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EVALUATION OF POLLUTANT LOAD ON NITRATES, PHOSPHATES AND FLUORIDE AND SEASONAL VARIATION FROM SELECTED DAMS AND WATER PANS IN WEST POKOT COUNTY, KENYA

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Abstract

In Kenya most local communities particularly in rural and semi-arid areas suffer the most due to lack of access to potable water. West Pokot is one county experiencing this problem largely due their agricultural practices of pastoralism and livestock watering around the dams and pans. This study aimed to evaluate the quality of water by assessing concentration and temporal variation of nitrates (NO_3^-), phosphates (PO_4^{3-}), and fluorides (F) in three dams (Siyoi Murung, Nakuyen and Sook) and three water pans (Pampa, Kitalakapel and Limangole) in six wards of West-Pokot. Samples of water were collected in April 2025 to represent wet season and December 2025 to represent the dry season and analyzed using standard AOAC procedures. The results were then analyzed descriptively and statistically using one way ANOVA and t-test at $P \leq 0.05$ significance for spatial variation between dams and water pans. Comparisons were made with the set standards by World Health Organization (WHO). The results showed mean ranges of NO_3^-, and PO_4^{3-}were within WHO standards for Sook dam and allowable levels in Siyoi Muruny. Pamba pan recorded the highest NO_3^- [24.2 ± 0.15 mg/L] seasonal variations and showed significant difference between wet and dry season ($P \leq 0.05$). The high level of pollutants in wet season could be due to storm water run offs carrying a higher load of contaminants while in dry season it is likely due to the increased solubility of ions because of the elevated water temperature causing higher evaporation rate. The levels of F alarmingly exceeded the recommended limits in all sites but no F was detected during the dry season at Sook dam. This suggests that heavy rainfall facilitates the leaching of fluoride-rich volcanic ash and weathered rock minerals into open water sources and the extremely high concentrations suggests the mobilization of fluoride-bearing minerals from the underlying volcanic rocks. This study advocates control measures to be taken to avoid the dams and water pans manifesting serious environmental pollution leading to health risks.

Keywords: *Pollution, seasonal variability, water dams and pans*

Introduction

Kenya's Arid and Semi-Arid Lands (ASALs) like many developing countries face serious water scarcity. Water pollution is a global environmental issue in developing countries as well as in developed countries that affects human health, ecosystems and economic activities. It is defined as the addition of substances or energy forms that directly or indirectly alter the nature of the water body in such a manner that negatively affects its legitimate uses (Nzeve & Matata, 2021).

West Pokot County presents a stark landscape of ecological extremes, geographic diversity, and profound environmental vulnerability. Encompassing over 9,123 square kilometers in northwestern Kenya, the county represents a complex intersection of rugged topography, accelerating climate change, prolonged draughts, erratic rainfall and acute human-induced

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resource strain which usualy lead to pollution of existing water bodies. Approximately 74.5% of the county's total landmass is officially classified as Arid and Semi-Arid Land (ASAL), rendering the region structurally vulnerable to climatic variations. Compounding this challenge, decades of unsustainable land use have depleted the county's forest cover to an alarming 3.9%, far below Kenya's national target. This environmental crisis manifests through dual threats: chronic hydrological deficits in the lowlands and destructive landslides across highland escarpments. To secure sustainable livelihoods, the region requires a thorough evaluation of its environmental challenges, structural policy gaps, and ongoing community adaptation frameworks.

Dams and water pans are critical water resources in West Pokot where reliable access to water is limited (Gedi, 2019; Ikobe, 2014; Nyachieo, 2016). These man-made reservoirs are designed to capture and store surface runoff during the rainy seasons, ensuring a steady supply of water during dry periods (Kiringe *et al.,* 2016).

The scarcity of piped or treated water sources in the region has led communities to depend primarily on surface water sources comprising of dams and water pans, for both domestic, irrigation and livestock use (Lolemtum, 2023; Munyaka *et al.,* 2024; Vehrs, 2022).

The construction and operation of dams and water pans have significantly transformed landscapes and water systems in West Pokot region, providing substantial benefits for the local household however the open nature of these water sources makes them vulnerable to pollution due to increasing anthropogenic activities, weathering and runoff from flash floods

Water contamination resulting from excessive nitrogen, phosphorus and fluorides inputs is a major ecological issue that impacts water quality in West Pokot County. The nutrients (NO_3^-N), (PO_4-P) are essential for the growth of aquatic plants and algae, but their overabundance has been documented to cause ecological imbalances, including eutrophication, harmful algal blooms (HABs) and hypoxia (Smith & Schindler, 2009). Eutrophication, characterized by the excessive growth of aquatic plants due to nutrient enrichment which leads to depletion of oxygen in water bodies, creating "dead zones" where aquatic life cannot survive (Sarma & Kumar, 2024). Fluorides (F) mainly emanate from geological fluoride sources. The heavy rainfall which lead to flash floods facilitates the leaching of fluoride-rich volcanic ash and weathered rock minerals into open water sources (Okello et al., 2024) and the mobilization of fluoride-bearing minerals from the underlying volcanic rocks, a phenomenon well-documented throughout the Kenyan Rift (Olago et al., 2009).

The environmental impacts of nutrient and fluoride pollution extend beyond eutrophication to hypoxia and hyper-fluoridosis risk both dental and skeletal. Consuming nitrite which emanates from nitrate is documented to affect how blood carries oxygen especially in children and can cause methemoglobinemia, also known as blue baby syndrome (Gehle, 2013).

This study intends to quantify the pollution matrix and find solutions in reducing the extent of pollution from both point and non-point sources.

Methodology

The study area for this research was West Pokot County due to its water scarcity which forces communities to depend on other sources instead of rain. The people from this region are mainly pastoralists and limited agro-pastoralism is practiced. The stratified random sampling technique was used for site selection specifically considering anthropogenic activities, structure type, internal spatial variations, hydrodynamic and seasonal constraints, anthropogenic and Microbiological Risks. The water sources selected were Siyoi Muruny, Nakuyen, and Sook dams and Kitalakapel, Pampa, and Limangole water pans. Sampling was done using crab sampling technique and seasonally during wet and dry seasons April and December of 2025 respectfully in order to capture temporal component of the study. Samples were collected in three points (both surface and sub-surface) in every water source in order to account for replication. The collected samples were transported to the chemistry laboratory of the University of Eldoret in

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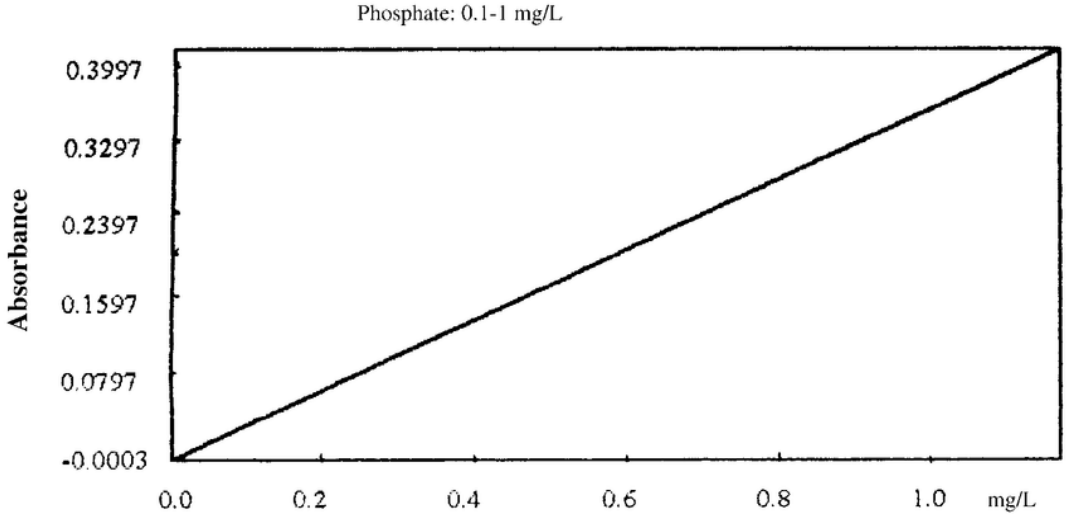
iceboxes at 4°C specifically to prevent conversion of parameters like nitrate to nitrite.

To determine the nitrate concentration in water samples the use of a UV-VIS Spectrophotometry which measures the absorption of UV light (often 220–275 nm) to correlate with nitrate concentration. Initially, 10 mL of the water sample were pipetted into a test tube. To this, 1 mL of 1.3 M sodium hydroxide (NaOH) were added and gently mixed. Following this, 1 mL of a zinc dust, as a reducing mixture were added, and the contents were mixed gently. The test tube was then placed in a water bath at 60°C for 10 minutes to facilitate the reduction process. After heating, the mixture was allowed to cool to room temperature. Subsequently, 1 mL of like sulfanilamide for colour development and ethylenediamine dihydrochlorideas a coupling agent which react to form a distinct pink/magenta azocolor. The solution was shaken to ensure thorough mixing. The absorbance of the resulting solution was measured at 520 nm using a UV-Vis spectrophotometer (Shimadzu UV-1900i) to quantify the nitrate concentration in the sample.

The Phosphate analysis involves the formation of molybdophosphoric acid, which is reduced to an intensely colored complex, molybdenum blue. This analytical method is extremely sensitive and is reliable up to concentrations below 0.1 ppm phosphorus per liter. The Spintronic 20 spectrophotometer was employed in the measurement of color intensity of the blue solution at wavelength of 650 nm. Glassware was washed thoroughly with hot water followed by rinsing with distilled water without using phosphate-containing detergents. Standards from stock phosphate solutions were prepared to get a calibration graph (Figure I) Color Development in Sample was done by measuring 25 mL portion of the water sample and placed in an Erlenmeyer flask. One mL of ammonium molybdate solution was added into the flask and swirled to mix. Two drops of stannous chloride solution were again added into the flask and mixed by swirling. A blue color developed (for samples with phosphate) to a maximum intensity in 5 minutes. While waiting for the blue colour to develop, the wavelength was set to 650 nm on the spectrophotometer. The blank solution was used to set it to read zero absorbance. Using 650 nm wavelengths, the absorbance (after 5-15 minutes' development) of the blue sample was measured. Preparation of Standards Plot A calibration graph (Figure 1) with the correlation coefficient $R^2 = 0.9953$ was used to determine concentrations (mg/L).

Figure 1

Standard calibration curve for phosphate determination in mg/L



Fluoride analysis was done using Ion-Selective Electrode (ISE) method: A Total Ionic Strength Adjusting Buffer (TISAB) was added to the water sample (1:1 ratio) to break up metal-fluoride complexes, pH was adjusted to 5.0–5.5, in order to standardize ionic

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strength. Absorbance was measured at 570 nm using a spectrophotometer.

Laboratories analysis began by preparing a sequential series of standard fluoride dilutions from a dried sodium fluoride standard, spanning the anticipated concentration profile of the target samples. Each standard and unknown sample was mixed equally with Total Ionic Strength Adjustment Buffer (TISAB) and placed on a magnetic stir plate. Calibration was executed by immersing the rinsed electrodes into the standard solutions from lowest concentration to highest, allowing the millivolt reading to reach a steady-state equilibrium. A linear calibration curve had been mapped by plotting the stable potential against the log-concentration. Unknown samples are measured under identical, constant stirring. The exact concentration of fluoride was then read directly from the microprocessor of ion meter.

Experimental Controls and QA/QC:

Field Blanks consisted of f deionized water.

For Laboratory Duplicates: Within every batch of samples (typically every 10 or 20 samples), a single water sample was split and analyzed as two independent replicates. Comparing the relative percent difference (RPD) between these laboratory duplicates measures the precision and repeatability of the method. High RPD values indicate operational inconsistency, poor sample homogenization, or equipment instability

Matrix Validation through Spike Recoveries: matrix Spikes (MS) and Matrix Spike Duplicates (MSD) were used to detect these matrix interferences. To perform the spike recovery, a known concentration of a certified fluoride standard was added directly into a replicate of the environmental water sample. The sample was then analyzed alongside the unspiked sample, and the percentage of the added standard that is successfully recovered was calculated using the following equation:

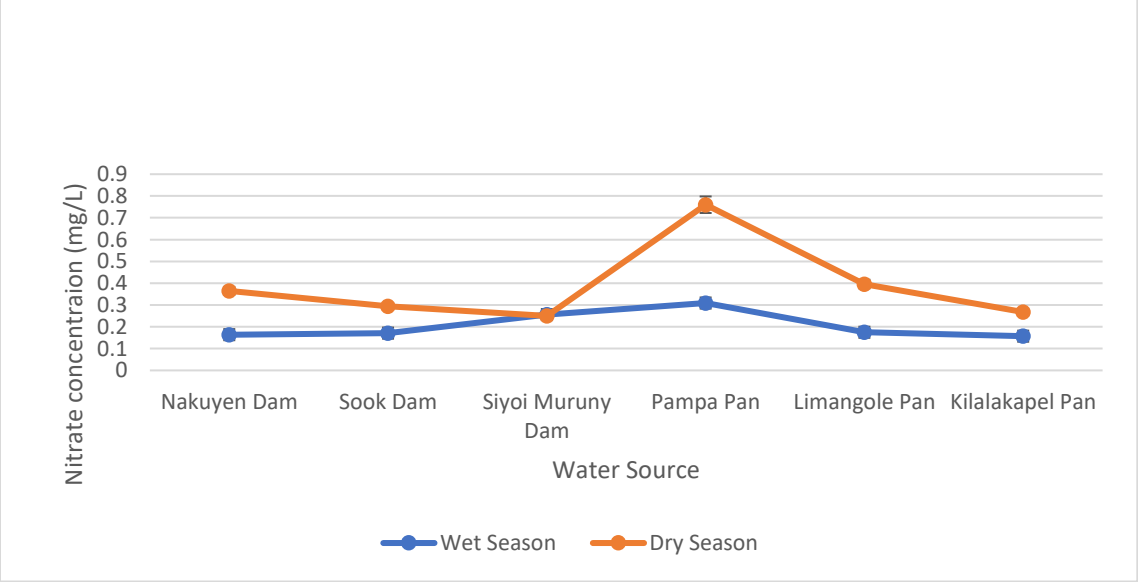
$$\text{Recovery } (\%) = C_{spiked} - C_{unspiked} / C_{added} \times 100$$

Collected data was analyzed descriptively using MS Excel spreadsheets and statistical package for social science (SPSS) version 20. Results were presented using means, standard deviations, and graphical representation. Comparison for variations between the sampling sites was done using one way ANOVA at $p \leq 0.05$ and t-test value for spatial significant difference between dams and water pans.

Results and discussion

Seasonal nitrate concentrations measured are summarized in Figure 2

Figure 2
Seasonal nitrate concentrations



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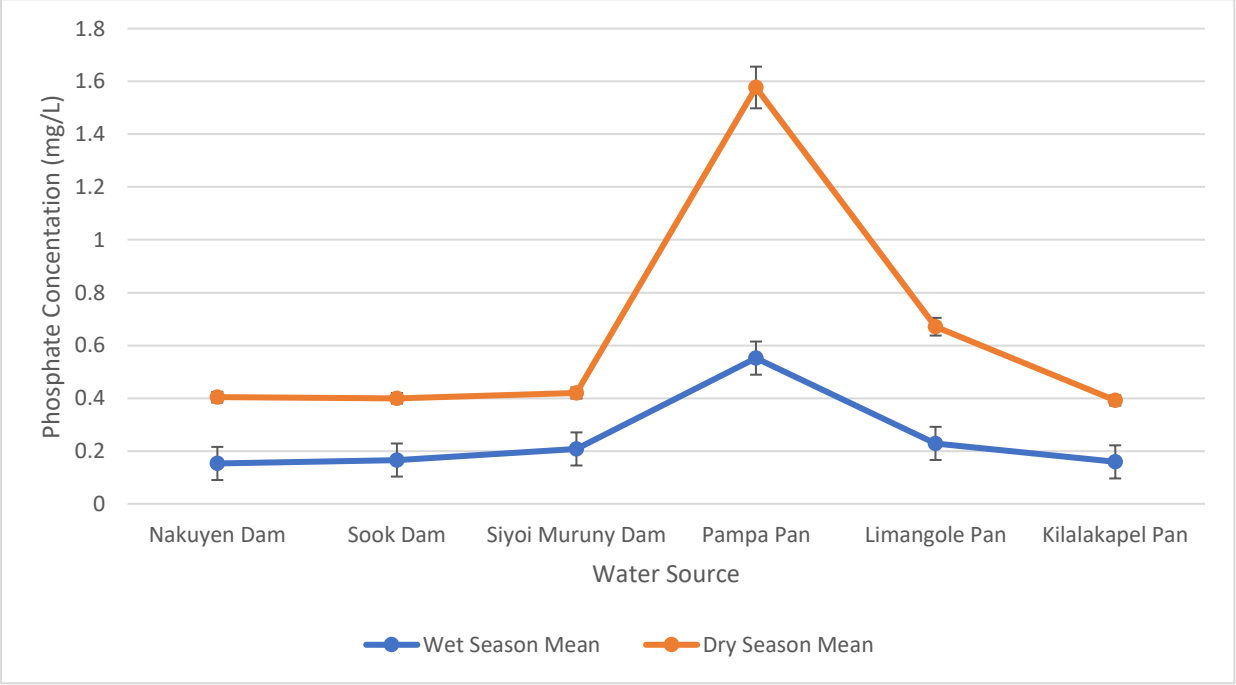
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Nitrate concentrations across the sampling sites ranged from 0.15 mg/L to 0.93 mg/L during the study period. The highest concentrations occurred at Pampa Pan, particularly during the dry season (0.760 ± 0.225 mg/L), while the lowest values occurred at Kitalakapel Pan during the wet season (0.157 ± 0.008 mg/L). Most sites recorded higher nitrate concentrations during the dry season, which suggests concentration of nutrients due to evaporation and reduced dilution. Nakuyen Dam increased from 0.164 mg/L in the wet season to 0.365 mg/L in the dry season, while Sook Dam increased from 0.171 mg/L to 0.294 mg/L. Limangole Pan also showed a significant increase from 0.175 mg/L to 0.396 mg/L. Siyoi Muruny Dam showed minimal seasonal variation, with values of 0.256 mg/L in the wet season and 0.250 mg/L in the dry season, indicating relatively stable nitrate levels. All measured nitrate concentrations remained well below the guideline value of 50 mg/L for drinking water recommended by the WHO indicating low risk of nitrate contamination in the sampled water sources while wide nutrient ranges in the water pans, attributes variability to localized catchment runoff, livestock activity, and sediment-water interactions.

Phosphate concentrations are shown in figure 3 and they ranged from 0.13 mg/L to 1.97 mg/L across all sampling sites. The highest values occurred at Pampa Pan during the dry season (1.577 ± 0.294 mg/L), while the lowest concentrations occurred at Siyoi Muruny Dam during the wet season (0.13 mg/L). Phosphate concentrations generally increased during the dry season across most water bodies. Nakuyen Dam increased from 0.153 mg/L to 0.404 mg/L, while Sook Dam increased from 0.166 mg/L to 0.400 mg/L. Limangole Pan showed a substantial increase from 0.229 mg/L to 0.671 mg/L. Although phosphate does not have a strict health-based drinking water guideline, concentrations above 0.1 mg/L in surface waters can stimulate eutrophication and algal growth, according to the World Health Organization.

Figure 3

Seasonal phosphate concentrations



The results of nitrate and phosphate concentrations across West Pokot County exhibited significant seasonal and variation, reflecting the interplay between hydrological processes and anthropogenic pressures driven primarily by evaporation-driven concentration and reduced dilution capacity during low-flow periods. Notably, water pans exhibited significantly higher nutrient levels than dams a pattern inverting the contamination trend observed for microbial and human activity indicators. Unlike dams, which flush

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accumulated nutrients through continuous outflow, water pans act as closed systems where evaporation concentrates solutes in finite volumes. Phosphate levels exceeding 0.1 mg/L at multiple sites signal eutrophication risk, particularly given the shallow, warm conditions typical of ASAL water bodies that favor algal proliferation.

Table 1

Descriptive Statistics for seasonal nitrate concentration

	N	Minimum	Maximum	Mean		Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic
Nakuyen dam	5	.16	.17	.1644	.00294	.00658
Nakuyen dam	5	.29	.51	.3650	.03939	.08807
Sook dam	5	.17	.18	.1706	.00211	.00472
Sook dam	5	.27	.32	.2944	.00865	.01935
Siyoi muruny dam	5	.16	.39	.2562	.04781	.10691
Siyoi muruny dam	5	.23	.27	.2498	.00957	.02141
Pampa pan	5	.19	.54	.3092	.06166	.13786
Pampa pan	5	.42	.93	.7600	.10084	.22549
Limangole pan	5	.16	.21	.1748	.00825	.01846
Limangole pan	5	.33	.42	.3958	.01696	.03792
Kitalakapel pan	5	.15	.17	.1568	.00354	.00792
Kitalakapel pan	5	.24	.30	.2666	.00942	.02107
Valid N (listwise)	5					

Levels of nitrates were generally higher during the dry season and the same applied to phosphates

One-way analysis of variance (ANOVA) assessed differences in nitrate and phosphate concentrations among the six water sources. The analysis tested whether nutrient levels varied significantly between dams and water pans across the study area.

Table 2

ANOVA results for spatial variation in nutrient concentrations

		Sum of Squares	Df	Mean Square	F	Sig.
Nitrates (mg/L)	Between Groups	.710	5	.142	6.565	.000
	Within Groups	1.168	54	.022		
	Total	1.878	59			
Phosphates (mg/L)	Between Groups	4.835	5	.967	12.604	.000
	Within Groups	4.143	54	.077		
	Total	8.977	59			

ANOVA results indicate significant spatial variation in both nitrate and phosphate concentrations among the six sampling sites. Nitrate concentrations differed significantly between water sources ($F = 6.565$, $p < 0.001$), indicating that nutrient inputs vary across the dams and water pans. Phosphate concentrations also showed strong spatial variation ($F = 12.604$, $p < 0.001$). The higher F-value suggests greater variability in phosphate distribution among the sites compared with nitrate. Water pans generally recorded higher nutrient concentrations than dams, which likely results from shallower depth, sediment disturbance, livestock activity around the water bodies, and accumulation of organic matter.

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Table 3

Independent t-test for seasonal variation in nutrient concentrations

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Nitrates	Equal variances assumed	5.590	.046	-5.07	8	.001	-.20060	.039	-.291	-.109
	Equal variances not assumed			-5.07	4.045	.007	-.20060	.03950	-.30978	-.09142
Phosphates	Equal variances assumed	26.314	.001	-8.62	8	.000	-.25140	.02915	-.31863	-.18417
	Equal variances not assumed			-8.62	4.253	.001	-.25140	.02915	-.33048	-.17232

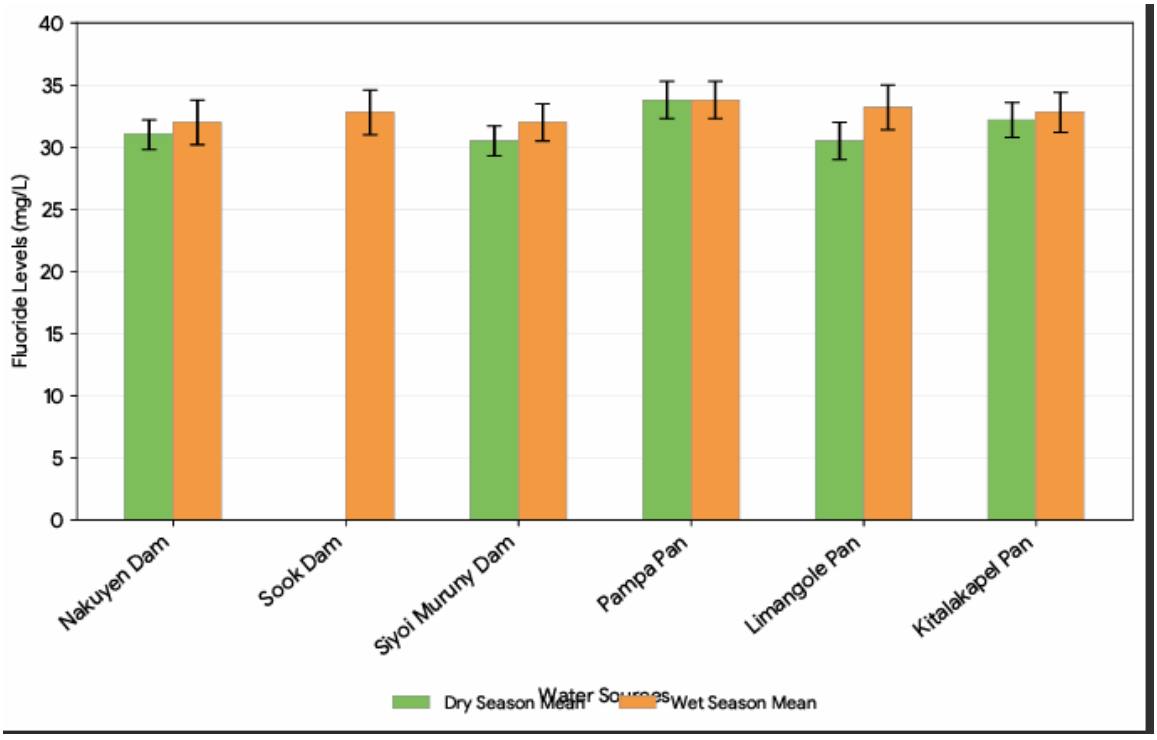
All nitrate concentrations remained well below WHO and NEMA portable water guidelines (50 mg/L), suggesting limited immediate health risk from nitrogenous compounds.

The t-test results show significant seasonal variation in both nitrate and phosphate concentrations. Nitrate levels differed significantly between seasons ($t = -5.079$, $p = 0.001$). The negative t-value indicates that nitrate concentrations were generally higher during the dry season compared with the wet season.

Fluoride concentrations measured across the six sites during wet and dry seasons are presented in figure 4. The WHO and NEMA recommended limit for fluoride is 1.5 mg/L in water.

Figure 4

Seasonal Fluoride Concentrations in Water Sources



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Fluoride concentrations varied notably across the six water sources, with clear seasonal differences. At Nakuyen Dam, levels increased from 30.52 ± 4.62 mg/L in the dry season to 32 .50 ± 1.55 mg/L in the wet season. Sook Dam recorded 0.00 ± 0.00 mg/L in the dry season, rising sharply to 32.70 ± 0.93 mg/L during the wet season. Siyoi Muruny Dam showed concentrations of 30.78 ± 1.24 mg/L in the dry season and 31.14 ± 1.41 mg/L in the wet season. At Pampa Pan, fluoride levels were relatively high but stable, ranging from 33.00 ± 1.07 mg/L in the dry season to 33.26 ± 0.65 mg/L in the wet season. Limangole Pan exhibited an increase from 30.02 ± 6.31 mg/L in the dry season to 33.52 ± 3.43 mg/L in the wet season, while Kitalakapel Pan recorded 32.28 ± 1.75 mg/L in the dry season and 33.84 ± 0.69 mg/L in the wet season. In many parts of Kenya, fluoride levels typically increase during the dry season due to evapoconcentration—where water evaporates and leaves minerals behind—and decrease during the wet season due to rainfall dilution (Dibal et al., 2017). However, the West Pokot data show the opposite trend, with wet season values generally higher than dry season values. This suggests that heavy rainfall facilitates the leaching of fluoride-rich volcanic ash and weathered rock minerals into open water sources (Okello et al., 2024). This extreme elevation is likely driven by the mobilization of fluoride-bearing minerals from the underlying volcanic rocks, a phenomenon well-documented throughout the Kenyan Rift (Olago et al., 2009). All measured concentrations far exceeded the WHO guideline of 1.5 mg/L and the Kenya NEMA drinking water limit of 1.5 mg/L, indicating a potential risk of fluoride-related health effects if consumed without treatment. Water pans, particularly Pampa, Limangole, and Kitalakapel, consistently showed higher fluoride accumulation compared with dams, likely due to evaporation and mineral concentration during seasonal cycles.

Seasonal shifts in fluoride levels are likely due to water volume fluctuations and evaporation during the dry season.

The report of such extreme elevation poses an imminent risk of dental and skeletal fluorosis for the local population. While low concentrations of fluoride (0.5–1.0 mg/L) can be beneficial for bone development, concentrations exceeding 1.5 mg/L lead to permanent physiological damage (Okello et al., 2024). Dental fluorosis manifests as brown staining and pitting of teeth, while skeletal fluorosis is a debilitating condition where fluoride accumulates in the bones, leading to chronic stiffness, joint pain, and crippling deformities.

When compared with regional data, the maximum value of 33.26 mg/L recorded at Pampa Pan is exceptionally high even by the standards of the Rift Valley, where other high-fluoride areas typically record maximums around 23.5 mg/L (Okello et al., 2024). These extreme findings suggest that West Pokot contains localized hotspots of fluoride-bearing minerals. This underscores the urgent need for geological mapping and the development of alternative water sourcing or treatment strategies to protect the health of these pastoral communities.

Table 4

Seasonal Fluoride Concentrations in Selected Dams and Water Pans

Water Source	t-value	df	p-value	Mean Difference
Nakuyen Dam	-7.941	8	<0.001	-17.32
Sook Dam	-11.152	8	<0.001	-23.52
Siyoi Muruny Dam	-18.293	8	<0.001	-15.36
Pampa Pan	-2.254	8	0.054	-1.26
Limangole Pan	-8.254	8	<0.001	-26.50
Kitalakapel Pan	-10.180	8	<0.001	-8.56

All sites except Pampa Pan showed significant seasonal differences in fluoride concentrations ($p < 0.05$). Fluoride levels increased during the dry season, with Limangole Pan exhibiting the largest increase ($t = -8.254$, $p < 0.001$; mean difference = 9.50 mg/L). Pampa Pan had minimal change between seasons ($t = -2.254$, $p = 0.054$), indicating more stable water levels or lower evaporation effects.

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Conclusion and Recommendations

The findings indicate that nutrient concentrations in dams and water pans in West Pokot County remain generally low but show clear seasonal variation influenced by environmental and human factors. Nitrate levels across all sites remained within acceptable portable limits, suggesting minimal risk of nitrate-related contamination, although slight increases during the dry season point to concentration effects from evaporation and reduced dilution. In contrast, phosphate concentrations, while lacking strict drinking water limits, frequently exceeded levels associated with eutrophication risk, particularly during the dry season, indicating potential for algal growth and declining water quality. Seasonal analysis confirms that both nutrients increase significantly during the dry period, with phosphate showing stronger fluctuations than nitrate. Water pans and dams in West Pokot are a critical source of water for domestic, irrigation and livestock use. It is thus important to monitor the quality of the water stored in the dams to ensure it meets the recommended minimum threshold for potable water. Fluoride concentrations across all sampled water sources were extremely high and consistently exceeded the recommended limit of 1.5 mg/L, indicating serious water quality concerns. The results showed clear seasonal variation, with most sites recording significantly higher concentrations during the dry season due to evaporation and reduced dilution, although Pampa Pan remained relatively stable. Given the documented hyper-fluoridosis risk with fluoride concentrations universally exceeding 1.5 mg/L across all sources, the Ministry of Health must expand defluoridation programs utilizing bone char or activated alumina technologies at centralized collection points and use of green removal techniques while the Kenya Water Institute and relevant universities should collaborate on mapping geological fluoride sources and developing community-based defluoridation protocols suited to remote pastoral settings.

The National Environment Management Authority must strengthen enforcement of buffer zone regulations around dams and water pans, specifically targeting the high-intensity point source activities identified particularly clothes washing, bathing, and livestock dipping by establishing designated washing areas and sanitation facilities at safe distances from water edges, and by working with agricultural extension services to regulate fertilizer and pesticide application in upstream catchments to mitigate the phosphate enrichment driving eutrophication risks.

Declarations

Declaration of generative AI and AI-assisted technologies in the writing process

The authors, while preparing this work, utilized ChatGPT for spell checking and grammar refinement. After using this AI tool, the authors carefully reviewed and edited the content as necessary and assumed full responsibility for the publication's content.

Declaration of funding sources

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CRediT authorship contribution statement

Tarus SJ: Writing – original draft, Methodology, Data curation. Kituyi. L: Writing – review & editing, Conceptualization. Rono.M: Writing – review & editing, conceptualization

Declaration of conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Gedi, M. M. (2019). *Administration of devolved water services, transformational leadership and planning and water provision in arid and semi-arid lands in Kenya* [Doctoral dissertation, The Management University of Africa].

Gehle, K. (2013). *ATSDR case studies in environmental medicine: Nitrate/nitrite toxicity*. Agency for Toxic Substances and Disease Registry, Centers for Disease Control and Prevention. https://stacks.cdc.gov/view/cdc/113190

Received 16/09/2026
Revised 19/10/2026
Accepted 29/10/2026

Ghernaout, D. (2020). Water treatment challenges towards viruses' removal. *Open Access Library Journal*, 7(5), 1-22. https://doi.org/10.4236/oalib.1106408

Ikobe, G. A. (2014). *Assessment of small dams and pans in Tanathi Water Services Board* [Master's thesis, University of Nairobi]. University of Nairobi Repository. http://erepository.uonbi.ac.ke/handle/11295/76069

Kiringe, J. W., Mwaura, F., & Warinwa, F. (2016). Characterization of Water Source Types and Uses in Kirisia Forest Watershed, Samburu County, Kenya. *Environment and Natural Resources Research*, *6*(3), 77-90. https://doi.org/10.5539/enrr.v6n3p77

Lolemtum, J. T. (2023*). Impacts of climate change on sustainable pastoralist livelihoods of Pokot community in West Pokot County, Kenya* [Doctoral dissertation, University of Nairobi]. University of Nairobi Repository. https://erepository.uonbi.ac.ke/items/4b2f8d4e-02b8-48e5-b3e5-ed77bd1ecc98

Munyaka, J. C. B., Gallay, O., Abdem, S. A. E., Timu, L. J., Rida, A. Z. M. I., & Chenal, J. (2024). *Resilience and adaptation strategies in response to drought: A spatial and community-based study in West Pokot, Kenya*. Preprints.org. https://doi.org/10.20944/preprints202406.1549.v1

National Environment Management Authority (2018). *Water Quality Regulations and Guidelines for Kenya*. https://www.nema.go.ke

Nyachieo, J. (2016). *Promising practices in supporting management of water resources in pastoral areas*. Agriculture and Food Security Network. https://www.shareweb.ch/site/Agriculture-and-Food-Security/focusareas/Documents/pastoralism_brief_water_management_e.pdf

Nzeve, J.K & Matata, A. M (2021). Assessment of Water Quality in Kalundu Stream and Kalundu dam in Kitui County, Kenya. *Journal of Environment and Earth Science, 11*(1), 36 – 40. https://doi.org/10.7176/JEES/11-1-05

Okello, C., Githiora, Y. W., Sithole, S., & Owuor, M. A. (2024). Nature-based solutions for water resource management in Africa's arid and semi-arid lands (ASALs): A systematic review of existing interventions. *Nature-Based Solutions, 6*, Article 100172. https://doi.org/10.1016/j.nbsj.2024.100172

Olago, D., Opere, A., & Barongo, J. (2009). Holocene palaeohydrology, groundwater and climate change in the lake basins of the Central Kenya Rift. *Hydrological Sciences Journal*, *54*(4), 765–780. https://doi.org/10.1623/hysj.54.4.765

Sharma, S., Gray, D. K., Read, J. S., O'reilly, C. M., Schneider, P., Qudrat, A., ... & Woo, K. H. (2015). A global database of lake surface temperatures collected by in situ and satellite methods from 1985–2009. *Scientific data, 2*(1), 1-19. https://doi.org/10.1038/sdata.2015.8

Vehrs, H. P. (2022). *Pokot Pastoralism: Environmental Change and Socio-economic Transformation in North-west Kenya* (Vol. 1). Boydell & Brewer.

World Health Organization (2023). *Drinking water*. https://www.who.int/news-room/fact-sheets/detail/drinking-water