Research Statement

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We live in an era of widespread ecosystem collapse, biodiversity loss, and profound environmental change. Yet we are only beginning to understand their economic and distributional consequences for households and firms, as well as the costs and benefits of policies designed to address them. While economists have long studied the valuation of environmental goods and the design of environmental policies, we are now at a point where the consequences of environmental degradation and responses to regulation are increasingly observable, and where new data and empirical methods allow us to study them with greater precision.

My research program has two complementary strands. The first examines how environmental degradation affects livelihoods, nutrition, and welfare, focusing on coral reefs and, in the longer term, other ecosystems. The second investigates how environmental quality and climate policy affect firms, including the productivity consequences of air pollution and firms' responses to carbon pricing. Across both areas, I combine remote sensing, administrative and household data, and causal inference to understand the aggregate and distributional consequences of environmental change and policy.

Primary Agenda: Ecosystem Degradation and Human Welfare

Coral reefs are among the first ecosystems to suffer large-scale degradation from climate change. They are, in some sense, the canary in the coal mine for climate-induced ecosystem loss, which is why understanding the impacts of reef loss also helps us understand the dynamics that matter for ecosystems at large. Yet credible ex-post evidence on the costs of coral bleaching remains scarce, largely because consistent observations of bleaching are unavailable outside the Great Barrier Reef and selected survey sites. Existing studies therefore rely on thermal stress, which can affect fisheries and coastal economies through channels other than bleaching, or on limited in-situ observations. Overcoming this measurement problem and using the resulting data to identify causal economic effects forms the foundation of my research.

Job Market Paper: Coral Bleaching, Livelihoods, and Child Health

In my **single-authored** job market paper, *Coral bleaching reduces child growth through nutritional pathways* (under review at *Nature Climate Change*), I built a satellite-based coral bleaching dataset for East Africa from Sentinel-2 reflectance, normalized against non-coral benthic cover in the same pixel and classified using a deep recurrent neural network trained on global survey and Australian aerial-survey data. The model reliably separates bleached from non-bleached reef cells it has never seen, which makes the data dense and consistent enough to serve as a source of identifying variation rather than being confined to unevenly sampled survey sites. To identify causal effects, I instrument observed bleaching with accumulated heat stress while controlling flexibly for current sea surface temperatures. This exploits the fact that corals respond to long-run thermal accumulation, while reef fish respond to, and relocate with, contemporaneous temperature. A falsification test supports the design: past heat stress predicts catch in bleached areas but not in unbleached ones, conditional on my controls. Studying every link from a climate-driven ecosystem shock to child health, I find that a one-standard-deviation increase in bleaching reduces fish catch per fisher-day by about 26% of the mean in Kenya, that strongly affected households in Tanzania consume about 21% less fresh fish, and that children across four countries who are exposed to bleaching in utero or in their first two years are significantly shorter for their age: a one-standard-deviation increase in cumulative exposure lowers height-for-age by about 11%. Households, moreover, do not appear to adapt through assets, labor, or migration.

Research Infrastructure: A Global Satellite-Derived Bleaching Dataset

While the East African dataset was a proof of concept, I have now completed a global version providing monthly observations of coral bleaching at 5-kilometer resolution for all reefs mapped by the Allen Coral Atlas with Sentinel-2 coverage. I am preparing the accompanying paper for submission around the turn of 2026/2027. By providing spatially consistent observations across the fourth global bleaching event, the dataset creates new opportunities to study the ecological and economic consequences of reef degradation worldwide. I am also extending the model to measure bleaching intensity and distinguish coral mortality from subsequent recovery using temporal changes in satellite reflectance.

Ongoing Research: Fisheries, Micronutrients, and Ecosystem Impacts

Building on the dataset, I am currently working on three follow-up papers in different stages of completion. The first one, which is a direct extension of my job market paper, studies *how bleaching impacts micronutrient densities* in East African fisheries, together with Bryan Galligan. I also work on a project to *understand the impacts of coral bleaching on human–wildlife conflict* with Francesco Cenerini. Both projects have yielded initial results, and we are preparing manuscripts. A larger undertaking, which is still at an early stage, is an analysis of the *global bleaching impacts on fish biomass* with Christopher Golden and Jessica Zamborain-Mason, with an extension to long-term projections planned with Christina Dräger.

Next Major Projects: Global Nutrition and Australia's Reef Economy

I aim to make two follow-up projects my next major papers: one on the economic impacts of bleaching in Australia, with Ben Henley and Neal Cantin, and one on its global nutrition dimension, with Jonas Stehl. The first asks what mass bleaching has actually cost reef-dependent industries in Australia. We will combine an event-study design around the Great Barrier Reef's mass bleaching events with the instrumental-variable strategy from my dissertation, applied to Queensland commercial fisheries logbooks and Reef Authority visitor data, to separate the ecological channel from a perception channel operating through undifferentiated media coverage of a reef system 2,300 kilometers long. This distinction has direct policy implications, since existing Australian damage estimates so far vary widely and are drawn almost entirely from stated-preference methods rather than realized outcomes. We also plan to complement the analysis with an experimental valuation study to estimate the broader economic value of the Great Barrier Reef, including benefits not captured by observed market outcomes. Our aim is to provide one of the first causally identified estimates of the realized economic costs of coral bleaching in a high-income economy. The second project extends my identification strategy globally, using Demographic and Health Survey data for more than twenty countries to ask whether the East African fisheries-to-nutrition effects generalize across income levels and ecological settings. In particular, I aim to investigate how vulnerability varies with household wealth, access to alternative food sources, and local economic conditions, and whether ecosystem degradation reinforces existing inequalities in nutrition and human capital.

Long-Term Agenda: Beyond Coral Reefs

Going forward, I plan to extend my work to other ecosystems where the same measurement gap exists. For forests, satellite records capture outright clearing well, but much less so gradual degradation, such as drought-induced dieback, fire damage, or selective logging, even though degradation can erode the services forests provide long before any tree-cover loss is recorded. Among marine and coastal habitats, the loss of mangroves, seagrass meadows, and kelp forests threatens the same fisheries and coastal livelihoods my current work studies, but is rarely measured consistently over time. In each case, the combination I have developed for reefs and air quality carries over: models trained on ground-truth observations to detect environmental change from space, an identification strategy that separates environmental loss from the climatic and economic shocks that cause it, and collaborators from the relevant natural sciences.

Secondary Strand: Firm-Level Effects of Environmental Change and Policy

My second area of research examines the relationship between environmental quality, climate policy, and firm behavior. Using German administrative manufacturing data, I investigate both how environmental degradation affects firms' productive capacity and how firms respond to policies aimed at reducing emissions. Together, these projects contribute to understanding the economic costs of pollution, the adjustment costs of climate policy, and the potential benefits of cleaner production.

Working Paper: Air Pollution and Firm Productivity

My second main paper, *Bad for Business? The Impact of Air Quality on Firm Outcomes in Germany* (with Beat Hintermann and Corrado Di Maria), examines how fine particulate matter affects production and labor productivity in German manufacturing. Combining satellite-derived $PM_{2.5}$ with administrative plant-level data covering German manufacturing from 2003 to 2018, we face an identification problem similar to my coral work: economic activity itself generates pollution. We therefore instrument pollution with the strength of temperature inversions, which trap pollutants near the surface, while controlling flexibly for temperature, wind, and other weather conditions. As with coral bleaching, a falsification test

supports the design: pollution on weekdays reduces output, while pollution on weekends, when most plants do not operate, does not. A one-standard-deviation increase in $PM_{2.5}$ ($0.9\,\mu g/m^3$) reduces the value of production by 1.6% and hours worked by 1.1%. Because we observe output and hours within the same plants, a production framework allows us to separate the two channels: most of the loss comes from lower labor productivity for any plausible output elasticity of labor. We also show that aggregating to the firm level, as most of the literature has to, masks the effect on hours entirely. Even at Germany's comparatively low pollution levels, our estimates imply that a reduction of $1\,\mu g/m^3$ would have raised manufacturing value added by roughly EUR 12 billion in 2018, well above the cost of policies such as low-emission zones. The paper was reviewed at the *American Economic Review*, and we are currently revising it in response to the referee reports for submission to the Journal of the European Economic Association.

Ongoing Research: Firm Responses to Carbon Pricing

My air-quality research also connects to climate policy: fine particulates and greenhouse gases largely originate from the same combustion processes, making improvements in air quality an important potential co-benefit of carbon pricing. Building on my experience with German administrative firm data, I study with Francisco J. André, Corrado Di Maria, and Beat Hintermann whether firms regulated under the EU Emissions Trading System adjust their product mix in response to carbon pricing. This represents an adjustment mechanism beyond the commonly studied emissions-reduction and relocation channels, with implications for compliance costs and competitiveness. Complementing this firm-level research, an ongoing project with Paula Castro Pareja draws on my experience in international climate negotiations to examine how submissions by non-state actors influence global climate policy outcomes.

Planned Research: CBAM and the EU ETS

I plan to extend this strand as the EU ETS enters a new phase, characterized by a declining emissions cap and the gradual phase-out of free allocation alongside the Carbon Border Adjustment Mechanism (CBAM). Building on my existing work with German administrative manufacturing data, I aim to combine the AFiD firm and establishment panels with product-level production statistics, firm-level foreign trade records, and installation-level emissions and allowance allocations from the EU ETS Union Registry. Subject to data access and linkage, this would allow me to examine how firms adjust their production, product mix, and international sourcing as the costs of carbon-intensive production change. In particular, I plan to exploit differences in firms' initial exposure to CBAM-covered products, imported inputs, and free allocation to study adjustment along these margins. Combined with my air-quality research, this agenda would also allow me to investigate the local productivity benefits of emissions reductions, an often-overlooked component of the welfare effects of climate policy, and how the costs and benefits of climate policy differ across firms, industries, and regions. I intend this to remain a secondary strand, complementing rather than competing with my primary research agenda.

Interdisciplinary Research and Funding

My research is interdisciplinary by design. Measuring ecosystem degradation requires remote sensing and machine learning, while interpreting its consequences requires expertise in ecology, nutrition, and public health. I collaborate with researchers at Harvard University, KAUST, the Australian Institute of Marine Science, and RMIT University, contributing the economic questions and causal identification strategies that connect environmental observations to economic outcomes. These collaborations allow me to address questions that would be difficult to investigate within economics alone and to communicate findings to both economic and interdisciplinary audiences.

I have also built a track record of securing the resources this agenda requires. I co-developed the SNSF grant that funds the East Africa project (CHF 100,425) with Beat Hintermann, and separately secured a grant from the Supporters' Association of the Faculty of Business and Economics, a Burckhardt-Bürgin travel grant, and a competitive, university-wide Doc.Mobility fellowship of the University of Basel. Together, these have funded the data work, analysis, and international collaboration this agenda runs on, and I expect to build on this record as the agenda scales globally.

Looking Ahead

Over the next five years, I aim to establish the global bleaching dataset as openly available research infrastructure, use it to quantify the economic and distributional consequences of reef degradation across different settings, and extend this approach to other vulnerable ecosystems. Alongside this primary agenda, I will continue investigating how environmental quality and climate policy shape firm behavior and productivity. Across both strands, my approach remains the same: combining novel environmental data with credible causal identification and interdisciplinary collaboration to measure the economic consequences of environmental change and inform policy.