

**IMPACTS OF CLIMATE CHANGE AND HUMAN ACTIVITIES ON THE
WALUKUBA-MASESE WETLAND ECOSYSTEM (LAKE VICTORIA BASIN)**

BY

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DECLARATION

I, **VICTORIA KAKAIRE**, hereby declare that this dissertation is a result of my original effort except where cited and has never been submitted for any other degree award at this or any other University or institution of higher learning.

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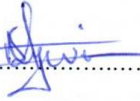
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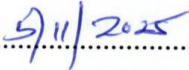
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ACRONYMS

BOD	Biological oxygen demand
FGD	Focus group discussion
COD.	Chemical oxygen demand
IPCC	Intergovernmental Panel on Climate Change
LULC	land use and land cover changes
SPI	Standardised precipitation index
NDVI	Normalised Difference Vegetation Index
PC	Principal Component
SDI	Site Degradation Index
PDM	Parish Development Model
NEMA	National environmental management authority
GPS.	Global positioning system
NGO.	None governmental organization
PET	Potential evapotranspiration

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ABSTRACT

Urban wetlands function as critical ecosystems, offering essential services such as water filtration, flood control, and biodiversity conservation to mention a few. However, this type of ecosystem faces immense pressure from both climate and anthropogenic stressors. Numerous studies have documented the effects of these stressors on wetland processes and ecosystem services; however, these studies span a wide range of geographical scales, and the findings may not be directly applicable at local scales. The aim of this study, therefore, was to examine the socio-ecological dynamics of the Walukuba Masese wetland system in Jinja District, Uganda, focusing on its ecological condition, user characteristics, perceived drivers of change, and community adaptation strategies. Using a mixed-methods design combining structured household surveys, in-depth focus group discussions, and systematic field observations this study gathered insights from 257 wetland users and key institutional stakeholders. Findings revealed four core insights. First, long-term climate data revealed inter annual variability in rainfall, with no significant trend, and a $\sim 2^{\circ}\text{C}$ rise in temperature over 40 years, likely intensifying evapotranspiration and stressing wetland hydrology. Second, satellite imagery revealed a greater than 50% loss of wetland area alongside a fivefold increase in built-up and agricultural land, which has fragmented the wetland area and increased the incidence of flooding. Third, water samples showed elevated biological oxygen demand (BODs) up to 80 mg/L, chemical oxygen demand (COD) up to 130 mg/L, elevated coliforms, and a 10–15% drop in Shannon diversity at highly degraded sites. Fourth, household interviews showed that changes in wetland's ecological status have affected fish abundance and other wetland-derived services, especially for low-income households. Adaptation strategies are diverse, depending on the impacted user, but can broadly be grouped into four categories: diversification (especially for the low-income households), innovation, participation, and

modification (especially for users who mainly degrade the wetland). Four logistic regression models, representing each of the adaptation strategies above, showed that training, income, awareness, and gender increase the odds of adaptation, while age and experience reduce the odds of adaptation. In conclusion, this study showed evidence of climate variability at a local scale, consistent with the regional and global trends. There is also evidence of significant land cover change, but this is primarily driven by human activities rather than climate variability. Wetland ecosystem services (using water quality, biodiversity, and livelihoods as proxy indicators) are also likely more threatened by anthropogenic stressors (habitat degradation) than by climate variability. Based on these findings, it is vital to strengthen policy enforcement, integrate user groups into development initiatives, and support local initiatives with training, compensation, and incentives. These measures may enhance both the resilience of wetlands and the livelihoods of local communities.

REFERENCES

- Acreman, M. C., & McCartney, M. P. (2009). Hydrological Impacts in and around Wetlands. *The Wetlands Handbook*, 643–666. <https://doi.org/10.1002/9781444315813.CH28>
- Adhikari, U., Nejadhashemi, A. P., & Herman, M. R. (2015). A Review of Climate Change Impacts on Water Resources in East Africa. *Transactions of the ASABE*, 58(6), 1493–1507. <https://doi.org/10.13031/TRANS.58.10907>
- Adla, K., Dejan, K., Neira, D., & Dragana, Š. (2022). Degradation of ecosystems and loss of ecosystem services. *One Health*, 281–327. <https://doi.org/10.1016/b978-0-12-822794-7.00008-3>
- Agaton, C. B., & Guila, P. M. C. (2023). Ecosystem Services Valuation of Constructed Wetland as a Nature-Based Solution to Wastewater Treatment. *Earth*, 4, 78–92. <https://doi.org/10.3390/earth4010006>
- Akwany, L., Sayer, C., & Maiz-Tome, L. (2022). *The importance of freshwater species to livelihoods in the Lake Victoria Basin*.
- Akwetaireho, S., & Getzner, M. (2010). Livelihood dependence on ecosystem services of local residents: a case study from Mabamba Bay wetlands (Lake Victoria, Uganda). *International Journal of Biodiversity Science, Ecosystem Services & Management*, 6(1–2), 75–87. <https://doi.org/10.1080/21513732.2010.521139>
- Alikhani, S., Nummi, P., & Ojala, A. (2021). Urban Wetlands: A Review on Ecological and Cultural Values. *Water*, 13, 3301. <https://doi.org/10.3390/w13223301>
- Ampaire, E. L., Jassogne, L., Providence, H., Acosta, M., Twyman, J., Winowiecki, L., & van Asten, P. (2017). Institutional challenges to climate change adaptation: A case study on policy action gaps in Uganda. *Environmental Science & Policy*, 75, 81–90. <https://doi.org/10.1016/j.envsci.2017.05.013>

- Anyah, R. O., & Semazzi, F. H. M. (2004a). Simulation of the sensitivity of Lake Victoria basin climate to lake surface temperatures. *Theoretical and Applied Climatology*, 79(1–2), 55–69. <https://doi.org/10.1007/S00704-004-0057-4>
- Anyah, R. O., & Semazzi, F. H. M. (2004b). Simulation of the sensitivity of Lake Victoria basin climate to lake surface temperatures. *Theoretical and Applied Climatology*, 79(1–2), 55–69. <https://doi.org/10.1007/S00704-004-0057-4>
- Aragão, H. G., Pereira, V. A., & Da Silva, R. F. (2022). FREE GEOTECHNOLOGIES APPLIED TO BASIC SANITATION MANAGEMENT: A CASE STUDY AT THE EMPRESA BAIANA DE ÁGUAS E SANEAMENTO. *Revista de Gestao Social e Ambiental*, 16(2). <https://doi.org/10.24857/RGSA.V16N2-018>
- Aragaw, T. A. (2021). Functions of various bacteria for specific pollutants degradation and their application in wastewater treatment: a review. *International Journal of Environmental Science and Technology*, 18(7), 2063–2076. <https://doi.org/10.1007/S13762-020-03022-2>
- Asadullah, A., McIntyre, N., & Kigobe, M. (2008). Evaluation of five satellite products for estimation of rainfall over Uganda. *Hydrological Sciences Journal*, 53(6), 1137–1150. <https://doi.org/10.1623/HYSJ.53.6.1137>
- Asante, L. A., Akomea Bonsu, B., & Helbrecht, I. (2024). Wetland gentrification: the African variant on ecological gentrification. *Environment and Urbanization*. <https://doi.org/10.1177/09562478241253179>
- Assefa, W. W., Eneyew, B. G., & Wondie, A. (2021). The impacts of land-use and land-cover change on wetland ecosystem service values in peri-urban and urban area of Bahir Dar City, Upper Blue Nile Basin, Northwestern Ethiopia. *Ecological Processes*, 10. <https://doi.org/10.1186/s13717-021-00310-8>

- Assessment (MEA), M. E. (2005). *Ecosystems and Human Well-Being: Wetlands and Water Synthesis*. Washington, D.C.: World Resources Institute. <https://vtechworks.lib.vt.edu/items/05f6e5e0-3cac-4418-bc7d-9a4edc5fbab0>
- Athukorala, D., Estoque, R. C., Murayama, Y., & Matsushita, B. (2021). Impacts of urbanization on the muthurajawela marsh and negombo lagoon, sri lanka: Implications for landscape planning towards a sustainable urban wetland ecosystem. *Remote Sensing*, 13(2), 1–22. <https://doi.org/10.3390/RS13020316>
- Awange, J. L., Ogalo, L., Bae, K. H., Were, P., Omondi, P., Omut, P., & Omullo, M. (2008). Falling Lake Victoria water levels: Is climate a contributing factor? *Climatic Change*, 89(3–4), 281–297. <https://doi.org/10.1007/S10584-008-9409-X>
- Bai, L., Xiu, C., Feng, X., & Liu, D. (2019). Influence of urbanization on regional habitat quality: a case study of Changchun City. *Habitat International*, 93. <https://doi.org/10.1016/j.habitatint.2019.102042>
- Baig, A., Atif, S., & Tahir, A. (2024). Urban development and the loss of natural streams leads to increased flooding. *Discover Cities 2024 1:1*, 1(1), 1–21. <https://doi.org/10.1007/S44327-024-00010-W>
- Bamdadi, P., Abessi, O., & Amini Rad, H. (2024). *Ecological modeling of pollutant removal in urban wetlands*.
- Bamford, A. J., Razafindrajao, F., Young, R. P., & Hilton, G. M. (2017). Profound and pervasive degradation of Madagascar's freshwater wetlands and links with biodiversity. *PLoS ONE*, 12(8). <https://doi.org/10.1371/JOURNAL.PONE.0182673>
- Barbour, M. G., Burk, J. H., & Pitts, W. D. (1999). *Terrestrial plant ecology*. Addison Wesley Longman.

- Barman, A., Rajak, F., & Jha, R. (2025). Integrating Traditional Knowledge Systems for Wetland Conservation and Management: A Critical Analysis. *Nature Environment and Pollution Technology*, 24(1), B4212. <https://doi.org/10.46488/NEPT.2025.v24i01.B4212>
- Bates, B., Kundzewicz, Z. W., Wu, S., Arnell, N., Burkett, V., & Wilbanks, T. (1996). Climate Change and Water (Intergovernmental panel on climate change). *Environmental Science and Pollution Research*, 3, 52–57. <file:///C:/Users/LAWRENCE/Downloads/Documents/doc135.pdf>
- Beyene, B. B., Li, J., Yuan, J., Liu, D., Chen, Z., Kim, J., Kang, H., Freeman, C., & Ding, W. (2024). Climatic zone effects of non-native plant invasion on CH₄ and N₂O emissions from natural wetland ecosystems. *Science of the Total Environment*, 906. <https://doi.org/10.1016/j.scitotenv.2023.167855>
- Bhaga, T. D., Dube, T., Shekede, M. D., & Shoko, C. (2020). Impacts of Climate Variability and Drought on Surface Water Resources in Sub-Saharan Africa Using Remote Sensing: A Review. *Remote Sensing*, 12, 4184. <https://doi.org/10.3390/rs12244184>
- Bhardwaj, K., Mishra, A., & Khedun, C. P. (2025). Global droughts in a warming climate: Evaluation of SPI and SPEI under 1.5°, 2°, and 3 °C global warming. *Journal of Hydrology*, 659. <https://doi.org/10.1016/j.jhydrol.2025.133309>
- Bitew, M. M., & Kebede, H. H. (2024). Effect of land use land cover change on stream flow in Azuari watershed of the Upper Blue Nile Basin, Ethiopia. *Sustainable Water Resources Management*, 10(3). <https://doi.org/10.1007/S40899-024-01084-5>
- Bolan, S. (2024). Impacts of climate change on the fate of contaminants through extreme weather events. *Science of The Total Environment*, 909, 168388. <https://doi.org/10.1016/j.scitotenv.2023.168388>

- Boyd, C. E. (2000). *Water quality: An introduction*. Kluwer Academic Publishers.
- Briggs, M. A., Newman, C., Benton, J. R., Rey, D. M., Konrad, C. P., Ouellet, V., Torgersen, C. E., Gruhn, L., Fleming, B. J., Gazoorian, C., & Doctor, D. H. (2025). James Buttle Review: The Characteristics of Baseflow Resilience Across Diverse Ecohydrological Terrains. *Hydrological Processes*, 39(3). <https://doi.org/10.1002/HYP.70101>
- C Tungaraza. (2012). Long-term climate impact on the Lake Victoria region influences water level fluctuation and resource availability. *International Journal of Environmental Sciences*, 2(3). <https://doi.org/10.6088/IJES.00202030055>
- Cantonati, M., Poikane, S., Pringle, C. M., Stevens, L. E., Turak, E., Heino, J., Richardson, J. S., Bolpagni, R., Borrini, A., Cid, N., Tvrtlíková, M., Galassi, D. M. P., Hájek, M., Hawes, I., Levkov, Z., Naselli-Flores, L., Saber, A. A., Cicco, M. Di, Fiasca, B., ... Znachor, P. (2020). Characteristics, Main Impacts, and Stewardship of Natural and Artificial Freshwater Environments: Consequences for Biodiversity Conservation. *Water* 2020, Vol. 12, Page 260, 12(1), 260. <https://doi.org/10.3390/W12010260>
- Castello, L., & Macedo, M. N. (2016). Large-scale degradation of Amazonian freshwater ecosystems. *Global Change Biology*, 22(3), 990–1007. <https://doi.org/10.1111/GCB.13173>
- Chandra Voumik, L., & Sultana, T. (2022). Impact of urbanization, industrialization, electrification and renewable energy on the environment in BRICS: fresh evidence from novel CS-ARDL model. *Heliyon*, 8(11). <https://doi.org/10.1016/j.heliyon.2022.e11457>
- Cheeseman, K. (2025). *Barriers and Opportunities for Wetland Conservation in Uganda*. <https://doi.org/10.19088/K4DD.2025.084>

- Cook, P. A., Black, E. C. L., Verhoef, A., Macdonald, D. M. J., & Sorensen, J. P. R. (2022). Projected increases in potential groundwater recharge and reduced evapotranspiration under future climate conditions in West Africa. *Journal of Hydrology: Regional Studies*, 41. <https://doi.org/10.1016/j.ejrh.2022.101076>
- Cooper, D. J., Wolf, E. C., Ronayne, M. J., & Roche, J. W. (2015). Effects of groundwater pumping on the sustainability of a mountain wetland complex, Yosemite National Park, California. *Journal of Hydrology: Regional Studies*, 3, 87–105. <https://doi.org/10.1016/j.ejrh.2014.10.002>
- da Rocha, R. P., Reboita, M. S., Dutra, L. M. M., Llopart, M. P., & Coppola, E. (2014). Interannual variability associated with ENSO: present and future climate projections of RegCM4 for South America-CORDEX domain. *Climatic Change*, 125(1), 95–109. <https://doi.org/10.1007/S10584-014-1119-Y>
- Dallan, E., Bagarello, V., Ferro, V., Pampalone, V., & Borga, M. (2025). Evaluation and projected changes in rainfall erosivity: Topography dependence revealed by Convection-Permitting climate projections for the Mediterranean island of Sicily. *Catena*, 254. <https://doi.org/10.1016/j.catena.2025.108975>
- Das, M., Das, A., & Singha, S. (2025). Development of a comprehensive framework for wetland ecosystem assessment and management. *Geoscience Frontiers*, 16(3). <https://doi.org/10.1016/j.gsf.2025.102036>
- Davis, S., Grainger, M., Pfeifer, M., Pattison, Z., Stephens, P., & Sanderson, R. (2025). Restoring riparian habitats for benefits to biodiversity and human livelihoods: a systematic map protocol for riparian restoration approaches in the tropics. *Environmental Evidence*, 14(1). <https://doi.org/10.1186/S13750-025-00355-8>
- de Groot, D., Brander, L., & Max Finlayson, C. (2018). Wetland Ecosystem Services. *The Wetland Book: I: Structure and Function, Management, and Methods*, 323–333. https://doi.org/10.1007/978-90-481-9659-3_66

- Dharma, W., Yasmin, Y., Nasir, M., Fauziah, F., & Rauzana, A. (2024). Changes in urban forest land cover in Banda Aceh. *SCIENCE AND TECHNOLOGY RESEARCH SYMPOSIUM* 2022, 3065, 030011. https://doi.org/10.1063/5.0224802/20150681/030011_1_5.0224802.PDF
- Dosskey, M. G., Vidon, P., Gurwick, N. P., Allan, C. J., Duval, T. P., & Lowrance, R. (2010). The role of riparian vegetation in protecting and improving chemical water quality in streams. *Journal of the American Water Resources Association*, 46(2), 261–277. <https://doi.org/10.1111/J.1752-1688.2010.00419.X>
- Erku, D., Khatri, R., Endalamaw, A., Wolka, E., Nigatu, F., Zewdie, A., & Assefa, Y. (2023). Community engagement initiatives in primary health care to achieve universal health coverage: A realist synthesis of scoping review. *PLOS ONE*, 18. <https://doi.org/10.1371/journal.pone.0285222>
- Everard, M. (2016). Nutrient Cycling in Wetlands. *The Wetland Book*, 1–4. https://doi.org/10.1007/978-94-007-6172-8_256-2
- Fay, P. A., Guntenspergen, G. R., Olker, J. H., Johnson, W. C., Fay, P. A., Guntenspergen, G. R., Olker, J. H., & Johnson, W. C. (2016). Climate change impacts on freshwater wetland hydrology and vegetation cover cycling along a regional aridity gradient. *Ecosphere*, 7(10), e01504. <https://doi.org/10.1002/ECS2.1504>
- Ferreira, C. S. S., Kašanin-Grubin, M., Solomun, M. K., Sushkova, S., Minkina, T., Zhao, W., & Kalantari, Z. (2023a). Wetlands as nature-based solutions for water management in different environments. *Current Opinion in Environmental Science and Health*, 33. <https://doi.org/10.1016/j.coesh.2023.100476>
- Ferreira, C. S. S., Kašanin-Grubin, M., Solomun, M. K., Sushkova, S., Minkina, T., Zhao, W., & Kalantari, Z. (2023b). Wetlands as nature-based solutions for water

management in different environments. *Current Opinion in Environmental Science and Health*, 33. <https://doi.org/10.1016/j.coesh.2023.100476>

Ferronato, N., & Torretta, V. (2019). Waste Mismanagement in Developing Countries: A Review of Global Issues. *International Journal of Environmental Research and Public Health*, 16, 1060. <https://doi.org/10.3390/ijerph16061060>

Fikri, E., Fauzi, Mhd., & Firmansyah, Y. W. (2023). A Study on the Projection of Drinking Water 2023-2033 in Dki Jakarta Indonesia. *Revista de Gestão Social e Ambiental*, 17(1), e03157. <https://doi.org/10.24857/RGSA.V17N1-014>

Fortier, J., Gagnon, D., Truax, B., & Lambert, F. (2010). Nutrient accumulation and carbon sequestration in 6-year-old hybrid poplars in multiclonal agricultural riparian buffer strips. *Agriculture, Ecosystems and Environment*, 137(3–4), 276–287. <https://doi.org/10.1016/j.agee.2010.02.013>

Fry, E. L., Wilkinson, A., Johnson, D., Pritchard, W. J., Ostle, N. J., Baggs, E. M., & Bardgett, R. D. (2021). Do soil depth and plant community composition interact to modify the resistance and resilience of grassland ecosystem functioning to drought? *Ecology and Evolution*, 11(17), 11960–11973. <https://doi.org/10.1002/ECE3.7963>

Fuchslueger, L., Bahn, M., Fritz, K., Hasibeder, R., & Richter, A. (2014). Experimental drought reduces the transfer of recently fixed plant carbon to soil microbes and alters the bacterial community composition in a mountain meadow. *New Phytologist*, 201(3), 916–927. <https://doi.org/10.1111/NPH.12569>

Garzón, N. T. (2025, February 13). ‘Even the sound of the water has changed’: can Bogotá bring its wetlands back from the brink? | Colombia | The Guardian. *The Guardian*. <https://www.theguardian.com/global-development/2025/feb/13/water-colombia-bogota-bring-its-wetlands-back-from-the-brink-urban-development?>

- Geris, J., Comte, J. C., Franchi, F., Petros, A. K., Tirivarambo, S., Selepeng, A. T., & Villholth, K. G. (2022). Surface water-groundwater interactions and local land use control water quality impacts of extreme rainfall and flooding in a vulnerable semi-arid region of Sub-Saharan Africa. *Journal of Hydrology*, 609. <https://doi.org/10.1016/j.jhydrol.2022.127834>
- Granitto, M., Lopez, M. E., Bursztyn Fuentes, A. L., Maluendez Testoni, M. C., & Rodríguez, P. (2025). Relationship between riparian zones and water quality in the main watersheds of Ushuaia City, Tierra del Fuego (Argentina). *Ecological Processes*, 14(1). <https://doi.org/10.1186/S13717-025-00585-1>
- GRIFFIN, P. (2012). The Ramsar Convention: A new window for environmental diplomacy? *The IEDS Research Paper Series Institute for Environmental Diplomacy & Security IEDS*, 56–58. file:///C:/Users/LAWRENCE/Downloads/Documents/Ramsar_IEDSResearchSeries.pdf
- Griffin-Nolan, R. J., Blumenthal, D. M., Collins, S. L., Farkas, T. E., Hoffman, A. M., Mueller, K. E., Ocheltree, T. W., Smith, M. D., Whitney, K. D., & Knapp, A. K. (2019). Shifts in plant functional composition following long-term drought in grasslands. *Journal of Ecology*, 107(5), 2133–2148. <https://doi.org/10.1111/1365-2745.13252>
- Hadad, H. R., Mufarrege, M. M., Di Luca, G. A. D., & Maine, M. A. (2018). Salinity and pH effects on floating and emergent macrophytes in a constructed wetland. *Water Science and Technology*, 2017(1), 270–275. <https://doi.org/10.2166/WST.2018.110>
- Hailu, T., Assefa, E., & Zeleke, T. (2024). Urban expansion induced land use changes and its effect on ecosystem services in Addis Ababa, Ethiopia. *Frontiers in Environmental Science*, 12, 1454556. <https://doi.org/10.3389/FENV.2024.1454556/BIBTEX>

- Hajam, Y. A., Kumar, R., & Kumar, A. (2023). Environmental waste management strategies and vermi transformation for sustainable development. *Environmental Challenges*, 13, 100747. <https://doi.org/10.1016/j.envc.2023.100747>
- Hassan, W. H., Nile, B. K., Kadhim, Z. K., Mahdi, K., Riksen, M., & Thiab, R. F. (2023). Trends, forecasting and adaptation strategies of climate change in the middle and west regions of Iraq. *SN Applied Sciences*, 5(12). <https://doi.org/10.1007/S42452-023-05544-Z>
- Hedman, A. (2019). *Effects of land use on wetland carbon storage and ecosystem services in the tropics : A first estimation investing rural wetlands in central and eastern Uganda*.
- Hodge, I., & McNally, S. (2000). Wetland restoration, collective action and the role of water management institutions. *Ecological Economics*, 35, 107–118. [https://doi.org/10.1016/S0921-8009\(00\)00171-3](https://doi.org/10.1016/S0921-8009(00)00171-3)
- Hoffmann, C. C., Kjaergaard, C., Uusi- Kämpä, J., Hansen, H. C. B., & Kronvang, B. (2009). Phosphorus Retention in Riparian Buffers: Review of Their Efficiency. *Journal of Environmental Quality*, 38(5), 1942–1955. <https://doi.org/10.2134/JEQ2008.0087>
- Ikeda-Castrillon, S. K., Oliveira-Junior, E. S., Rossetto, O. C., Saito, C. H., & Wantzen, K. M. (2022). The Pantanal: A Seasonal Neotropical Wetland Under Threat. *The Palgrave Handbook of Global Sustainability*, 1–27. https://doi.org/10.1007/978-3-030-38948-2_36-1
- Ilyas, H., & Masih, I. (2017). The performance of the intensified constructed wetlands for organic matter and nitrogen removal: A review. *Journal of Environmental Management*, 198, 372–383. <https://doi.org/10.1016/J.JENVMAN.2017.04.098>

- Isunju, J. B., & Kemp, J. (2016). Spatiotemporal analysis of encroachment on wetlands: A case of Nakivubo wetland in Kampala, Uganda. *Environmental Monitoring and Assessment*, 188(4). <https://doi.org/10.1007/S10661-016-5207-5>
- Jennings, V., & Bamkole, O. (2019). The Relationship between Social Cohesion and Urban Green Space: an Avenue for Health Promotion. *International Journal of Environmental Research and Public Health*, 16, 452. <https://doi.org/10.3390/ijerph16030452>
- Jiang, Z., Li, Y., Wu, H., Mohamed Shariff, A. R. Bin, Zhou, H., & Fan, K. (2024). Unveiling the impacts of climate change and human activities on land-use evolution in ecologically fragile urbanizing areas: A case study of China's Central Plains urban agglomeration. *Ecological Indicators*, 169. <https://doi.org/10.1016/j.ecolind.2024.112936>
- Joyce, C. B., Simpson, M., & Casanova, M. (2016). Future wet grasslands: ecological implications of climate change. *Ecosystem Health and Sustainability*, 2(9). <https://doi.org/10.1002/EHS2.1240>
- Julien, N., Innocent, N., Innocent, N., & Alice, M. (2023). *Assessment on the Impacts of Urbanization on Wetland. Case Study City of Kigali*. www.globalscientificjournal.com
- Jumbi, F., Glenday, J., & Mazvimavi, D. (2024). Variation in soil water content and groundwater levels across three land cover types in a floodplain of the Kromme catchment, South Africa. *Wetlands Ecology and Management*. <https://doi.org/10.1007/S11273-024-10009-0>
- Kabiri, S., Allen, M., Okuonzia, J. T., Akello, B., Ssabaganzi, R., & Mubiru, D. (2022). Detecting wetland encroachment and urban agriculture land classification in Uganda using hyper-temporal remote sensing. *Open Research Africa*, 3, 18. <https://doi.org/10.12688/aasopenres.13040.2>

- Kairu, J. K. (2001). Wetland use and impact on Lake Victoria, Kenya region. *Lakes & Reservoirs: Science, Policy and Management for Sustainable Use*, 6, 117–125. <https://doi.org/10.1046/j.1440-1770.2001.00135.x>
- Kamal, A. S. M. M., Shamsudduha, M., Ahmed, B., Hassan, S. M. K., Islam, M. S., Kelman, I., & Fordham, M. (2018). Resilience to flash floods in wetland communities of northeastern Bangladesh. *Int J Disaster Risk Reduct*, 31, 478–488. <https://doi.org/10.1016/j.ijdrr.2018.06.011>
- Kansiime, F., Kateyo, E., Oryem-Origa, H., & Mucunguzi, P. (2007). Nutrient status and retention in pristine and disturbed wetlands in Uganda: Management implications. *Wetlands Ecology and Management*, 15(6), 453–467. <https://doi.org/10.1007/S11273-007-9054-6>
- Keith, D. A., Benson, D. H., Baird, I. R. C., Watts, L., Simpson, C. C., Krogh, M., Gorissen, S., Ferrer- Paris, J. R., & Mason, T. J. (2022). Effects of interactions between anthropogenic stressors and recurring perturbations on ecosystem resilience and collapse. *Conservation Biology*, 37. <https://doi.org/10.1111/cobi.13995>
- Kendall, M. G. (1975). *Rank correlation methods* (Griffin., Ed.; 4th ed.).
- Kent, M. (2012). *Vegetation description and data analysis: a practical approach*. John Wiley & Sons.
- Kilavi, M., MacLeod, D., Ambani, M., Robbins, J., Dankers, R., Graham, R., Helen, T., Salih, A. A. M., & Todd, M. C. (2018). Extreme rainfall and flooding over Central Kenya Including Nairobi City during the long-rains season 2018: causes, predictability, and potential for early warning and actions. *Atmosphere*, 9(12). <https://doi.org/10.3390/atmos9120472>

- Kisembe, J., Favre, A., Dosio, A., Lennard, C., Sabiiti, G., & Nimusiima, A. (2019). Evaluation of rainfall simulations over Uganda in CORDEX regional climate models. *Theoretical and Applied Climatology*, 137(1–2), 1117–1134. <https://doi.org/10.1007/S00704-018-2643-X>
- Kiwanuka-Tondo, J., Semazzi, F., & Pettiway, K. (2019). Climate risk communication of navigation safety and climate conditions over Lake Victoria basin: Exploring perceptions and knowledge of indigenous communities. *Cogent Social Sciences*, 5(1). <https://doi.org/10.1080/23311886.2019.1588485>
- Koch, S., Bianchi, V., Grutka, S. A., Martins, C. T. A., de Almeida Alves, A. A., da Silva, J. A. G., da Rosa, J. A., & Alessi, O. (2023). DIAGNOSIS OF WATER QUALITY IN AN URBAN WETLAND. *Revista de Gestao Social e Ambiental*, 17(2). <https://doi.org/10.24857/RGSA.V17N2-022>
- Kuchara, V., Charan, R., Mankad, A., & Solanki, H. (2023). WETLAND DEGRADATION AND LOSS DUE TO THE EXPANSION OF ANTHROPOGENIC ACTIVITIES. *International Association of Biologicals and Computational Digest*, 2, 41–47. <https://doi.org/10.56588/iabcd.v2i2.191>
- Kundzewicz, Z. W., Hirabayashi, Y., & Kanae, S. (2010). River Floods in the Changing Climate-Observations and Projections. *Water Resources Management*, 24(11), 2633–2646. <https://doi.org/10.1007/S11269-009-9571-6>
- Lázaro-Lobo, A., & Ervin, G. N. (2021). Wetland Invasion: a Multi-Faceted Challenge during a Time of Rapid Global Change. *Wetlands*, 41(5), 1–16. <https://doi.org/10.1007/S13157-021-01462-1/METRICS>
- Li, L., Xiao, Z., Luo, S., & Yang, A. (2020). Projected Changes in Precipitation Extremes over Shaanxi Province, China, in the 21st Century. *Advances in Meteorology*, 2020. <https://doi.org/10.1155/2020/1808404>

- Li, Z., Ma, L., Gou, D., Hong, Q., Fai, L., & Xiong, B. (2022). The Impact of Urban Development on Wetland Conservation. *Sustainability* 2022, Vol. 14, Page 13747, 14(21), 13747. <https://doi.org/10.3390/SU142113747>
- Little, C., Cuevas, J. G., Lara, A., Pino, M., & Schoenholtz, S. (2015). Buffer effects of streamside native forests on water provision in watersheds dominated by exotic forest plantations. *Ecohydrology*, 8(7), 1205–1217. <https://doi.org/10.1002/ECO.1575>
- Liu, H., Hu, Z., Zhang, J., Ngo, H. H., Guo, W., Liang, S., Fan, J., Lu, S., & Wu, H. (2016). Optimizations on supply and distribution of dissolved oxygen in constructed wetlands: A review. *Bioresource Technology*, 214, 797–805. <https://doi.org/10.1016/J.BIORTECH.2016.05.003>
- Liu, Y., Li, Y., Yang, X., Huang, G., Research, Y. L.-E., & 2021, undefined. (n.d.). of an integrated multivariate trend-frequency analysis method: Spatial-temporal characteristics of climate extremes under global warming for Central Asia. *Elsevier*. Retrieved October 27, 2025, from <https://www.sciencedirect.com/science/article/pii/S0013935121001535>
- Lolu, A. J., Ahluwalia, A. S., Sidhu, M. S., Reshi, Z. A., & Mandotra, S. K. (2019). Carbon Sequestration and Storage by Wetlands: Implications in the Climate Change Scenario. *Springer EBooks*, 45–58. https://doi.org/10.1007/978-981-13-7665-8_4
- Lu, M., & Xiao, Z. (2024). Wetland ecology and climate change: Addressing global challenges with countermeasures. *Advances in Resources Research*, 4, 67–88. https://doi.org/10.50908/arr.4.1_67
- Luhunga, P. M., & Songoro, A. E. (2020). Analysis of Climate Change and Extreme Climatic Events in the Lake Victoria Region of Tanzania. *Frontiers in Climate*, 2, 559584. <https://doi.org/10.3389/FCLIM.2020.559584/BIBTEX>

- Mann, H. B. (1945). *Nonparametric tests against trend*. *Econometrica* (13th ed.).
- Marzec, M., Listosz, A., Malik, A., Kulik, M., & Józwiakowski, K. (2024). Organic Pollutants Removal in a Hybrid Constructed Wetland Wastewater Treatment Plant with an Aeration System. *Water* 2024, Vol. 16, Page 947, 16(7), 947. <https://doi.org/10.3390/W16070947>
- Matovu, B., Sarfo, I., Bbira, Y., Yeboah, E., Muhoozi, Y., & Lukambagire, I. (2024). Navigating through Complexity by Profiling the Main Threats to Sustainable Tropical Wetlands Management and Governance: A Case Study of Mityana District, Uganda. *Discover Environment*, 2(1), 1–23. <https://doi.org/10.1007/S44274-024-00041-5/FIGURES/7>
- Maua, J. O., Mbuvi, M. T. E., Matiku, P., Munguti, S., Mateche, E., & Owili, M. (2022). The difficult choice - to conserve the living filters or utilizing the full potential of wetlands: Insights from the Yala swamp, Kenya. *Environmental Challenges*, 6. <https://doi.org/10.1016/j.envc.2021.100427>
- McCune, B., & Grace, J. B. (2002). *Analysis of ecological communities*. MjM Software Design.
- McQuaid, K., Vanderbeck, R. M., Valentine, G., Liu, C., Chen, L., Zhang, M., & Diprose, K. (2018). Urban climate change, livelihood vulnerability and narratives of generational responsibility in Jinja, Uganda. *Africa*, 88(1), 11–37. <https://doi.org/10.1017/S0001972017000547>
- Meli, P., Benayas, J. M. R., Balvanera, P., & Ramos, M. M. (2014). Restoration enhances wetland biodiversity and ecosystem service supply, but results are context-dependent: A meta-analysis. *PLoS ONE*, 9(4). <https://doi.org/10.1371/JOURNAL.PONE.0093507>

- Meng, B., Liu, J. ling, Bao, K., & Sun, B. (2020). Methodologies and Management Framework for Restoration of Wetland Hydrologic Connectivity: A Synthesis. *Integrated Environmental Assessment and Management*, 16(4), 438–451. <https://doi.org/10.1002/IEAM.4256>
- Mfitumukiza, D., Sinha, A., Simane, B., Hammill, A., Rahman, M., & Huq, S. (2020). *SCALING LOCAL AND COMMUNITY-BASED ADAPTATION*. https://gca.org/wp-content/uploads/2020/12/Local_Adaptation_Paper_-_Global_Commission_on_Adaptation.pdf
- Mganga, K. Z., Nyariki, D. M., Musimba, N. K. R., & Mwang'ombe, A. W. (2019). Indigenous Grasses for Rehabilitating Degraded African Drylands. *Climate Change Management*, 53–68. https://doi.org/10.1007/978-3-030-12974-3_3
- Mitsch, W. J., Bernal, B., & Hernandez, M. E. (2015). Ecosystem services of wetlands. *International Journal of Biodiversity Science, Ecosystem Services and Management*, 11(1), 1–4. <https://doi.org/10.1080/21513732.2015.1006250>
- Mitsch, W. J., & Gosselink, J. G. (2007a). *Wetlands*. John Wiley & Sons.
- Mitsch, W. J., & Gosselink, J. G. (2007b). *Wetlands*. John Wiley & Sons.
- Mkonda, M. Y. (2022). Sustainable management of wetlands in east Africa: A case of Akagera Wetland in the north-western Tanzania. *Environmental and Sustainability Indicators*, 16, 100210. <https://doi.org/10.1016/j.indic.2022.100210>
- Mohorji, A. M., Şen, Z., & Almazroui, M. (2017). Trend Analyses Revision and Global Monthly Temperature Innovative Multi-Duration Analysis. *Earth Systems and Environment*, 1(1), 1–13. <https://doi.org/10.1007/S41748-017-0014-X/FIGURES/13>
- Moomaw, W. R., Chmura, G. L., Davies, G. T., Finlayson, C. M., Middleton, B. A., Natali, S. M., Perry, J. E., Roulet, N., & Sutton-Grier, A. E. (2018). Wetlands In a

Changing Climate: Science, Policy and Management. *Wetlands*, 38(2), 183–205.
<https://doi.org/10.1007/S13157-018-1023-8>

Moursi, H., Youssef, M. A., & Chescheir, G. M. (2022). Development and application of DRAINMOD model for simulating crop yield and water conservation benefits of drainage water recycling. *Agricultural Water Management*, 266.
<https://doi.org/10.1016/j.agwat.2022.107592>

Moyers, K., Sabie, R., Waring, E., Preciado, J., Naughton, C. C., Harmon, T., Safeeq, M., Torres-Rua, A., Fernald, A., & Viers, J. H. (2023). A Decade of Data-Driven Water Budgets: Synthesis and Bibliometric Review. *Water Resources Research*, 59(11). <https://doi.org/10.1029/2022WR034310>

Mueller-Dombois, D., & Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. John Wiley & Sons.

Muluneh, M. G. (2021). Impact of climate change on biodiversity and food security: a global perspective—a review article. *Agriculture and Food Security*, 10(1).
<https://doi.org/10.1186/S40066-021-00318-5>

Muñoz, S. M., Schoelynck, J., Tetzlaff, D., Debbaut, R., Warter, M., & Staes, J. (2024). Assessing biodiversity and regulatory ecosystem services in urban water bodies which serve as aqua-Nature-based Solutions. *Frontiers in Environmental Science*, 11. <https://doi.org/10.3389/fenvs.2023.1304347>

Nabihamba, E. (2019). *Towards Resilient Urban Futures for Secondary Cities in Africa the case for Jinja*. 1–51.
<file:///C:/Users/LAWRENCE/Downloads/Documents/PresentationtotheSummerSchoolJinjaClimateChangeResilienceErnestNabihamba.pdf>

Namaalwa, S., Van dam, A. A., Funk, A., Ajie, G. S., & Kaggwa, R. C. (2013). A characterization of the drivers, pressures, ecosystem functions and services of

Namatala wetland, Uganda. *Environmental Science & Policy*, 34, 44–57.
<https://doi.org/10.1016/J.ENVSCI.2013.01.002>

Namaalwa, S., van Dam, A. A., Gettel, G. M., Kaggwa, R. C., Zsuffa, I., & Irvine, K. (2020). The Impact of Wastewater Discharge and Agriculture on Water Quality and Nutrient Retention of Namatala Wetland, Eastern Uganda. *Frontiers in Environmental Science*, 8. <https://doi.org/10.3389/FENVS.2020.00148/FULL>

Namisi, H., & Kasiko, M. (2009). Pressure From Below: The Case of Walukuba-Masese Division in the Municipality of Jinja, Uganda. *IDS Bulletin*, 40, 50–59.
<https://doi.org/10.1111/j.1759-5436.2009.00084.x>

Nguvava, M., & Abiodun, B. J. (2023). Potential impacts of 1.5 °C and 2 °C global warming levels on drought modes over Eastern Africa. *Climatic Change*, 176(12).
<https://doi.org/10.1007/S10584-023-03631-Z>

Nsubuga, F. N. W., Namutebi, E. N., Nsubuga-Ssenfuma, M., Nsubuga, F. N. W., Namutebi, E. N., & Nsubuga-Ssenfuma, M. (2014). Water Resources of Uganda: An Assessment and Review. *Journal of Water Resource and Protection*, 6(14), 1297–1315. <https://doi.org/10.4236/JWARP.2014.614120>

Nyamweya, C., Lawrence, T. J., Ajode, M. Z., Smith, S., Achieng, A. O., Barasa, J. E., Masese, F. O., Taabu-Munyaho, A., Mahongo, S., Kayanda, R., Rukunya, E., Kisaka, L., Manyala, J., Medard, M., Otoung, S., Mrosso, H., Sekadende, B., Walakira, J., Mbabazi, S., ... Nkalubo, W. (2023a). Lake Victoria: Overview of research needs and the way forward. *Journal of Great Lakes Research*, 49. <https://doi.org/10.1016/j.jglr.2023.06.009>

Nyamweya, C., Lawrence, T. J., Ajode, M. Z., Smith, S., Achieng, A. O., Barasa, J. E., Masese, F. O., Taabu-Munyaho, A., Mahongo, S., Kayanda, R., Rukunya, E., Kisaka, L., Manyala, J., Medard, M., Otoung, S., Mrosso, H., Sekadende, B., Walakira, J., Mbabazi, S., ... Nkalubo, W. (2023b). Lake Victoria: Overview of

research needs and the way forward. *Journal of Great Lakes Research*, 49(6).
<https://doi.org/10.1016/j.jglr.2023.06.009>

Nyamweya, C., Lawrence, T. J., Ajode, M. Z., Smith, S., Achieng, A. O., Barasa, J. E., Masese, F. O., Taabu-Munyaho, A., Mahongo, S., Kayanda, R., Rukunya, E., Kisaka, L., Manyala, J., Medard, M., Otoung, S., Mrosso, H., Sekadende, B., Walakira, J., Mbabazi, S., ... Nkalubo, W. (2023c). Lake Victoria: Overview of research needs and the way forward. *Journal of Great Lakes Research*, 49(6).
<https://doi.org/10.1016/j.jglr.2023.06.009>

Olaka, L. A., Ogutu, J. O., Said, M. Y., & Oludhe, C. (2019). Projected Climatic and Hydrologic Changes to Lake Victoria Basin Rivers under Three RCP Emission Scenarios for 2015–2100 and Impacts on the Water Sector. *Water* 2019, Vol. 11, Page 1449, 11(7), 1449. <https://doi.org/10.3390/W11071449>

Olokeogun, O. S., Ayanlade, A., & Popoola, O. O. (2020). Assessment of riparian zone dynamics and its flood-related implications in Eleyele area of Ibadan, Nigeria. *Environmental Systems Research*, 9(1). <https://doi.org/10.1186/S40068-020-00167-4>

Onyutha, C., Rutkowska, A., Nyeko-Ogiramoi, P., & Willems, P. (2019). How well do climate models reproduce variability in observed rainfall? A case study of the Lake Victoria basin considering CMIP3, CMIP5 and CORDEX simulations. *Stochastic Environmental Research and Risk Assessment*, 33(3), 687–707.
<https://doi.org/10.1007/S00477-018-1611-4/TABLES/5>

Oram, N. J., Brennan, F., Praeg, N., Bardgett, R. D., Illmer, P., Ingrisch, J., & Bahn, M. (2025). Plant community composition and traits modulate the impacts of drought intensity on soil microbial community composition and function. *Soil Biology and Biochemistry*, 200. <https://doi.org/10.1016/j.soilbio.2024.109644>

- Ostrowski, A., Connolly, R. M., & Sievers, M. (2021). Evaluating multiple stressor research in coastal wetlands: A systematic review. *Marine Environmental Research*, 164, 105239. <https://doi.org/10.1016/j.marenvres.2020.105239>
- Paz, L. E., Rodriguez, M., Gullo, B., & Rodrigues Capítulo, A. (2022). Impacts of urban and industrial pollution on functional traits of benthic macroinvertebrates: Are some traits advantageous for survival? *Science of the Total Environment*, 807. <https://doi.org/10.1016/j.scitotenv.2021.150650>
- Peng, F., Liu, L., Gao, Y., Krivtsov, V., Dobson, B., & Mijic, A. (2023). *Evaluating the impact of urban wetlands as nature-based solutions at the catchment scale*. <https://doi.org/10.5194/egusphere-egu23-6780>
- Pietroiusti, R., Vanderkelen, I., Otto, F. E. L., Barnes, C., Temple, L., Akurut, M., Bally, P., Van Lipzig, N. P. M., & Thiery, W. (2024). Possible role of anthropogenic climate change in the record-breaking 2020 Lake Victoria levels and floods. *Earth System Dynamics*, 15(2), 225–264. <https://doi.org/10.5194/ESD-15-225-2024>
- Priya, A. K., Muruganandam, M., Rajamanickam, S., Sivarethinamohan, S., Reddy, M. K., Velusamy, P., Gomathi, R., Ravindiran, G., Gurugubelli, T. R., & Munisamy, S. K. (2023). Impact of climate change and anthropogenic activities on aquatic ecosystem – A review. *Environmental Research*, 238, 117233. <https://doi.org/10.1016/j.envres.2023.117233>
- Proutsos, N. D., Tsiros, I. X., Nastos, P., & Tsaousidis, A. (2021). A note on some uncertainties associated with Thornthwaite's aridity index introduced by using different potential evapotranspiration methods. *Atmospheric Research*, 260. <https://doi.org/10.1016/j.atmosres.2021.105727>
- Qian, W., Lin, X., Zhu, Y., Xu, Y., & Fu, J. (2007). Climatic regime shift and decadal anomalous events in China. *Climatic Change*, 84(2), 167–189. <https://doi.org/10.1007/S10584-006-9234-Z/METRICS>

- Raimundo Lopes, N. D., Li, T., Qian, D., Matomela, N., & Sá, R. M. (2022). Factors influencing coastal land cover change and corresponding impact on habitat quality in the North-western Coastline of Guinea-Bissau (NC-GB). *Ocean and Coastal Management*, 224. <https://doi.org/10.1016/j.ocecoaman.2022.106181>
- Raisin, G. W. (1996). The Role of Small Wetlands in Catchment Management: Their Effect on Diffuse Agricultural Pollutants. *Internationale Revue Der Gesamten Hydrobiologie*, 81(2), 213–222. <https://doi.org/10.1002/IROH.19960810207>
- Rebello, L.-M., McCartney, M. P., & Finlayson, C. M. (2009). Wetlands of Sub-Saharan Africa: distribution and contribution of agriculture to livelihoods. *Wetlands Ecology and Management*, 18, 557–572. <https://doi.org/10.1007/s11273-009-9142-x>
- Rojas, O., Soto, E., Rojas, C., & López, J. J. (2022). Assessment of the flood mitigation ecosystem service in a coastal wetland and potential impact of future urban development in Chile. *Habitat International*, 123. <https://doi.org/10.1016/J.HABITATINT.2022.102554>
- Rowell, D. P., Booth, B. B. B., Nicholson, S. E., & Good, P. (2015). Reconciling past and future rainfall trends over East Africa. *Journal of Climate*, 28(24), 9768–9788. <https://doi.org/10.1175/JCLI-D-15-0140.1>
- Ruffins, R. (2015). *The Industrial Impact on Wetlands in Jinja and the Nexus of Industry , Wetlands , and Community (A RightsBased Sustainable Development Approach) The Industrial Impact on Wetlands in Jinja and the Nexus of Industry , Wetlands , and Community Project Adv.* file:///C:/Users/LAWRENCE/Downloads/Documents/The
- Saeed, T., & Sun, G. (2012). A review on nitrogen and organics removal mechanisms in subsurface flow constructed wetlands: Dependency on environmental parameters,

operating conditions and supporting media. *Journal of Environmental Management*, 112, 429–448. <https://doi.org/10.1016/J.JENVMAN.2012.08.011>

Sati, P., Chandola, V., Chandra, S., Trivedi, V. L., Purohit, V. K., & Nautiyal, M. C. (2025). Global environmental change mediated response of wetland plants: Evidence from past decades. *Science of the Total Environment*, 966. <https://doi.org/10.1016/j.scitotenv.2025.178668>

Shagega, F., Codalli, F., Jacobs, S., Munishi, S., Windhorst, D., & Breuer, L. (2024). Quantifying preferential flow occurrence in dependence of land cover on the southern slopes of Mount Kilimanjaro, Tanzania. *SSRN Electronic Journal*. <https://doi.org/10.2139/ssrn.4879196>

Sharma, S. N., & Ayuba, D. (2024). *Nature Based Solutions to Prevent Urban Flooding*. file:///C:/Users/LAWRENCE/Downloads/Documents/eBook_NatureBasedSolutionsUrbanFlooding.pdf

Siegel, D. I. (1988). A Review of the Recharge-Discharge Function of Wetlands. *The Ecology and Management of Wetlands*, 59–67. https://doi.org/10.1007/978-1-4684-8378-9_6

Sigopi, M., Shoko, C., & Dube, T. (2024). Advancements in remote sensing technologies for accurate monitoring and management of surface water resources in Africa: an overview, limitations, and future directions. *Geocarto International*, 39. <https://doi.org/10.1080/10106049.2024.2347935>

Sileshi, A., Awoke, A., Beyene, A., Stiers, I., & Triest, L. (2020). Water Purifying Capacity of Natural Riverine Wetlands in Relation to Their Ecological Quality. *Frontiers in Environmental Science*, 8. <https://doi.org/10.3389/FENVS.2020.00039/FULL>

- Siwiec, T., Reczek, L., Michel, M. M., Gut, B., Hawer-Strojek, P., Czajkowska, J., Jóźwiakowski, K., Gajewska, M., & Bugajski, P. (2023). Correlations between organic pollution indicators in municipal wastewater. *Archives of Environmental Protection*. <https://doi.org/10.24425/aep.2018.122296>
- Song, Z. (2025). *Characteristics and Climatic Drivers of Global Wetland Dynamics*. Helsingin yliopisto. <http://hdl.handle.net/10138/598164>
- Srivastava, S., Basche, A., Traylor, E., & Roy, T. (2023). The efficacy of conservation practices in reducing floods and improving water quality. *Frontiers in Environmental Science*, 11. <https://doi.org/10.3389/FENVS.2023.1136989/FULL>
- Sun, X., Cao, W., Pan, D., Li, Y., Ren, Y., & Nan, T. (2024). Assessment of aquifer specific vulnerability to total nitrate contamination using ensemble learning and geochemical evidence. *Science of the Total Environment*, 912. <https://doi.org/10.1016/j.scitotenv.2023.169497>
- Tam, B., Bonsal, B., Zhang, X., Zhang, Q., & Rong, R. (2024). Assessing Potential Evapotranspiration Methods in Future Drought Projections across Canada. *Atmosphere - Ocean*, 62(3), 193–205. <https://doi.org/10.1080/07055900.2023.2288632>
- Ted, F. (2011). *A Glimpse Into a Changing Climate: New 1981–2010 Climate Normals Take Effect*. *Weatherwise* (64th ed.).
- Tendurus, M., Baydin, A. G., Eleveld, M. A., & Gilbert, A. J. (2013). *City versus wetland: Predicting urban growth in the Vecht area with a cellular automaton model*. <https://arxiv.org/pdf/1304.1609>
- Trenberth, K. E. (2005). The Impact of Climate Change and Variability on Heavy Precipitation, Floods, and Droughts. *Encyclopedia of Hydrological Sciences*. <https://doi.org/10.1002/0470848944.HSA211>

- Turyahabwe, N., Kakuru, W., Tweheyo, M., & Tumusiime, D. M. (2013). Contribution of wetland resources to household food security in Uganda. *Agriculture and Food Security*, 2(1), 1–12. <https://doi.org/10.1186/2048-7010-2-5/TABLES/2>
- Turyahabwe, N., Tumusiime, D. M., Kakuru, W., & Barasa, B. (2013). Wetland Use/Cover Changes and Local Perceptions in Uganda. *Sustainable Agriculture Research*, 2(4), p95. <https://doi.org/10.5539/SAR.V2N4P95>
- Twesigye, C. K., Igunga, K., & Nakayinga, R. (2025). Effect of Land Use Activities on Water Quality and Vegetation Cover Change in Nsooba-Lubigi Wetland System, Kampala City. *East African Journal of Biophysical and Computational Sciences*, 5(2). <https://doaj.org/article/9cc58d6643564c2ea537822ae8b948b3>
- Tyole, H. (2023). Assessing the impacts of wetland degradation on the socio-economic welfare of the people in Masese wetland in Jinja district, eastern Uganda. *Mak.Ac.Ug*. <https://doi.org/http://hdl.handle.net/20.500.12281/17485>
- Ulibarri, N., Ajibade, I., Galappaththi, E. K., Joe, E. T., Lesnikowski, A., Mach, K. J., Musah-Surugu, J. I., Nagle Alverio, G., Segnon, A. C., Siders, A. R., Sotnik, G., Campbell, D., Chalastani, V. I., Jagannathan, K., Khavhagali, V., Reckien, D., Shang, Y., Singh, C., & Zommers, Z. (2021). A global assessment of policy tools to support climate adaptation. *Climate Policy*, 22, 77–96. <https://doi.org/10.1080/14693062.2021.2002251>
- UNEP. (2021). *Progress on fresh water ecosystems: tracking SDG6 series - global indicator 6.6.1 updates and acceleration needs*.
- van Dam, A., Kipkemboi, J., Zaal, F., & Okeyo-Owuor, J. B. (2011). The ecology of livelihoods in East African papyrus wetlands (ECOLIVE). *Reviews in Environmental Science and Biotechnology*, 10(4), 291–300. <https://doi.org/10.1007/S11157-011-9255-6/METRICS>

- Van Etten, E. J. B. (2009). Inter-annual rainfall variability of arid Australia: Greater than elsewhere? *Australian Geographer*, 40(1), 109–120. <https://doi.org/10.1080/00049180802657075>
- Verhoeven, J. T. A., Arheimer, B., Yin, C., & Hefting, M. M. (2006). Regional and global concerns over wetlands and water quality. *Trends in Ecology and Evolution*, 21(2), 96–103. <https://doi.org/10.1016/j.tree.2005.11.015>
- Vilas-Boas, J. A., Arenas-Sánchez, A., Vighi, M., Romo, S., den Brink, P. J., Pedroso Dias, R. J., & Rico, A. (2021). Multiple stressors in Mediterranean coastal wetland ecosystems: Influence of salinity and an insecticide on zooplankton communities under different temperature conditions. *Chemosphere*, 269, 129381. <https://doi.org/10.1016/j.chemosphere.2020.129381>
- Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., Glidden, S., Bunn, S. E., Sullivan, C. A., Liermann, C. R., & Davies, P. M. (2010). Global threats to human water security and river biodiversity. *Nature*, 467(7315), 555–561. <https://doi.org/10.1038/NATURE09440>
- Wang, S., Hu, M., Wang, Y., & Xia, B. (2022). Dynamics of ecosystem services in response to urbanization across temporal and spatial scales in a mega metropolitan area. *Sustainable Cities and Society*, 77. <https://doi.org/10.1016/J.SCS.2021.103561>
- Weiskopf, S. R., Rubenstein, M. A., Crozier, L. G., Gaichas, S., Griffis, R., Halofsky, J. E., Hyde, K. J. W., Morelli, T. L., Morissette, J. T., Muñoz, R. C., Pershing, A. J., Peterson, D. L., Poudel, R., Staudinger, M. D., Sutton-Grier, A. E., Thompson, L., Vose, J., Weltzin, J. F., & Whyte, K. P. (2020). Climate change effects on biodiversity, ecosystems, ecosystem services, and natural resource management in the United States. *Science of the Total Environment*, 733. <https://doi.org/10.1016/j.scitotenv.2020.137782>

- Wetzel, R. G. (2001). *Limnology: Lake and river ecosystems*. Academic Press.
- Wood, A., Dixon, A., & McCartney, M. (2013). *Wetland Management and Sustainable Livelihoods in Africa*.
- Wood, A., Dixon, A., & McCartney, M. (2013). *Wetland Management and Sustainable Livelihoods in Africa*. Routledge. <https://doi.org/10.4324/9780203128695>
- Wu, S., Bashir, M. A., Raza, Q. U. A., Rehim, A., Geng, Y., & Cao, L. (2023). Application of riparian buffer zone in agricultural non-point source pollution control—A review. *Frontiers in Sustainable Food Systems*, 7. <https://doi.org/10.3389/FSUFS.2023.985870/PDF>
- Xu, X., Chen, M., Yang, G., Jiang, B., & Zhang, J. (2020). Wetland ecosystem services research: A critical review. *Global Ecology and Conservation*, 22, e01027. <https://doi.org/10.1016/J.GECCO.2020.E01027>
- Yager, G. O., Modu, M., & Chijioke, F. C. (2024). The Effects of Urbanization on Wetland Ecosystem and Aquatic Biodiversity in Makurdi Metropolis, Nigeria. *Sustainability and Biodiversity Conservation*, 3(3), 15–28. <https://doi.org/10.5281/ZENODO.13996596>
- Yimer, E. A., Trift, L. De, Lobkowicz, I., Villani, L., Nossent, J., & van Griensven, A. (2024). The underexposed nature-based solutions: A critical state-of-art review on drought mitigation. *Journal of Environmental Management*, 352, 119903. <https://doi.org/10.1016/j.jenvman.2023.119903>
- Zhang, X., Wang, J., Yue, C., Ma, S., Hou, L., & Wang, L. J. (2023). Impact of wetland change on ecosystem services in different urbanization stages: A case study in the Hang-Jia-Hu region, China. *Ecological Indicators*, 153, 110382. <https://doi.org/10.1016/J.ECOLIND.2023.110382>

Zhou, H., Rao, K., Yao, M., Xiong, Y., Wang, Y., & Yin, Y. (2022). Effects of land use, meteorology, and hydrology on nutrients, biochemical indexes, and heavy metals in Qingjiang River Basin, China. *Journal of Cleaner Production*, 370. <https://doi.org/10.1016/j.jclepro.2022.133416>

Zhu, R., Zheng, H., Croke, B. F. W., & Jakeman, A. J. (2020). Quantifying climate contributions to changes in groundwater discharge for headwater catchments in a major Australian basin. *Science of the Total Environment*, 729. <https://doi.org/10.1016/j.scitotenv.2020.138910>