

Towards an Integrated Future: Examining Water, Climate, and Gender Dynamics for Sustainable Development in Kenya

Kelvin Mutugi Kithaka ^{1,*}, Bonface Ombasa Manono ² and Esther Akoth Amolo ³

¹ National Environment Management Authority, Nairobi P.O. Box 6739-00200, Kenya

² Colorado State University Extension, Fort Collins, CO 80523, USA; bonface.manono@colostate.edu (B.O.M.)

³ Department of Environment, Social, Governance and Partnerships, Davis & Shirliff, Nairobi P.O. Box 41762-00100, Kenya; eakoth@dayliff.com (E.A.A.)

* Corresponding author. E-mail: kelvinmutugi910@gmail.com (K.M.K.)

Supplementary Materials

Table S1. Literature considered in the SLR (n=63) ordered according to title.

Sno.	Title	Author Names	Year	Key Information retrieved
1.	Achieving sustainable development goals from a water perspective.	Bhaduri, A., Bogardi, J., Siddiqi, A., Voigt, H., Vörösmarty, C , Pahl-Wostl, C. & Osuna, V. R.	2016	Synergies with sustainable development.
2.	Assessing the Impacts of Climate Change and Water Scarcity on Agricultural Practices in Kenya-Implications for Adaptation Strategies.	Oishee, S. R.	2023	Gendered impacts of climate change on water resources.
3.	An Analysis of Commercial Banks' Responses to Climate Change: A Case of Commercial Banks in Kitui County Kenya.	Kitonga, F., Manono, B. O., & Mwinzi , D. M.	2023	Policy and institutional frameworks.
4.	Assessing the impacts of climate change on surface water resources using WEAP model in Narok County, Kenya.	Opere, A. O., Waswa, R., & Mutua, F. M.	2022	Gendered impacts of climate change on water resources.
5.	A review on climate change impacts, models, and its consequences on different sectors: a systematic approach.	Rawat, A., Kumar, D., & Khati, B. S.	2024	Integrated approaches.
6.	Beneath the Dryland: Kenya drought gender analysis	Dometita, M. L. M.	2017	Gender responsive climate change adaptation.
7.	Climate Change, Resource Scarcity And Violent Conflict In The Horn Of Africa: A Case Study Of Turkana County, Kenya	Ouda, J. O.	2017	Gender and water governance.
8.	Climate variability and water resources degradation in Kenya: improving water resources development and management	Mogaka, H	2006	Synergies with sustainable development.
9.	Climate, migration, and access to water: A case study of Kenya.	Lundberg, A	2025	Gendered access to and control of resources.
10.	Climate change adaptation and women's land rights in Uganda and Kenya: Creating legal pathways for building the resilience of women.	Kabaseke, C.	2020	Policy and institutional frameworks.
11.	Climate change situation in Kenya and measures towards adaptive management in the water sector.	Nyika, J. M.	2022	Integrated approaches.
12.	Climate finance in Kenya: review and future outlook.	Odhengo, P., Atela, J., Steele, P., Orindi, V., & Imbali, F.	2019	Policy and institutional frameworks
13.	Constraints and solutions for groundwater development, supply and governance in urban areas in Kenya.	Olago, D. O.	2019	Synergies with sustainable development.
14.	Climate change and education in Kenya.	Fitzpatrick, R., & Amenity, D.	2023	Gendered impacts of climate change on water resources.

15.	Droughts and famines: the underlying factors and the causal links among agro-pastoral households in semi-arid Makueni district, Kenya.	Speranza, C. I., Kiteme, B., & Wiesmann, U.	2008	Gendered access to and control over resources.
16.	Drought responses and adaptation strategies to climate change by pastoralists in the semi-arid area, Laikipia County, Kenya.	Ndiritu, S. W.	2021	Gender responsive climate change adaptation.
17.	Devolving water governance in the Kenyan Arid Lands: from top-down drought and flood emergency response to locally driven water resource development planning.	King-Okumu, C., Jillo, B., Kinyanjui, J., & Jarso, I.	2018	Synergies with sustainable development.
18.	Exploring water access in rural Kenya: narratives of social capital, gender inequalities and household water security in Kitui county.	Bukachi, S. A., Omia, D. O., Musyoka, M. M., Wambua, F. M., Peter, M. N., & Korzenevica, M.	2021	Gender and water governance.
19.	Engaging with gender in water governance and practice in Kenya.	Ifejika Speranza, C., & Bikketi, E.	2017	Gender and water governance.
20.	Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhea and child growth in rural Kenya: a cluster-randomized controlled trial.	Null, C., Stewart, C. P., Pickering, A. J., Dentz, H. N., Arnold, B. F., Arnold, C. D., ... & Colford, J. M.	2018	Gendered impacts of climate change on water resources.
21.	Evaluation of water accessibility, distribution, water use policies and management in Kenya.	Njora, B., & Yilmaz, H.	2021	Integrated approaches.
22.	Effects of Climate Change on Pastoralist Women in the Horn of Africa.	Musau, B.	2021	Gendered impacts of climate change on water resources.
23.	Factors influencing performance of water projects in arid and semi-arid areas: A case of Ewaso Ng'iro North borehole projects, Isiolo County, Kenya.	Maimuna, M., & Kidombo, H.	2017	Gender and water governance.
24.	Gender and economic growth in Kenya: Unleashing the power of women. World Bank Publications.	Ellis, A.	2007	Integrated approaches.
25.	Giving women a voice on decision-making about water: barriers and opportunities in Laikipia, Kenya.	Coulter, J. E., Witinok-Huber, R. A., Bruyere, B. L., & Dorothy Nyingi, W.	2019	Gender and water governance.
26.	Girls' and women's education in Kenya. Gender Perspectives and trends, 91, 86-90.	Chege, F., & Sifuna, D. N.	2006	Gendered impacts of climate change on water resources.
27.	Gender Resilience to Climate Change Adaptation in Africa: A Case Study of Women in Eastern Kenya	Salome, O. F.	2016	Gendered access to and control over resources.
28.	Gender-Differentiated Roles and Perceptions on Climate Variability among Pastoralist and Agro-Pastoralist Communities in Marsabit, Kenya.	Galwab, A. M., Koech, O. K., Wasonga, O. V., & Kironchi, G.	2024	Gendered impacts of climate change on water resources.
29.	Gender disparities and economic growth in Kenya: A social accounting matrix approach.	Wanjala, B. M., & Were, M.	2009	Policy and institutional frameworks.
30.	Has the vision of a gender quota rule been realized for community-based water management committees in Kenya?	Hannah, C., Giroux, S., Krell, N., Lopus, S., McCann, L. E., Zimmer, A., ... & Evans, T. P.	2021	Gender and water governance.
31.	Human rights, gender and water in Kenya—law, prospects and challenges.	Kameri-Mbote, P., Kariuki, F., Hellum, A., & Van Koppen, B.	2015	Policy and institutional frameworkss

32.	Implications of time to water source on water use in the arid and semi-arid land counties of Kenya.	Afullo, A. O., Danga, B. O., & Odhiambo, F.	2014	Gendered access to and control of water resources.
33.	'I know how stressful it is to lack water!' Exploring the lived experiences of household water insecurity among pregnant and postpartum women in western Kenya.	Collins, S. M., Mbullo Owuor, P., Miller, J. D., Boateng, G. O., Wekesa, P., Onono, M., & Young, S. L.	2019	Gendered impacts of climate change on water resources.
34.	Influence of women empowerment on adoption of agroforestry technologies to counter climate change and variability in semi-arid Makueni County, Kenya.	Kalovoto Damariis, M., Kimiti Jacinta, M., & Manono Bonface, O.	2020	Gender responsive climate change adaptation.
35.	Integrity management in community-based water tenure in Kajiado County, Kenya.	Keega, M., Manishimwe, E., Schreiner, B., van Koppen, B., & Amarnath, G.	2023	Policy and institutional frameworks.
36.	Kenyan women bearing the cost of climate change.	Allen, E. M., Munala, L., & Henderson, J. R.	2021	Gendered impacts of climate change on water resources.
37.	Kenya National Climate Change Policy	N/A	2016	Synergies with sustainable development
38.	Local organization and gender in water management: a case study from the Kenya Highlands.	Were, E., Roy, J., & Swallow, B.	2008	Integrated approaches.
39.	No peace in my heart?: Exploring psychosocial problems experienced by women in relation to water insecurity and inadequate sanitation in an informal settlement, Kenya.	Kimutai, J. J., Lund, C., Moturi, W. N., Shewangizaw, S., & Hanlon, C.	2025	Gendered impacts of climate change on water resources.
40.	Relationship between ecological, economic, conflict, socio-cultural factors and enrollment of girls in rural public primary schools in Samburu County, Kenya.	Lanyasunya, A. R.	2024	Gendered impacts of climate change on water resources.
41.	Rural investments to accelerate growth and poverty reduction in Kenya.	Thurlow, J., Kiringai, J., & Gautam, M.	2007	Synergies with sustainable development.
42.	Rainwater harvesting possibilities and challenges in Kenya.	Wanyonyi, J. M.	2013	Integrated approaches.
43.	Short-Run Impacts of Reducing Water Collection Times on Time Use, Well-Being, and Education in Rural Kenya.	Cook, J., Kabubo-Mariara, J., & Kimuyu, P.	2024	Gender responsive climate change adaptation.
44.	Strategic resource allocation and performance of Kisumu water and sewerage company, Kenya.	Owako, E., & Nyangara	2021	Policy and institutional frameworks.
45.	Sustainable supply of safe drinking water for underserved households in Kenya: investigating the viability of decentralized solutions.	Cherunya, P. C., Janezic, C., & Leuchner, M.	2015	Integrated approaches
46.	The role of women in water management and conflict resolution in Marsabit, Kenya.	Yerian, S., Hennink, M., Greene, L. E., Kiptugen, D., Buri, J., & Freeman, M. C.	2014	Gendered access to and control over resources.
47.	Time spent on household chores (fetching water) and the alternatives forgone for women in Sub-Saharan Africa: Evidence from Kenya.	Agesa, R. U., & Agesa, J.	2019	Gendered impacts of climate change on water resources.
48.	The relation between access to water poverty and patriarchy: The case of women slum dwellers in Kibera Kenya.	Odeny, M. A.	2020	Gendered impacts of climate change on water resources.
49.	The impacts of increasing water scarcity and the potential for water-related conflict in Lamu, Kenya.	Maingey, Y., Opondo, M., Olago, D., & Ouma, G.	2022	Gendered impacts of climate change on water resources

50.	The Impact of Legal Frameworks on Gender Mainstreaming in Kenya.	Gachoki, J. W., & Mulu, F.	2023	Policy and institutional frameworks.
51.	Who is Being Left Behind? Participatory Exclusion of Marginalized Groups in Kenya.	Kenyatta, G. N.	2024	Synergies with sustainable development.
52.	Women's empowerment in water management across Africa.	Haddout, S., Cardoso, L., Hogue, A. M., Priya, K. L., C. Casila, J. C., Kurniawan, T. A., & Ljubenkova, I.	2024	Gender and water governance
53.	Water–energy–food nexus in Kenya: A review of policy interventions.	Kanda, E. K., Luswet, E., & Odhiambo, K. O.	2023	Policy and institutional frameworks.
54.	Water insecurity and water governance in urban Kenya.	Sarkar, A.	2022	Gender and water governance.
55.	Water and water-borne diseases in North Masaba District, Kenya.	Nyagwencha, J. M., Kaluli, J. W., Home, P. G., & Hunja, M.	2012	Policy and institutional frameworks.
56.	Water, sanitation and hygiene situation in Kenya's urban slums.	Kamau, N., & Njiru, H.	2018	Gender and water governance
57.	Women, climate change and environmentally-induced conflicts in Africa.	Jaggernath, J	2014	Gendered impacts of climate change on water resources.
58.	Women in politics in Kenya: an analysis of participation and barriers.	Opoku, M. P., Anyango, B., & Alupo, B. A.	2018	Integrated approaches.
59.	Water challenges in rural and urban sub-Saharan Africa and their management.	Nyika, J., & Dinka, M. O.	2023	Gender and water governance.
60.	Water risk perceptions across the life-course of women in Kenya.	Varickanickal, J., Bisung, E., & Elliott, S. J	2020	Gender and water governance.
61.	Water policy, politics, and practice: The case of Kitui County, Kenya.	Koehler, J., Nyaga, C., Hope, R., Kiamba, P., Gladstone, N., Thomas, M., ... & Trevett, A.	2022	Policy and institutional frameworks.
62.	Water insecurity and water governance in urban Kenya.	Sarkar, A.	2022	Integrated approaches.
63.	Water risk perceptions across the life-course of women in Kenya.	Varickanickal, J., Bisung, E., & Elliott, S. J.	2020	Gender and water governance.

Table S2. Prisma checklist.

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	This is reported in the title.
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	The article abstract fulfils this requirement
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Reported in the introduction.
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Reported in the introduction.
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	This information is provided in Table 1 in the manuscript
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	This information is provided in section 2.2.3
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	This section is provided in Section 2.2.3;2.2.4
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	This information is provided in section 2.2.5
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	This information is at section 2.2.2 and Section 2.2.3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	This information is located at Section 2.2.3
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	All information sought was obtained.
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	This information is provided in section 2.2.3

Section and Topic	Item #	Checklist item	Location where item is reported
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	This information is provided in Section 2.2.4 and 2.2.5
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	This information is provided in Table 1 of the manuscript.
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	This information is provided in Section 2.2.5. We did not encounter missing data.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	This information is provided in Section 2.2.5
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	This information is provided in section 2.2.5.
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	We did not carry out these procedures.
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	We did not collect sensitive data.
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	No missing results
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	We did not carry this procedure.
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	The flow diagram is reported as Figure 2 in the manuscript.
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	This is indicated in Figure 2 in the manuscript.
Study characteristics	17	Cite each included study and present its characteristics.	This is reported in Table A1 in this supplementary material.
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	We did not carry this procedure.
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	We did not carry out this procedure.
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	We have provided Table A1 with the main theme in the selected papers.

Section and Topic	Item #	Checklist item	Location where item is reported
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Our study did not involve comparative studies.
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Our study objective was not meant to determine a cause of an occurrence.
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Our study did not warrant this procedure.
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	We collected all the data for our study.
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	We did not carry out this procedure.
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	This is discussed in sections 3, 4, 5 and 6 in the revised manuscript.
	23b	Discuss any limitations of the evidence included in the review.	This is included in the conclusion.
	23c	Discuss implications of the results for practice, policy, and future research.	This has been discussed in section 6
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	The review was not registered
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	The protocol was not prepared.
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	No financial support was provided for this review. This has been declared in the revised manuscript under the funding section.
Competing interests	26	Declare any competing interests of review authors.	No competing interests.
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	All the data provided in this review study is publicly available.

Adopted from: Page et al (2021).