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Silicon Streams and Concrete Forests: Evaluating the Environmental, Economic, and Social Tradeoffs of AI-Driven Data Center Expansion in Northern Virginia

Ryan S. Nisay^{1,*}, Shray Vji,² Enzo Garcia-Eguiluz,³ Nawaf Shehzad,³ Christian Shire⁴ and Carter Lepuil⁵

^{1, 2, 3, 4, 5}Research Division, Loudoun Nature Conservation Project, 20166, VA, USA, ¹Cornell University, 14850, VA, USA, ²Academies of Loudoun, 20175, VA, USA, ³Northern Virginia Community College, 20164, VA, USA, ⁴Gannon University, 16541, PA, USA and ⁵Boston Conservatory at Berklee, 02215, MA, USA

*Corresponding author. ryan.nisay@loudounnatureconservation.org

Abstract

The rapid expansion of AI-driven data centers has transformed Northern Virginia into one of the most concentrated digital infrastructure hubs in the world, raising new questions about the environmental and social sustainability of large-scale computational development. While data centers are often framed as intangible components of the digital economy, they function as energy- and water-intensive industrial systems with measurable ecological and public health impacts. This study evaluates the environmental, economic, and social tradeoffs associated with AI-driven data center expansion through an interdisciplinary synthesis of environmental science literature, public health research, economic analyses, and regional policy documents. Using Northern Virginia as a case study, the analysis compares widely cited economic benefits, including tax revenue generation, employment growth, and AI-enabled technological innovation, with localized environmental pressures such as land-use change, habitat fragmentation, freshwater withdrawal, thermal discharge, and increased energy demand. Findings suggest that while institutional and regional economic gains remain significant, environmental burdens are spatially concentrated and may intensify under current regulatory frameworks that prioritize project-level approval over cumulative regional assessment. The results highlight the need for lifecycle-informed planning strategies and governance models capable of balancing technological growth with long-term environmental resilience and community health.

Key words: AI infrastructure, data centers, environmental policy, Northern Virginia, land-use change, water resources, energy demand, sustainability governance