regional climate model (2021-2049)

3.3. Correlation between Heavy Rainfall and Dam Sedimentation

3.3.1. Model Setup, Calibration and Validation

The analysis of land use and land cover (LULC) for the Sota catchment (Table 6) identifies shrubland and agricultural land as the predominant classes, covering 46% and 36% of the area, respectively.

The SWAT model delineated 25 sub-catchments and 120 hydrological response units (HRU). The spatial configuration and hydrological connectivity of dams within the sub-catchment network are presented in Figure 4.

Model calibration was performed using eight sensitive parameters (Table 7). These parameters govern key hydrological processes, including surface runoff (CN2.mgt, USLE_C.plant.dat), infiltration (BIOMIX.mgt), soil properties (SOL_K.sol, SOL_AWC.sol, SOL_Z.sol), and groundwater flow (ALPHA_BF.gw, GWQMN.gw).

Table 6. Land use/Landcover classes in the Sota catchment

Landuse/landcover classes	% of LULC
Shrubland	42
Grassland	15
Agricultural land	36
Forest	7

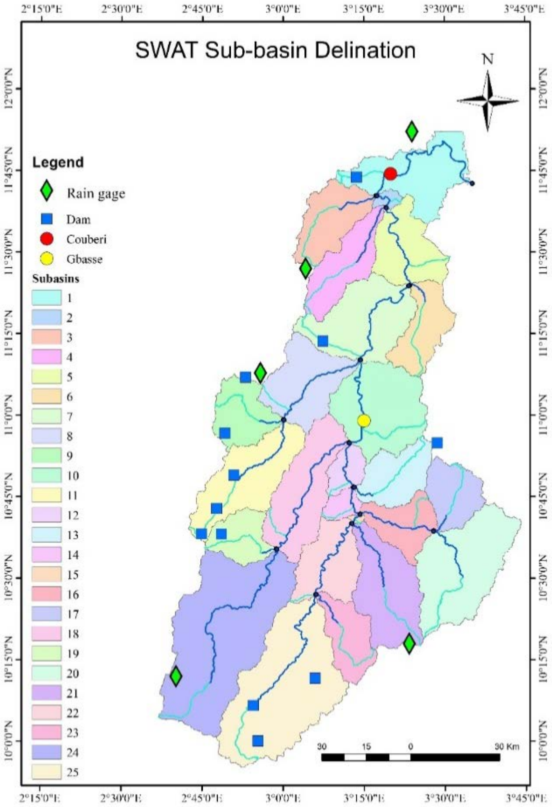

Figure 4. Representation of dam-sub-catchment connections within the SWAT model for the study area

Table 7. Most sensitive parameters used during model calibration

Parameters	Description
CN2.mgt	SCS runoff curve number
USLE_C.plant.dat	Min value of USLE C factor applicable to the land cover/plant
SOL_K.sol	Saturated hydraulic conductivity
SOL_AWC.sol	Available water capacity of the soil layer
SOL_Z.sol	Depth from soil surface to bottom of layer
ALPHA_BF.gw	Baseflow alpha factor
GWQMN.gw	Threshold depth of water in the shallow aquifer required for return flow to occur
BIOMIX.mgt	Biological mixing

Table 8 presents the model performance statistics for the calibration and validation periods. The NSE values exceed 0.65, the R^2 values surpass 0.7, and the PBIAS values fall within the range ±10% to ±15% for both periods, indicating a satisfactory model performance.

Table 8. Calibration and validation performance of the SWAT model in the Sota catchment

Phase	Period	NSE	PBIAS (%)	R^2
Calibration	1995 - 2015	0.70	- 13.5	0.76
Validation	2016 - 2020	0.66	- 14.9	0.75

3.3.2. Historical and Future Sediment Yield and Hotspot in the Sota Catchment

Figure 5 presents the spatial variability of sediment yield simulated by the SWAT model for both the baseline and future periods. The results indicate that dams in the southwestern and western regions of the Sota catchment are sedimentation hotspots. In contrast, dams located in the central area exhibit lower sediment yields.

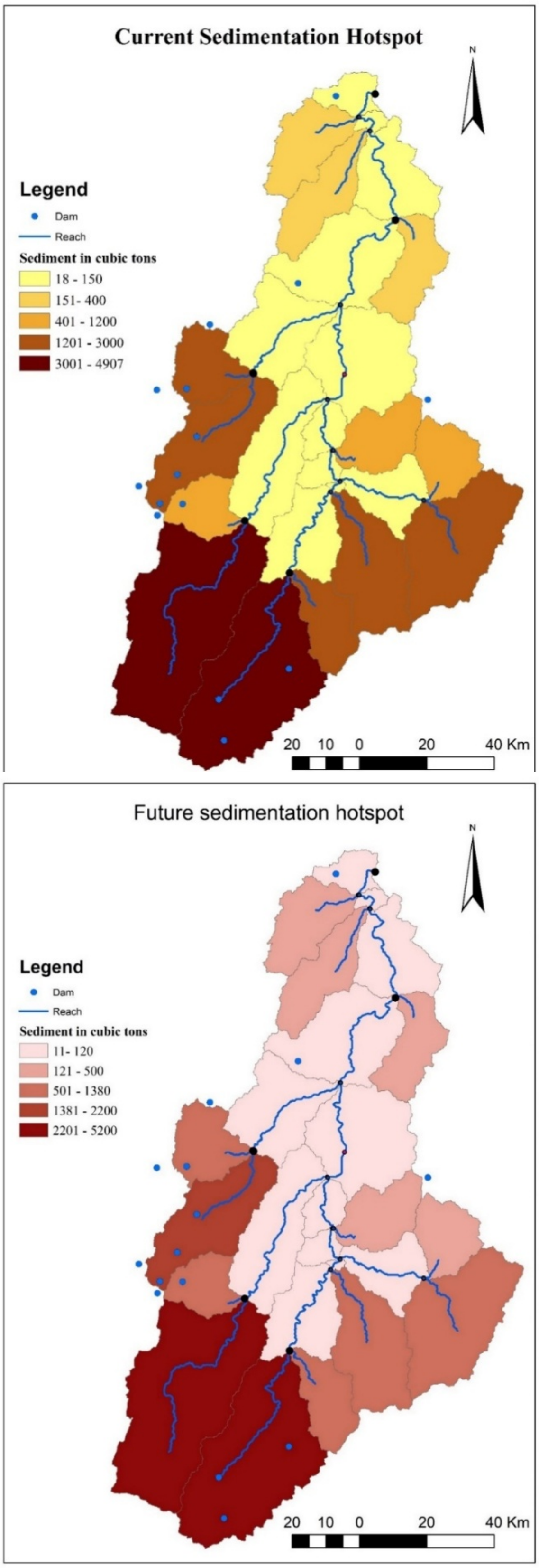

Figure 5. Modeled sediment yield in the Sota Basin for the baseline period (1980-2020) and future projection (2021-2049)

The simulated historical sediment yield averaged 18.6 ton ha^{-1} yr^{-1} for the Sota catchment, exceeding widely reported sustainability thresholds of 11 ton $ha^{-1}yr^{-1}$ [32,33]. Our values are comparable to sediment yields of 12.54 to 15.17 ton $ha^{-1}yr^{-1}$ documented in similar West African and

East African basins affected by land degradation and intense rainfall events [34,35]. While some studies in humid regions reported lower sediment yields, of for example 0.5 ton ha-1yr-1 in the Ouémé catchment [36] and 0.014 ton $ha^{-1}yr^{-1}$ the Aghien Lagoon catchment [37], differences in soil erodibility, land use, and climatic conditions explain these contrasts.

A key contribution of this study is the explicit assessment of extreme precipitations as a driver of sediment yield and dams' sedimentation. Prior works in the region have either examined rainfall variability and/or reservoir sedimentation, but few studies have directly linked changing rainfall extremes to reservoir sedimentation [38]. Indeed, while some regional studies analyzed rainfall erosivity [39,40], others using the SWAT model focused on reservoir sedimentation [41,42], but the African literature remains sparse on this point compared to the global literature [38,43]. Thus, by combining extreme precipitation trend analysis with reservoir sedimentation, the present research demonstrates that sedimentation patterns in small reservoirs respond not only to total rainfall but also to shifts in extreme rainfall intensity.

Projections for the near-future period reveal a divergent trend between runoff and sediment yield. Whereas simulated runoff is projected to increase from 113.36 mm yr^{-1} to 297.92 mm yr^{-1}, the sediment yield is projected to decrease from 18.6 to 12.8 ton $ha^{-1}yr^{-1}$. While this may appear counterintuitive, several mechanisms explain this decoupling. First, our results suggest a shift toward less erosive rainfall regimes, characterized by a decreasing trend in future heavy rainfall (See Section 3.2.2.). Similar findings were reported by [30] and [44] who found trends consistent with our results. Second, rising temperatures may enhance soil surface drying and crusting, reducing detachment efficiency, a mechanism also identified by [45].

Nevertheless, the non-quantification of erosivity indices (e.g., R-factor) limits the depth of interpretation. Future work should compute erosivity metrics to strengthen the causal linkage between rainfall intensity and sediment response.

Spatially, the southwestern part of the catchment is projected to remain the most vulnerable to sedimentation in the near future, highlighting the necessity for sustainable management practices such as filter strips, soil or stone bunds, contour farming and terracing [46]. For immediate risk mitigation, desilting the small dams in this area could be a viable solution [47].

3.3.3. Limitations of the Study

This study has several limitations that should be acknowledged. First, due to the absence of measured sediment flux data, SWAT sediment outputs could not be fully validated. As a result, sediment yield estimates should be interpreted as indicative rather than absolute values, consistent with similar data-constrained studies in Africa. Second, only a single climate scenario (RCP 4.5) was considered, limiting the robustness of future projections. Incorporating multiple scenarios (e.g., SSP2-4.5, SSP5-8.5) would provide a more comprehensive uncertainty range. Third, rainfall erosivity was not quantified; therefore, the inferred explanation for declining sediment yield under future conditions remains qualitative. Fourth, land use was assumed to remain static in future simulations, whereas agricultural expansion and land degradation are ongoing processes in northern Benin. This assumption may underestimate future sediment yield, as dynamic land use change is known to significantly alter erosion patterns [48].

4. Conclusions

This study analyzed historical and projected changes in extreme precipitations and assessed their implications for reservoir sedimentation in northern Benin. Historical daily rainfall data (1980-2020) and future climate projections (2021-2049) from the WRF regional climate model under the RCP 4.5 scenario were analyzed to assess trends in extreme rainfall using the Modified Mann-Kendall test and the Theil-Sen slope estimator. Results indicate heterogeneous historical trends in heavy rainfall, with a statistically significant shift toward decreasing extremes projected for more than 40% of the stations.

The impacts of changing heavy rainfall patterns on runoff and reservoir sedimentation were simulated using the SWAT model applied to the Sota catchment. The model produced satisfactory performance for streamflow simulation and estimated an alarming sediment yield (18.6 ton $ha^{-1}.yr^{-1}$) during the baseline period, particularly in the southwestern part of the Sota catchment. Future simulations suggest a decline in sediment yield (12.8 ton ha^{-1}. yr^{-1} by 2049.) despite increasing runoff, likely reflecting a transition toward less erosive rainfall conditions and temperature-induced changes in soil surface processes. These findings highlight the sensitivity of reservoir sedimentation to changes in extreme rainfall patterns.

The identification of persistent sedimentation hotspots provides valuable insights for future watershed management planning. Further research incorporating dynamic land-use scenarios, multi-scenario climate projections, and measured sediment data is essential to refine sediment forecasts and support sustainable reservoir operation in the region.

ACKNOWLEDGMENTS

The authors acknowledge with gratitude the financial support of the International Foundation for Science (Grant No. I2-W-6663-1).

Statement of Competing Interests

The authors declare no conflict of interests.

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