



Environmental health performance and the nexus between terrorism and the economics of technological innovation

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Abstract

This study employs an instrumental variable fixed effect model with Driscoll-Kraay robust standard errors and System GMM to investigate the relationship between terrorism, environmental health, and technological innovation in Africa. The research explores the moderating impact of environmental health on the terrorism-innovation nexus. The empirical findings demonstrate a significant and negative influence of terrorism fatalities and incidents on environmental health indicators, indicating adverse effects on the well-being of the environment and the vitality of ecosystems. Moreover, the study validates these results by illustrating how the interaction between terrorism and environmental health indicators impedes technological innovation. In nations with lower levels of environmental health indicators, terrorism significantly hampers innovation growth, emphasizing the impact of health risks associated with terrorism on the innovation process. Conversely, in countries with high environmental health indicators, the statistical significance of terrorism's impact on innovation is not observed. The study's robustness conforms with the primary findings. The study suggests that policies should prioritize enhancing environmental sustainability and fortifying counter-terrorism measures to facilitate technological innovation for sustainable development in Africa.

Keywords Terrorism fatalities and incidents · Technological innovation · Environmental health · Africa

Highlights

1. Terrorism significantly reduces innovation rates in countries with low environmental health indicators.
2. High environmental health indicators mitigate the adverse effects of terrorism on technological innovation.
3. Enhancing environmental health infrastructure can buffer against the negative impacts of terrorism on innovation.
4. Advocating for policies prioritizing environmental sustainability and robust counter-terrorism measures for sustainable development.

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Introduction

Terrorism, a pervasive global threat, has far-reaching consequences that extend well beyond the immediate loss of life and physical destruction. Its impacts infiltrate various facets of society, including environmental health, forest ecosystem services, and technological innovation. As terrorism becomes increasingly prominent, particularly in Africa, its repercussions on these critical areas necessitate thorough examination and understanding. The escalation of terrorist activities across Africa has had profound effects on the environment, exacerbating ecological damage and undermining sustainable development prospects. Recent studies, such as those by Bussotti (2021) and Okolo et al. (2023a, 2023b, 2023c), have highlighted the rising frequency of terrorist attacks and their detrimental impact on environmental health. Terrorist acts targeting natural resources—such as forests, wildlife habitats, and water sources—have led to severe ecological disruptions. Illegal logging, wildlife poaching, and habitat destruction in regions affected by groups like Boko Haram in Nigeria, Al-Shabaab in Somalia, and al-Qaeda in the Islamic Maghreb (AQIM) in the Sahel

have significantly impaired environmental quality (Forest 2019). This environmental degradation threatens biodiversity and ecosystem stability and can hamper sustainable development efforts, impeding technological innovation for addressing environmental challenges.

Empirical evidence highlights the importance of a healthy environment for fostering technological progress. Studies by Dey et al. (2019) emphasize that environmental resilience is fundamental to socioeconomic development and innovation. However, the existing literature has not fully explored how terrorism-induced environmental degradation translates into barriers to technological advancement. For instance, while Hsu et al. (2021) have documented the general importance of environmental health for innovation, limited research links terrorism's specific environmental impacts to technological stagnation. This study aims to bridge this gap by investigating how terrorism-related environmental harm disrupts technological innovation, particularly in conflict-affected regions of Africa. The adverse effects of terrorism extend beyond direct destruction, including indirect consequences that further degrade environmental health and hinder innovation. Research has shown that terrorism disrupts governance structures and law enforcement, increasing illegal activities such as poaching, logging, and unregulated mining (Bildirici and Gokmenoglu 2020). These activities exacerbate environmental damage and undermine efforts to manage natural resources sustainably. Additionally, destroying critical infrastructure, such as energy facilities and transportation networks, impedes the deployment and use of innovative technologies essential for environmental sustainability (Akpan 2017; Bassey 2012).

The detrimental effects of terrorism on environmental health can affect technological innovation. Therefore, environmental health is crucial for fostering a conducive environment for research and development (R&D). When terrorism causes environmental degradation, such as pollution from bombings or the destruction of industrial facilities, it creates hazardous conditions that can halt or severely disrupt R&D activities. Laboratories and research facilities in areas affected by terrorism may face contamination, making it difficult for researchers to continue their work safely and effectively. For example, the release of toxic substances during terrorist attacks can lead to long-term contamination of research sites, as seen in the aftermath of the 9/11 attacks (Landrigan et al. 2004). This not only hampers current projects but also deters future investments in R&D in these regions. The degradation of environmental health due to terrorism also diverts focus and resources from innovation aimed at long-term sustainability to immediate health and safety concerns. Governments and institutions may prioritize addressing the urgent health crises caused by environmental degradation over investing in innovative technologies. This redirection of resources is evident in regions experiencing

frequent terrorist attacks, where funding is often shifted from sustainable development projects to emergency response and health care (Ellis 2008). As a result, technological advancements that could mitigate environmental health issues are delayed or sometimes abandoned.

Terrorism-induced resource depletion strains the availability of natural resources essential for innovation. In conflict zones, the over-exploitation of resources, such as water and energy, due to the displacement of populations leads to scarcity, which in turn affects the ability to sustain innovative projects. For instance, the pressure on water resources in regions hosting large numbers of refugees can impede the development of new technologies that rely on water, such as certain clean energy technologies (Nakalembe et al. 2022). This scarcity forces researchers and developers to either slow down or halt their work due to a lack of necessary inputs. Resource depletion caused by terrorism diminishes incentives for sustainable technological innovation. When resources become scarce, the immediate focus shifts to securing and rationing existing supplies rather than developing new, sustainable alternatives. This short-term focus undermines long-term innovation efforts to create more efficient and sustainable resource use. Additionally, companies and investors may be reluctant to fund innovation in regions with ongoing terrorist activities due to the high risks and uncertain returns, further stifling technological progress.

Ecological disruption caused by terrorism destabilizes ecosystems, which can have a cascading effect on innovation. The destruction of habitats and loss of biodiversity reduces the availability of natural assets, often the basis for bio-inspired technologies and ecological research. For instance, deforestation and soil degradation resulting from terrorism in Nigeria have led to a loss of plant and animal species that could have been sources of inspiration or raw materials for new biotechnologies (Targba 2022). This loss limits the potential for innovative solutions that rely on a healthy and diverse ecosystem. Ecological disruption affects the development of technologies aimed at enhancing environmental resilience. Innovations designed to mitigate the impacts of climate change, restore damaged ecosystems, or improve agricultural sustainability are hindered when terrorism disrupts ecological balances. For example, projects focused on reforestation or soil restoration may be continuously set back by recurring conflicts, delaying advancements in these critical areas. To foster innovation, it is crucial to establish a stable environment that supports sustainable development practices, including preserving natural resources and promoting environmental health.

Furthermore, this research explores the implications of terrorism-induced environmental degradation for achieving the 2030 Sustainable Development Goals (SDGs). Previous studies have addressed the environmental and socio-economic impacts of terrorism separately (Crawford 2019; Lai