Received: 3 February 2025 | Revised: 29 January 2026 | Accepted: 30 January 2026

DOI: 10.1111/cobi.70295

Conservation Biology

RESEARCH NOTE

Salary inequality as a predictor of biodiversity research output in Africa

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Article impact statement: Closing salary gaps is essential to strengthen local biodiversity research capacity and reduce dependence on foreign-led science in Africa.

Abstract

African nations contribute <1% of global scientific output, with biodiversity research productivity constrained by political instability, limited infrastructure, and restricted access. An often-overlooked barrier is low salaries, which limit the feasibility of fieldwork for local researchers. Using publication data from the Scopus database, we explored the relationship between salary disparities among locally affiliated and non-African-affiliated researchers (i.e., foreign researchers) and biodiversity research output in Africa. We then used generalized linear models to test whether these disparities predicted national publication output and the proportion of foreign-affiliated studies. We found that salary disparities between locally based and foreign researchers were inversely correlated with national research productivity and positively correlated with the proportion of foreign-affiliated publications. Local researchers face major financial barriers to conducting fieldwork and are often unable to cover basic costs without external funding, whereas foreign researchers may still retain sufficient disposable income to self-finance high-quality fieldwork even after accounting for travel expenses. These disparities perpetuate reliance on foreign institutions, constrain local research capacity, and limit Africa's ability to address its unique conservation challenges. Addressing salary inequality is essential to strengthen local research capacity and ensure more equitable contributions to global biodiversity science, especially given the rapid global decline of biodiversity.

KEYWORDS
African, income, inequality, publications, research, scientific publications

INTRODUCTION

Africa is rich in biodiversity, yet vast regions of the continent remain largely understudied (Farooq et al., 2021; Klopper et al., 2006). The scarcity of biodiversity research on the continent reflects the overall low scientific output from African nations, which contributes <1% to global scientific output (Fonn et al., 2018). This low figure correlates with Africa's minimal investment in scientific research, where sub-Saharan governments allocate, on average, only 0.4% of the gross domestic product (GDP) (Gálvez et al., 2000; The Lancet, 2019). Several factors may contribute to the limited scientific productivity, including political and economic instability (Aisen & Veiga, 2013; Waldron et al., 2013), a shortage of trained scientists and research leadership (Corbera et al., 2021; Nganhane & Farooq, 2024; Pouris & Pouris, 2009), and underdeveloped research cultures and institutional support (Gibbons, 1994; Harris, 2004; Sawyerr, 2004). Additional constraints include inadequate infrastructure and facilities, restricted accessibility and difficulties in obtaining research permits (Farooq et al., 2021), limited recognition of local knowledge in favor of foreign expertise (Tilley & Kalina, 2021), and weak collaboration among local researchers or their marginalization in international collaborations (Dahdouh-Guebas et al., 2003; Genda et al., 2022; Miller et al., 2023).

These factors create dependence on external researchers to conduct biodiversity research, despite the knowledge that local researchers have about local biodiversity and the environment (Nganhane & Farooq, 2024; Stefanoudis et al., 2021). Among these factors, salary inequalities remain relatively understudied in the context of scientific productivity. This financial constraint may contribute to the fact that much of the continent's biodiversity research is conducted in collaboration with institutions based outside Africa, rather than led by local organizations, which are few and have limited funding (Binka, 2005; Mouton & Beaudry, 2018).

Conducting fieldwork in biodiversity is inherently costly due to a wide range of logistical and operational expenses. Travel costs alone can be substantial, particularly when accessing remote or difficult-to-reach field sites, and may include transportation to and within field sites, food provisioning during expeditions, and hiring of local guides (Funk et al., 2005; Haelewaters et al., 2021; Hilhorst et al., 2016; Nganhane & Farooq, 2024). Fieldwork also requires specialized equipment to collect, analyze, and document data, ranging from traps and sampling devices to drones and imaging equipment (Lahoz-Monfort & Magrath, 2021). Biological samples and digital data often require temporary storage during expeditions, which may require the use of preservation devices and secure data storage systems (ISBER, 2008; Langlois et al., 2018; Schulz et al., 2023; Valeggia, 2007; Vaught & Henderson, 2011). Research permits and compliance with ethical standards and safety procedures can further add to the expenses, including researcher safety, adequate food supplies (Hilhorst et al., 2016; Irgil et al., 2021), and compensation of local communities or employment of local staff (Sandbrook et al., 2021).

After fieldwork is completed, additional costs arise from long-term storage and processing of samples and data, which depend on infrastructure, such as herbaria, biorepositories, freezers, and laboratory facilities. Subsequent analyses, particularly genetic studies, require specialized laboratories and associated consumables (Shokralla et al., 2012; Suarez & Tsutsui, 2004). Together, these requirements make biodiversity research financially demanding and ideally supported at the institutional level. However, there is considerable inequality in institutional budgets and in the capacity of national (African) and foreign institutions to allocate funds for research (Benito et al., 2019). These disparities add another layer to the financial challenges faced by local researchers. In some cases, scientists may still undertake expeditions despite limited grant support, often to satisfy research or degree requirements, resulting in partial or full self-funding (Mouton & Beaudry, 2018; Paudel & Giri, 2024).

We explored the relationship between the output in field-based biodiversity research and researcher salaries across Africa. We compared salaries between researchers affiliated with institutions based in African countries and those affiliated with foreign institutions conducting biodiversity research in Africa. Unlike aggregate indicators, such as GDP and HDI, individual researcher salaries directly affect the ability to self-fund research, particularly in biodiversity science, where fieldwork is costly and external funding is limited. Although scientific output is shaped by multiple factors, salary disparities are used here because they are easily measurable, policy relevant, and representative of a tangible economic constraint that may disproportionately affect local researchers' ability to lead or initiate biodiversity fieldwork. We did not distinguish between individual characteristics, such as years of research experience, secondary affiliations, additional income sources, or specific funding streams. Instead, we used the country of the institutional affiliation as a proxy for the financial environment in which the research is conducted. We hypothesized that increasing salary gaps between local and foreign-based researchers are associated with declining national scientific output and greater reliance on foreign-led research. We also assessed the feasibility of self-funding research expeditions among locally and externally based researchers while accounting for travel costs.

METHODS

To quantify the field-based biodiversity research output for each country in Africa ($n = 54$) (South et al., 2026), we used the Scopus database on 2 August 2024 because of its broad coverage and more than 99% overlap with the Web of Science database (Singh et al., 2021). We conducted individual searches for each of the countries by searching in the article title, abstract, and keywords for *survey* OR *inventory* AND "*X*," where X was the name of the country.

Because some names can be problematic (e.g., *Niger* within *Nigeria* and eSwatini was previously known as Swaziland), we tailored individual searches for each country. The list of prompts can be found in the Supporting Information (Appendix S1). To focus on contemporary research patterns and to work within a period when scientific publishing was increasingly digitized and indexed in bibliometric databases, we restricted our search to publications from the year 2000 onward. Finally, we filtered for agricultural and biological sciences to avoid studies not related to biodiversity. For each query, we retrieved the total number of publications, the names of the five affiliations with the most publications (including their country), and the number of publications assigned to the five affiliations with the most publications. Rather than assigning authors' institutional affiliations at the individual level, affiliations were aggregated across all publications per country, ensuring that papers with authors with multiple local and foreign affiliations contributed proportionally and did not bias estimates of foreign research.

We estimated the salary gap by comparing the national average salary for biology researchers in each African country with the average annual salary of the countries hosting the five affiliations with the most publications. To estimate researcher salaries, we used the International Average Salary Database (2024), which is widely used in salary comparison studies (e.g., Crocco, 2018; Hemmeda et al., 2023). Because this database does not provide separate salary estimates for different academic positions in biology, we calculated the average annual salary across the positions of biologist and professor of biology. Therefore, our analyses did not capture the nationality, career stage, or funding source of individual researchers. As such, we could not distinguish between African researchers with international grants, non-African researchers affiliated with African institutions, or other combinations. The raw data can be obtained in the Supporting Information (Appendix S1).

This approach was based on the assumption that researchers' capacity to lead or fund research was influenced by the financial resources of the country associated with their institution. We did not assess whether researchers were African nationals, nor whether funding came from grants or institutional support. We defined *foreign affiliation* as any institutional address listed on a publication that was located outside the African country

where the biodiversity research took place and *national affiliation* as one in the African country. This approach included cases where African researchers were affiliated with foreign institutions during graduate or postdoctoral training while conducting fieldwork in their home countries. Such cases may result in the research being classified as foreign affiliated even though the lead researcher also had a local connection. In these situations, we expected the researcher to have also listed a national affiliation, and therefore, the publication would have been counted under both categories, minimizing potential bias.

We calculated the salary gap as the ratio of the average estimated salary of the five affiliations with the most publications to the estimated local salary. The higher the difference between the two salaries, the higher the resulting score. Using this metric, we built two general linear models: NPub ~ salary gap and FPub ~ salary gap, where NPub is the number of publications associated with a given country and FPub is the proportion of foreign affiliations among the publications by authors from the five affiliations with the most publications (e.g., out of 100 published articles, if 90 were affiliated with foreign affiliations, then the fraction would be 0.9). Because one article may have more than one affiliation from one country, it is possible to obtain scores over 1.

To ensure that other important potential predictors for the number of publications and proportion of foreign research were not overlooked, we also ran models that included the following variables: GDP, human development index (HDI), Gini index (GINI), total population (POP) (Our World in Data, 2025a, 2025b, 2025c, 2025d), and country area (South et al., 2026). After removing GDP due to the presence of multicollinearity, we ran the following two models: NPub ~ salary gap + average salary + GINI + HDI + POP + area, and FPub ~ salary gap + average salary + GINI + HDI + POP + area.

We also compared the estimated national salary with the average salary of the foreign affiliations in the five affiliations with the highest output, while subtracting flight expenses from the country of origin to the African country (country capital to country capital). Flight expenses were calculated by retrieving the cheapest two-way ticket price for a duration of a month, provided by Skyscanner (www.skyscanner.net). The trip was scheduled 6 months in advance. This calculation allowed us to estimate the remaining salary after flight expenses at the start of the fieldwork. The raw data are also available in the Supporting Information (Appendix S1). We used USD 1000 as a conservative benchmark for the cost of a short biodiversity field trip in Africa, based on typical local expenses such as transportation, accommodation, field assistants, permits, and basic consumables, informed by our fieldwork experience, consultations with colleagues, and publicly available cost data. All analyses were conducted using R 4.4.0 (R Core Team, 2018).

RESULTS

We conducted the analyses at the country level for Africa. In total, we retrieved data for 54 countries, but due to the lack of available information on national salaries, we excluded South Sudan from our study. The estimated national salary for a researcher in biology, calculated as the average salary between a researcher in biology and a professor of biology, varied between Ethiopia, with USD 138/month, and Morocco, with USD 3584/month, whereas the median was USD 1023/month (Appendix S1). Our measure of salary gap, calculated as the ratio of the average estimated salary of the five affiliations with the most publications to the estimated local salary, varied between 1 for Algeria, Egypt, Ethiopia, Ghana, Kenya, Morocco, Nigeria, and South Africa and 34 in the case of Malawi. A value of 1 in the salary gap occurs when there is no gap between the national salaries and the average salary of the top five affiliations, which, in this case, meant that the top five affiliations in a given country were national. As for the maximum value in the case of Malawi, where all five affiliations with most publications were foreign, it showed that the average individual conducting research about Malawi had 34 times the salary of a Malawi-affiliated researcher. The second and third maximum values were from the Republic of the Congo and the Democratic Republic of the Congo, with 32 and 25 times their respective country's affiliated salary. The median salary gap had a score of 4 (four times the salary of the locally affiliated researcher). The complete table is in Appendix S1. There were no instances of foreign researchers with lower salaries than local salaries in the top five affiliations.

TABLE 1 Results of the generalized linear model relating the log-transformed number of biodiversity field survey publications about each African country to the salary gap between locally affiliated researchers and researchers affiliated with the foreign institutions producing the highest number of publications for that country.

Predictor	Estimate (SE)
Intercept	−0.373 (±0.87)
Salary gap	−0.561 (±0.14)*
National salary	0.001 (±0.16)
Gini coefficient	2.088 (±1.23)
Human development index	1.110 (±0.63)
Country area	−0.081 (±0.08)
Population size	0.607 (±0.12)

*$p < 0.001$.

We found a negative and significant relationship between the salary gap and the number of articles about a country ($R^2 = 0.40$) (Figure 1; Appendix S2). When other predictors were added to the model, the salary gap remained a significant predictor, alongside population size (Table 1) ($R^2 = 0.77$). A similar pattern was observed for the proportion of foreign research. Specifically, we found a significant and positive relationship between the proportion of foreign research and the salary gap ($R^2 = 0.35$) (Figure 1; Appendix S2), which persisted even after accounting for other predictors ($R^2 = 0.81$). When other predictors were included, both HDI and population size emerged as significant predictors, with an inverse relationship with the fraction of foreign research (Table 2).

When comparing the local with foreign salaries after controlling for flight expenses, we found that foreign researchers,

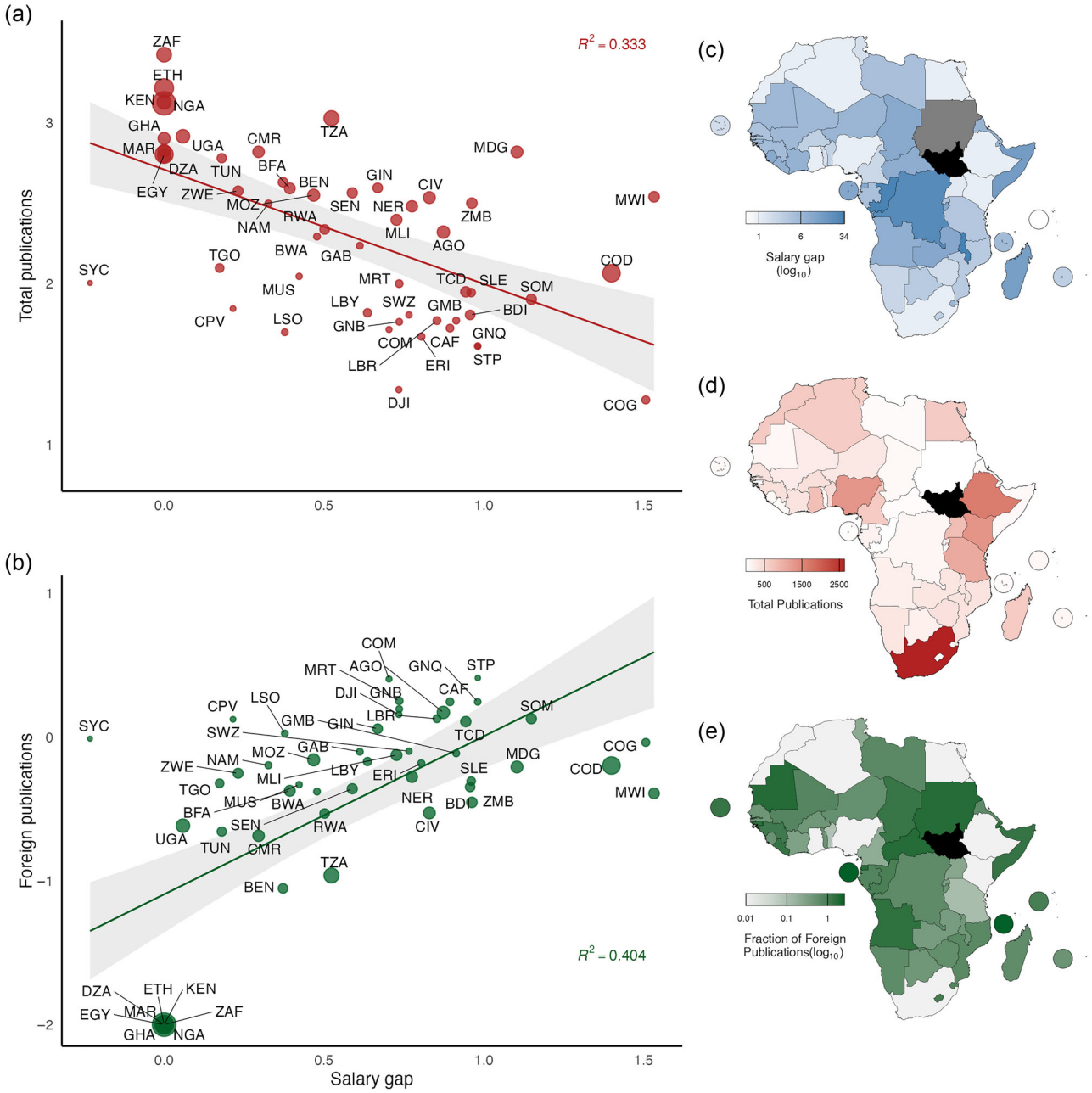

FIGURE 1 Relationship between the salary gap and (a) the number of total publications on biodiversity in each African country and (b) the fraction of publications produced by authors with non-African affiliations (abbreviations defined in Figure 2 and Appendix S1), and the continental distribution of (c) salary gap (log_{10}), (d) total number of publications, and (e) fraction of publications by authors with non-African affiliations (foreign publications).

often flying from other continents, would have a higher remaining salary to conduct the fieldwork than the local researchers with no flight expenses. With an arbitrary expense of USD 1000 for the fieldwork, only five countries would have kept at least half of their salary: Algeria, Cabo Verde, Djibouti, Morocco, and South Africa (Figure 2a). These five countries alone contribute a fifth of the publications of the continent. On the other hand, half of the countries in Africa would not be able to cover the USD 1000 fieldwork expenses with the totality of their salary (Appendix S1).

DISCUSSION

Our study highlights the significant impact of salary disparity between locally based and foreign-based researchers on the production of biodiversity-related research in Africa. As the disparity between the salaries of African-based researchers and foreign-based researchers increases, national scientific output declines, whereas the proportion of foreign-affiliated publications increases. This pattern suggests increased reliance on externally affiliated researchers (Chapman et al., 2022; Mabele

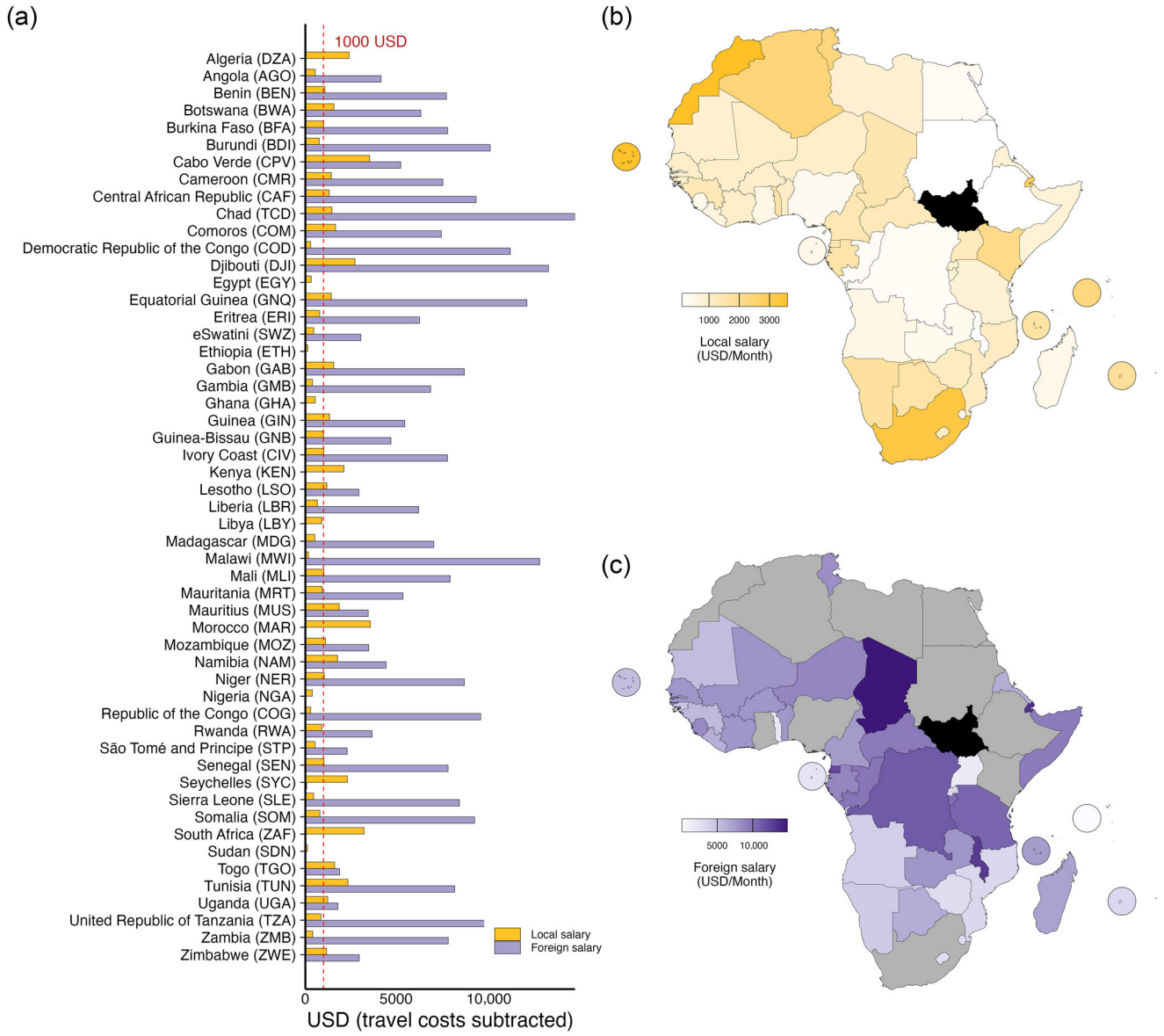

FIGURE 2 (a) Estimated local salary for an African researcher in biology (yellow) and average salary of the five most prevalent non-African (i.e., foreign) institutions associated with researchers working in each country (purple) and the continental distribution of (b) estimated salaries for researchers with African affiliations and (c) estimated average salary of researchers with foreign affiliations (black, excluded from analyses; dark gray, countries where the top five affiliations were national). Estimated foreign salaries were subtracted from the travel expenses to reach the capital of each country.

et al., 2023). Scientific productivity is, however, also shaped by a variety of structural and systemic factors, including governance, education systems, research infrastructure, and international networks (Gibbons, 1994; Kwiek, 2018; Nuñez et al., 2021). Therefore, our findings do not imply that salary is the sole or even dominant driver. Rather, we identify salary disparities as a significant correlate of biodiversity research output in Africa, even when controlling for other socioeconomic variables. Together, these results highlight Africa's limited ability to fully leverage its biodiversity for scientific advancement and conservation.

Financial barriers to local research

Fieldwork in biodiversity studies is resource intensive, requiring funding for travel, equipment, permits, and post-fieldwork analyses. We found that even after subtracting travel expenses, foreign-based researchers often retain a substantially higher disposable income than their local counterparts, enabling more extensive and higher-quality fieldwork, whereas locallybased researchers struggle to meet even basic needs (Bezuidenhout et al., 2017). For instance, half of the African countries studied could not meet a USD 1000 budget for fieldwork expenses,

TABLE 2 Results of the generalized linear model relating the log-transformed proportion of biodiversity field survey publications about each African country that includes foreign institutional affiliations to the salary gap between locally affiliated researchers and researchers affiliated with the foreign institutions producing the highest number of publications for that country.

Predictor	Estimate (SE)
Intercept	1.936 (±1.23)
Salary gap	0.720 (±0.17)**
National salary	0.290 (±0.20)
Gini coefficient	2.328 (±1.500)
Human development index	−2.783 (±0.77)**
Country area	0.126 (±0.10)
Population size	−0.785 (±0.14)**

*$p < 0.05$; **$p < 0.001$.

even when allocating their entire monthly salary to these costs. Despite most of the fieldwork in biodiversity research in Africa being conducted through short-scale and short-term expeditions (e.g., 1–2 weeks) (Melville & Gaugris, 2020), this amount remains an extremely conservative budget for a short field expedition once basic logistical requirements are considered.

Low salaries may further reduce productivity by forcing academics to pursue side work, such as consultancies or administrative roles, limiting time for scientific activities (Preston, 2004; Rhoades & Slaughter, 1997). Together, these mechanisms contribute to reduced biodiversity research output and perpetuate a system in which foreign researchers dominate biodiversity studies on the continent (Ahrends, Burgess, et al., 2011; Confraria et al., 2017). Although international collaborations can provide valuable expertise and resources (Mouton & Beaudry, 2018), their predominance often comes at the expense of local capacity (Haelewaters et al., 2021; Nganhane & Farooq, 2024; Rakotonarivo & Andriamihaja, 2023). The resulting low publication output further limits access to international funding, which often requires a demonstrated record of scientific productivity (Ger et al., 2024).

Broader implications for research capacity

In the Global North, biodiversity fieldwork is typically grant funded due to stronger institutional support, although early-career researchers and graduate students may still cover minor costs themselves (Chankseliani, 2023; Horta et al., 2018; Petersen, 2021). In contrast, researchers in Africa often rely on self-funding, particularly for exploratory fieldwork (Mouton & Beaudry, 2018). Consistent with this disparity, our analyses showed that financial constraints and population size shape research output and the proportion of foreign-led research. Low salaries may also negate the advantage of larger potential researcher pools. We found no association between scientific output and the GINI coefficient, but the low participation of women in African science likely represents an additional constraint on research capacity (Beaudry et al., 2023; El-Ouahi & Larivière, 2023; Sougou et al., 2022). Reliance on foreign-led research may also have important implications for research agendas and innovation, potentially limiting alignment with local conservation priorities and the integration of traditional ecological knowledge (Albuquerque et al., 2021; Genda et al., 2022; Haelewaters et al., 2021; Shackeroff & Campbell, 2007; Stefanoudis et al., 2021). Together, these patterns point to long-standing structural constraints on local research capacity shaped by historical and institutional factors (Cloete & Maassen, 2015; Farooq et al., 2026).

Limitations

Some of our assumptions warrant consideration. First, biodiversity research is generally expected to be grant funded rather than supported by individual salaries. However, grants rarely support exploratory expeditions into poorly studied areas (Ahrends, Rahbek, et al., 2011; Waldron et al., 2013), instead prioritizing known biodiversity hotspots or threatened taxa (Ahrends, Burgess, et al., 2011; Dasgupta, 2021; Farooq et al., 2021). As a result, exploratory fieldwork is often partially or fully self-funded by researchers or students (Mouton & Beaudry, 2018; Paudel & Giri, 2024). Second, we used the number of publications in the Scopus database as a surrogate for scientific output, which excludes reports, thesis, and scientific articles not indexed in this database (Benzies et al., 2006). Third, foreign affiliations may also include studies led by national institutions, potentially overestimating foreign research. However, because publications typically list both national and foreign affiliations, this is unlikely to affect our ratio-based approach. Distinguishing between locally led research and local middle authorship could provide complementary insights, but evidence suggests that researchers in developing countries are frequently included as middle authors in Global North–South collaborations, making the impact of this limitation minimal (Akudinobi & Kilmarx, 2022; Antonelli et al., 2023; González-Alcaide et al., 2017; Hedt-Gauthier et al., 2019).

Recommendations for bridging the gap

Many African countries invest <0.5% of GDP in scientific research (The Lancet, 2019). Researchers and other professionals also remain poorly remunerated (Kokwaro & Kariuki, 2001), reducing motivation, performance, and retention, as well as encouraging migration or the pursuit of alternative income generating activities (Harris, 2004; McCoy et al., 2008; Okeke, 2014; Preston, 2004; Roenen et al., 1997). Together, these conditions constrain the development of equitable and sustainable biodiversity research capacity across the continent. Addressing salary inequality, therefore, represents a critical leverage point, as increasing local researchers' salaries would improve their capacity to conduct fieldwork and help retain scientific talent. Achieving this will require increased investment in research and higher education. Governments, universities, and international organizations should prioritize investments in local research

capacity by dedicating a greater proportion of national GDP to research and higher education, providing competitive salaries, and establishing national research funds for biodiversity studies. Reducing reliance on foreign institutions will depend on a collaborative and ethical approach that combines increased investment, capacity building, and policy reform.

ACKNOWLEDGMENTS

The authors have no acknowledgments to declare.

DATA AVAILABILITY STATEMENT

Data used are in the Supporting Information.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Farooq, H., & Nganhane, I. D. N. (2026). Salary inequality as a predictor of biodiversity research output in Africa. *Conservation Biology*, e70295. https://doi.org/10.1111/cobi.70295