

Guta Wakbulcho Abeshu, PhD

Department of Civil and Environmental Engineering

New Mexico State University, Las Cruces, NM

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Assistant Professor, New Mexico State University

Education

University of Houston

Houston, TX, USA

Ph.D. in Civil Engineering (Hydrosystems)

May 2022

Dissertation: Understanding catchment ecohydrological processes and their interactions across multiple spatiotemporal scales: A Darwinian Perspective

Swiss Federal Institute of Technology (ETH Zurich)

Zürich, Switzerland

Master of Advanced Studies in Sustainable Water Resources

Feb 2016

Thesis: Remote Sensing-Based Evaluation of Hydrogeological Surplus in the Drought Prone Regions of East Africa

Addis Ababa University

Addis Ababa, Ethiopia

M.Sc. in Water Resources Engineering and Management

Jul 2013

Thesis: Hydrological and Hydrogeological Characterizations and Classifications using Remote Sensing Datasets and Models

Arba Minch University

Arba Minch, Ethiopia

B.Sc. in Hydraulic and Water Resources Engineering

Jul 2009

Thesis: Developing Rainfall-Runoff Model for Upper Omo-Ghibe River Basin and Understanding of the Cause of 2006 Flood at Omorate, Omo-Ghibe Basin, Ethiopia

Research Interest

Scientific machine learning and physics-informed AI for Earth and environmental systems • Hybrid physics–deep learning modeling, transfer and meta-learning, and deep reinforcement learning • Predictive modeling of cascading hydrological extremes, multi-sector failures • Model–data integration, surrogate modeling, and uncertainty quantification • Large-scale simulation of coupled human–Earth systems • Catchment ecohydrology and multi-scale hydrological modeling

Professional Experience

New Mexico State University

Las Cruces, NM, USA

Assistant Professor

Aug 17, 2026 – Present

Department of Civil and Environmental Engineering & The Institute for Applied Practice in AI and Machine Learning (IAAM)

Pacific Northwest National Laboratory

Richland, WA, USA

Postdoctoral Research Associate

Jan 2024 – Aug 15, 2026

Atmospheric, Climate, and Earth Sciences Division

- **GCIMS Project:** Developed hybrid physics-based and deep learning approach for global lake modeling (with T. Wild, M. Zhao, H-Y. Li)
- **ICoM Project:** Developed heterogeneity-aware deep learning model for predicting functional hydrologic signatures utilizing transfer learning and meta-learning (with H-Y. Li, Z. Tan, L.R. Leung)
- **WACCEM Project:** Developing numerical water tracer model for E3SM land component to track water sources and pathways (with H. Hu, L.R. Leung)
- **Regional Climate Research:** Investigating connections between East African drought spatial patterns and African Monsoon System dynamics (with S. Koriiche, University of Alabama)
- **Student Mentoring:** Supervising 2 PhD students at University of Houston and junior researchers at Addis Ababa University/Ethiopian Artificial Intelligence Institute on physics-informed deep learning for national streamflow modeling in Ethiopia

University of Houston

Houston, TX, USA

Postdoctoral Research Fellow

Jul 2022 – Sep 2023

Department of Civil and Environmental Engineering

- Developed a global lake modeling module for a global hydrologic model.
- Mentored graduate students.

University of Houston

Graduate Research Assistant

Department of Civil and Environmental Engineering

○ Conducted theoretical analysis in Catchment Ecohydrology.

○ Developed modeling and machine learning approaches for projects, including Xanthos-W and MOSART-Sediment.

Houston, TX, USA

Aug 2018 – May 2022

Montana State University

Graduate Research Assistant

Department of Land Resources and Environmental Sciences

○ Theoretical analysis: Catchment Ecohydrology.

○ Modeling for several projects, including Xanthos and MOSART.

Bozeman, MT, USA

Jan 2017 – Aug 2018

Teaching Experience

University of Houston

Guest Lecturer

Houston, TX, USA

2019 – Present

○ Hydrology (2 Semesters); Watershed Hydrology & Modeling (2 Semesters); Global Climate: Physical Models (3 Semester).

Montana State University

Teaching Assistant

Bozeman, MT, USA

2017 – 2018

○ Developed lab teaching material and taught lab for Watershed Analysis course.

Arba Minch University

Assistant Lecturer / Lecturer

Ethiopia

Department of Hydraulic and Water Resources Engineering

Sep 2009 – Dec 2016

○ Courses taught: Hydraulics, Open Channel Hydraulics, Engineering Hydrology, and more.

○ Supervised Bachelor Projects.

○ Served as an academic program advisor.

Grants

Project: Hydropower Reservoir Modeling Powered by Deep Reinforcement Learning

○ **Agency:** The U.S. Department of Energy's Water Power Technologies Office (WPTO)

○ **Summary:** To develop a Multi-Agent Deep Reinforcement Learning-powered, adaptive model for cascading, multipurpose reservoir systems at the basin scale.

○ **Grant Amount:** \$250,000

○ **Role:** Co-PI, Lead proposal writer

○ **Status:** Funded

Honors & Awards

○ Department of Civil and Environmental Engineering Best Dissertation Award, University of Houston, 2022

○ Graduate Student Teaching Award for Merit (2018), Montana State University, Montana, USA

○ WaterSmart Innovations and Exposition Travel Scholarship, Las Vegas, NV, 2017

○ Oeuvre St Justin Scholarship for MAS study at ETH Zurich, Sep 2014 – Sep 2015

○ Honor award, Ethiopian Institute of Water Resources, Addis Ababa University, Jul 2013

○ USAID-HED Fellowship award for M.S. study, Jun 2011 – Jul 2013

Peer-reviewed Publications

Under Review (lead)

Abeshu, G. W., Li, H.-Y., Chegini, T., Tan, Z., & Leung, L. R. (2025). Heterogeneity-aware deep learning for hydrologic signature prediction in ungauged watersheds. *Journal of Geophysical Research: Machine Learning and Computation, AGU.*

Abeshu, G. W., Li, H.-Y., & Leung, L. R. (2025). Coupling water balance and vegetation carbon dynamics in a parsimonious global hydrologic model. *Journal of Hydrology.*

Abeshu, G. W., Li, H.-Y., Wild, T., & Zhao, M. (2025). Xanthos-Lake: A novel approach to representing lakes in global hydrological models. *Journal of Advances in Modeling Earth Systems (JAMES)*, AGU.

Published

- Chowdhury, A. F. M. K., **Abeshu, G. W.**, Zhao, M., Wild, T. B., Niazi, H., Zhang, Y., Kim, G. J., Binsted, M., Lamontagne, J., & Li, H.-Y. (2026, February 3). *Repository of HydroSMADe: Hydropower site-level monthly availability data ensemble for 1950–2100 at existing and potential global sites*. <https://doi.org/10.57931/3015845>
- Li, L., Li, H.-Y., **Abeshu, G.**, Yang, X., Tang, J., Tan, Z., et al. (2026). ELM-MOSART-DOC: A large-scale riverine dissolved organic carbon model and its application over the United States. *Journal of Advances in Modeling Earth Systems*, 18, e2025MS005307. <https://doi.org/10.1029/2025MS005307>
- Abeshu, G. W.**, Li, H.-Y., Shi, M., & Leung, L. R. (2025). Causal relationships of vegetation productivity with root zone water availability and atmospheric dryness at the catchment scale. *Hydrology and Earth System Sciences*, 29(7), 1847–1864. <https://doi.org/10.5194/hess-29-1847-2025>
- Legesse, T. G., Xiao, J., Dong, G., Dong, X., Daba, N. A., **Abeshu, G. W.**, Qu, L., Zhu, W., Wang, L., Xin, X., & Shao, C. (2025). Differential responses of plant and microbial respiration to extreme precipitation and drought during spring and summer in the Eurasian meadow steppe. *Environmental Research*, 269, 120883. <https://doi.org/10.1016/j.envres.2025.120883>
- Li, L., Li, H.-Y., **Abeshu, G.**, Tang, J., Leung, L. R., Liao, C., Tan, Z., Tian, H., Thornton, P., & Yang, X. (2025). Transformation rate maps of dissolved organic carbon in the contiguous US. *Earth System Science Data*, 17(6), 2713–2733. <https://doi.org/10.5194/essd-17-2713-2025>
- Abeshu, G. W.**, Li, H.-Y., Shi, M., Brookshire, J., Tang, J., Xu, C., McDowell, N., & Leung, L. R. (2024). Generalized relationship linking water balance and vegetation productivity across site-to-regional scales. *Journal of Hydrologic Engineering*. <https://doi.org/10.1061/JHYEFF.HEENG-6163>
- Zhang, J., Yang, Y. E., **Abeshu, G. W.**, Li, H., Hung, F., Lin, C.-Y., & Leung, L. R. (2024). Exploring the food-energy-water nexus in coupled natural-human systems under climate change with a fully integrated agent-based modeling framework. *Journal of Hydrology*. <https://doi.org/10.1016/j.jhydrol.2024.131048>
- Abeshu, G. W.**, Tian, F., Wild, T., Zhao, M., Turner, S., Chowdhury, A. F. M. K., Vernon, C. R., Hu, H., Zhuang, Y., Hejazi, M., & Li, H.-Y. (2023). Enhancing the representation of water management in global hydrological models. *Geoscientific Model Development*, 16, 5449–5472. <https://doi.org/10.5194/gmd-16-5449-2023>
- Kreibich, H., Schröter, K., Di Baldassarre, G., Van Loon, A. F., Mazzoleni, M., **Abeshu, G. W.**, Agafonova, S., AghaKouchak, A., et al. (2023). Panta Rhei benchmark dataset: Socio-hydrological data of paired events of floods and droughts. *Earth Syst. Sci. Data*, 15, 2009–2023. <https://doi.org/10.5194/essd-15-2009-2023>
- Zhao, M., Wild, T. B., Graham, N. T., Kim, S., Binsted, M., Chowdhury, A. F. M. K., Msangi, S., Patel, P. L., Vernon, C. R., Niazi, H., Li, H.-Y., & **Abeshu, G. W.** (2023). GCAM-GLORY v1.0: Representing global reservoir water storage in a multisector human-earth system model. *Geoscientific Model Development Discussions*. <https://doi.org/10.5194/gmd-2023-204>
- Abeshu, G. W.**, Li, H.-Y., Zhu, Z., Tan, Z., & Leung, L. R. (2022). Median bed-material sediment particle size across rivers in the contiguous U.S. *Earth Syst. Sci. Data*. <https://doi.org/10.5194/essd-14-929-2022>
- Kreibich, H., Van Loon, A. F., Schröter, K., Ward, P., Mazzoleni, M., Sairam, N., **Abeshu, G. W.**, Agafonova, S., AghaKouchak, A., et al. (2022). The challenge of unprecedented floods and droughts in risk management. *Nature*, 608, 80–86. <https://doi.org/10.1038/s41586-022-04917-5>
- Li, H.-Y., Tan, Z., Ma, H., Zhu, Z., **Abeshu, G. W.**, Zhu, S., Cohen, S., Zhou, T., Xu, D., & Leung, L. R. (2022). A new large-scale suspended sediment model and its application over the United States. *Hydrol. Earth Syst. Sci.* <https://doi.org/10.5194/hess-26-665-2022>
- Abeshu, G. W.**, & Li, H.-Y. (2021a). Horton index: Conceptual framework for exploring multi-scale links between catchment water balance and vegetation dynamics. *Water Resources Research*, 57. <https://doi.org/10.1029/2020WR029343>
- Golaz, J. C., Caldwell, P. M., et al. (2019). The DOE E3SM coupled model version 1: Overview and evaluation at standard resolution. *Journal of Advances in Modeling Earth Systems*, 11(7), 2089–2129. <https://doi.org/10.1029/2018MS001603>

Awange, J., Gebremichael, M., Forootan, E., **Wakbulcho, G.**, Anyah, R., Ferreiraf, V., & Alemayehu, T. (2014). Characterization of Ethiopian mega hydrogeological regimes using GRACE, TRMM, and GLDAS datasets. *Advances in Water Resources*. <https://doi.org/10.1016/j.advwatres.2014.07.012>

Presentations

Conferences:

- Abeshu, G. W.**, Li, H.-Y., Chegini, T., & Leung, L. R. (2024). Transfer-learning and meta-learning for hydrological signatures regionalization [Poster]. *AGU Fall Meeting 2024*.
- Abeshu, G. W.**, Li, H.-Y., Wild, T. B., & Zhao, M. (2023). Advancing global hydrological models with a novel approach to global lake modeling [Poster]. *AGU Fall Meeting 2023*.
- Abeshu, G. W.**, & Li, H.-Y. (2022). A simple ecohydrological model for simulating vegetation carbon uptake at global scale [Oral]. *AGU Fall Meeting 2022*.
- Abeshu, G. W.**, Li, H.-Y., Wild, T. B., & Zhao, M. (2022). Representing lakes in the global hydrological model Xanthos [Poster]. *AGU Fall Meeting 2022*.
- Abeshu, G. W.**, & Li, H.-Y. (2021b). A unified functional relationship between catchment water balance and vegetation productivity [Oral]. *AGU Fall Meeting 2021*.
- Abeshu, G. W.**, Li, H.-Y., Hejazi, M. I., Wild, T. B., Vernon, C. R., & Zhao, M. (2021). A new global water management module: Distributed vs. lumped representations [Poster]. *AGU Fall Meeting 2021*.
- Abeshu, G. W.**, & Li, H.-Y. (2020). Analytical expression of Horton index using generalized proportionality hypothesis [Oral]. *AGU Fall Meeting 2020*.
- Abeshu, G. W.**, & Li, H.-Y. (2019). Catchments-scale vegetation water use efficiency: Patterns, processes, and implications [Poster]. *AGU Fall Meeting 2019*.
- Abeshu, G. W.**, & Li, H.-Y. (2018). Drought propagation through natural-human systems: The nonlinear filtering effects [Poster]. *AGU Fall Meeting 2018*.
- Abeshu, G. W.**, & Li, H.-Y. (2017). Catchment-scale water carbon coupling across the contiguous United States: A data-based analysis [Oral]. *American Water Resources Association Montana Section Conference*.
- Abeshu, G. W.**, Li, H.-Y., Yigzaw, W., Hejazi, M. I., Tang, J., & Demissie, Y. (2017). Reservoir-induced alterations in flood seasonality: Patterns, processes, and implications [Poster]. *AGU Fall Meeting 2017*.

Invited Talks:

- Surface Water Storages in Coastal Zones, University of Houston Coastal Sustainability Workshop, April 09, 2025.
- Multi-Scale Links Between Catchment Water Balance and Vegetation Dynamics, Department of Civil and Environmental Engineering, University of Houston, Houston, Texas, USA, February 11, 2022
- Drought Propagation through Coupled Water-Human System: A Darwinian Perspective, Department of Land Resources and Environmental Sciences, Montana State University, Bozeman, Montana, USA, December 4, 2017

Professional Activities

Committee Member:

- *Risk, Uncertainty, and Probabilistic Approaches Committee, American Society of Civil Engineers (ASCE)*. Role: Leading seminars and managing the social media account YouTube - EWRI RUPA.
- *Guest Editor, ASCE Journal of Hydrologic Engineering Special Collection: Water Management in a Changing Climate: Quantification and Communication of Uncertainties in Climate Predictions and Projections to Improve Decision-Making*. Special Collection - Climate Predictions and Projections.

Convened Session at Scientific Conferences:

- Primary Convener, *Understanding and Modeling Lakes Within the Hydro-Human-Ecosystem-Climate Nexus Across Local to Global Scales*, AGU2023.
- Primary Convener, *Advances in Understanding Climate, Vegetation, Soil, and Topographic Controls on Hydrologic Patterns, Processes, and Functions at the Watershed and Larger Scales*, AGU2023.
- Primary Convener, *Advances in Understanding Climate, Vegetation, Soil, Topographic, Precipitation*

Processes, and Their Subgrid-Scale Parameterization at the Watershed and Larger Scales, AGU2021.

- Session chair, *H104, Soil, Plant, and Climate Interactions in the Critical Zone under Varying Land Use, Ecosystem Management, and Climatic Forcing III eLightning*, AGU2020.
- Session chair, *H130, Human Influence on the Regional/Natural Hydroclimate*, AGU2019.
- Session chair, *H221, Water–Soil–Vegetation Dynamic Nexuses and Equilibriums in Changing Climate*, AGU2018.

Referee Roles:

- *Water Resources Research (WRR)*, *Geophysical Research Letter (GRL)*, *Journal of Hydrology (JoH)*, *Journal of Hydrologic Engineering*, *Geoscientific Model Development*, *Journal of Open Source Software (JOSS)*
- *NSF's Water, Landscape, and Critical Processes (WaLCZ) Program*

Memberships:

- American Geophysical Union (AGU), American Society of Civil Engineers (ASCE), European Geophysical Union (EGU), Ethiopian Geoscience Union International (ETGUI)

Technical Skills

Programming Languages: Python (proficient); MATLAB (proficient); FORTRAN (medium)

Software & Tools: ArcGIS / QGIS (proficient); Linux (proficient)

Techniques: Parallel Computing (working knowledge); Machine/Deep learning (proficient)