EDU468901

Design for Environmental Justice and Resilience

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Learning Objectives

- Discover ways in which engineers can take actions to design for environmental justice and resilience
- Examine historical, political, and unjust global practices which keep poor and vulnerable people at a global disadvantage
- Discover case studies in environmental justice engineering related to water quality, air quality, and climate resilience
- Learn about the differences between sustainable or unsustainable measures of global progress toward a more equitable world

Description

As engineers, we solve problems by evaluating inputs, outputs, and boundary conditions. Engineers have attempted to solve problems surrounding the effects of global poverty since it has existed, but often neglect important historical and political inputs. Neglecting these inputs has resulted in growing global inequalities in terms of wealth, human rights, and livelihood. One factor leading to these disparities is how we go about measuring progress toward a more equitable world. How can engineering help effectively measure global inequalities and give justice to vulnerable people who have been and continue to be excluded and exploited, all while bearing the brunt of the ecological impact of climate change? In this class, we will discuss better ways of measuring inequalities, designing for environmental justice, and bringing the industry's attention to these systemic and historical realities which are often ignored by practitioners.

Speaker(s)

Chantal Iribagiza is a Ph.D. Candidate at the University of Colorado, Boulder, in the Environmental Engineering program. Her research work with the Mortenson Center in Global Engineering concerns the adoption and service delivery of water and energy interventions in low-income communities.

Emily Bedell is a Graduate Research Assistant in the Mortenson Center in Global Engineering and Doctoral Student in the Environmental Engineering program at the University of Colorado, Boulder. Her current research centers around the development of an optimized, low-cost fluorescence sensor for detection of fecal contamination risk in drinking water, real-time. Emily is interested in challenging the current ideals of how engineering can be used to advance environmental protections in historically exploited countries and communities.

Introduction

As engineers, we are natural problem solvers. We take boundary and intial conditions as inputs to our equations and produce beautiful solutions to complex problems. When it comes to global development, engineers in the Global North have been missing critical intial and boundary conditions from their equations for decades. These inputs are the historical and political factors that have either been forgotten or intentionally ignored to perpetuate current global systematic injustices.

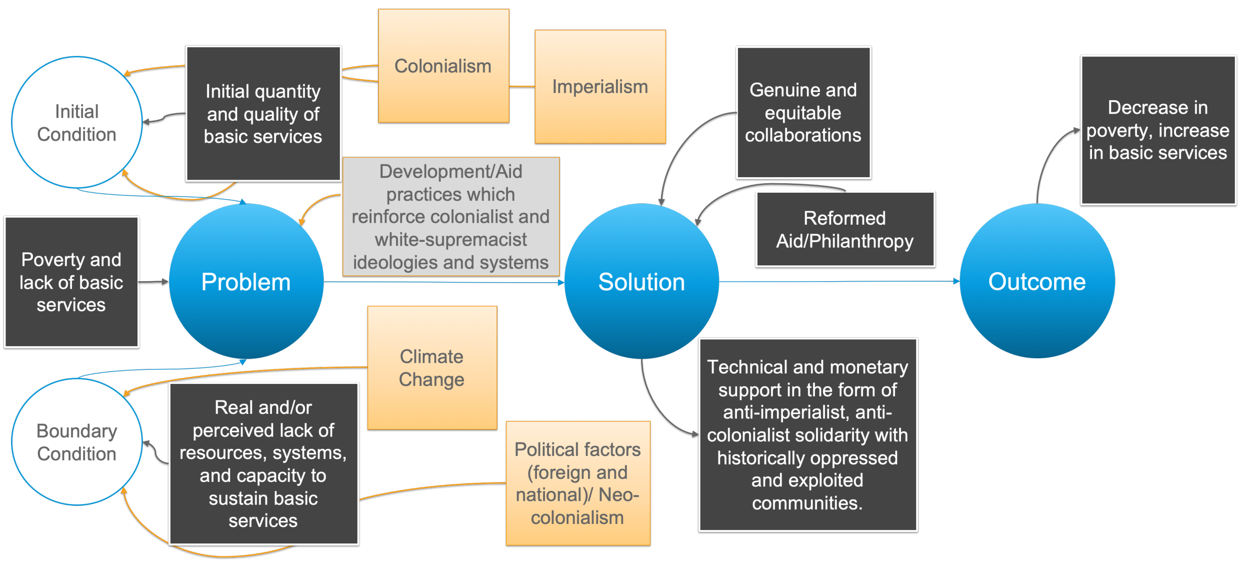

Figure 1. Often ignored inputs in the Global Engineering equation and how they can lead to a more impactful solution

Measuring Global Inequalities

How we measure and interpret global inequalities, whether they're economic, environmental, or in terms of access to basic services, will determine the strategy we implement to reduce and mitigate those inequalities.

Economic Inequalities

Comparing economic standing from country to country has been a contriversal topic for some time. Countries are now ranked from low-income to high-income, based on their Gross Domestic Product (GDP), but does that measure adequately account for social, human, or ecological dimensions of society? No. This is why the Sustainable Development Index (SDI) was created to measure the ecological efficiency of human development. The SDI should set the goal posts when engineering for sustainable development, not GDP, or else our environment and people's livlihood's will suffer.

Inequalities in Basic Services

Access to basic human needs such as safe drinking water and clean cooking energy remains a challenge for about 1 in 3 people globally. This poverty-related issue carries substantial health, environmental and socio-ecoomic consequences which are mainly suffered by people living in low and middle-income countries.

The Sustainable Development Goals, commonly know as the SDGs are another way of measuring global inequalities. The SDG were developed as part of Agenda 2030, which seeks to end poverty, protect the planet and improve human welfare. The agenda was adopted by all UN member countries in 2015 and the SDGs are now widely used to measure progress to sustainable development. This includes access to basic infrastructure and services, social equity, ecosystems conservation, as well as global peace and security, among other sustainable development indicators.

Figure 2. The Sustainable Development Goals highlighting Clean Water and Sanitation and Affordable and Clean Energy

Historical and Systematic Issues

Colonialism and Resource Extraction

Countries which are now low-income faced massive exploitation and seizure of resources by what are now considered high-income countries throughout the 1900's. This process of exploitation destabilized many governments throughout the world, leading them to rely on high-income countries for loans that would put them in debts that they are still paying off today.

Currently, resources provided from low-income countries to high-income countries—dramatically exceeds inflows. Financial outflows, attributable to debt and interest payments, repatriation of corporate profits, and capital flight including trade misinvoicing and tax avoidance, accounted for over 5 trillion dollars in 2012. This, currently, three trillion dollars per year in total net outflows is 18 times the annual global foreign aid budget. In other words, low-income countries are net creditors to rich countries.

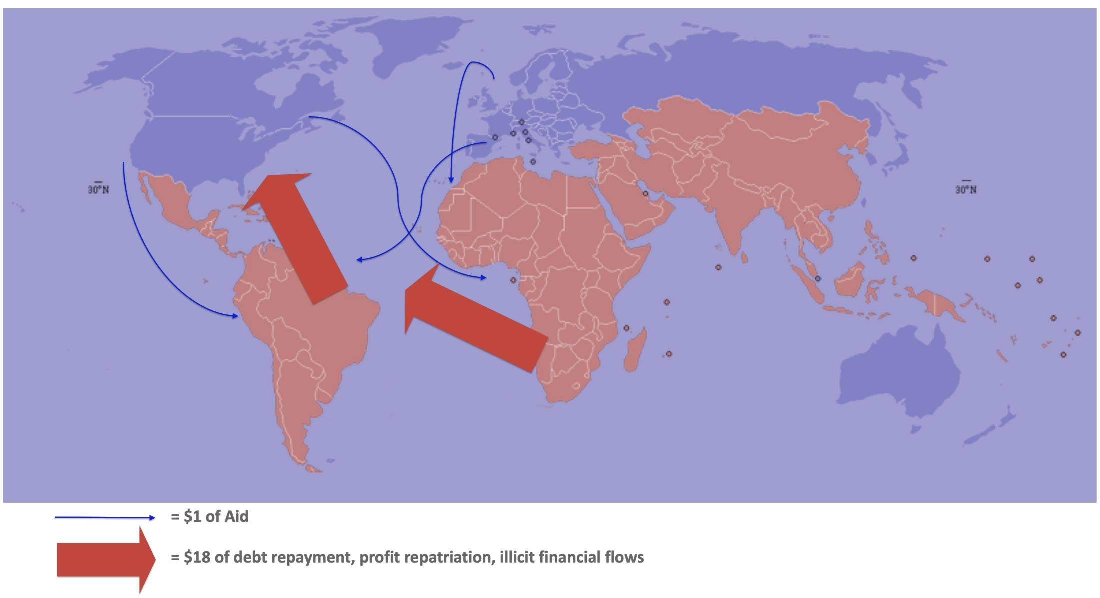

Figure 3. Money inflows and outflows to and from the Global South

The Role of Engineers

One of the things we can do as Global Engineers is to learn from past shortfalls and do better. Usually, as engineers, we tend to focus on technical solutions. However, the lack of access to clean drinking water in the Global South is deeply rooted in systems failure. Inventing a better water supply technology or better water filter is unlikely to help solve this issue. In addition, experimentations, short-term solutions, and misunderstanding of local and global systems at play in the water sector have hindered efforts to deliver universal access to safe drinking water. This failure often manifests itself in the form of poor service delivery. For example, water handpumps, a go-to technology for rural water supply in the Global South, face significant sustainability and service delivery challenges. The majority of these facilities are managed by volunteering community members, without adequate resources or technical capacity to deliver adequate maintenance when needed, or to adequately address safety issues when they arise. This results in a high rate of infrastructure breakdown and exposure to harmful water pollutants.

Our work in the Mortenson Center supported by Autodesk

Our work at the Mortenson Center in Global Engineering combines research, education, and partnerships in efforts to contribute to resilient communities worldwide.

This includes Drought Resilience work in arid regions of East Africa and California. We are using in-situ sensors and remote sensing technologies to monitor and forecast water availability. We then use that data to plan and allocate resources for drought emergencies mitigation. We do this work in partnership with the Millennium Water Alliance, local service providers and other in-country partners. We also use this sensor data to improve operational practices and service delivery. For example, in 2015, we tested a data-driven Operations and Maintenance model and compared its performance to a standard O&M model, and an improved O&M model. Through this new data-driven O&M model, we were able to improve infrastructure functionality, from a baseline of 57% to a record 91% functionality rate, over a period of about 7 months.

We are working to implement the application of smarter, more actionable monitoring and decision support systems can be useful toward realizing the health gains expected of global environmental health interventions and services, primarily through enhancing accountability between service providers, implementers, donors, and governments and the people who are the intended beneficiaries of development programming. We are developing these technologies to provide more timely feedback that can support an enabling environment wherein financial incentives are aligned with accountable and responsive services. Made possible in part by new measurement techniques, including emerging sensor technology, such systems have the potential to propel the development of solutions that can work over the long term, allowing the benefits of environmental health improvements to be sustained in settings where they are most critical.

One way we are working on doing this is developing water quality sensors that can alert communities and service providers of fecal contamination in drinking water supplies. Current state - of - the - art methods for the enumeration of microbial pathogens in drinking water sources have important limitations, including high initial cost, 24 - 48 hour delays in results, high staffing and facility requirements, and training requirements which all become especially problematic in low income contexts. With my sensor, water utilities and government health offices will be able to install the sensor in distribution lines and utilize 24/7 data on fecal contamination risk. From community to governmental levels, this data will have a huge impact on decision making, allowing the best allocation of resources for safer water infrastructure. The information provided by the sensor will also help to promote water access. Many water utilities are working to expand their piped water networks but lack the funds to maintain water quality testing in new infrastructure.

We use Fusion and Eagle to rapidly prototype 3D printed and CNC'd models of the sensor. We've gone through many iterations and are now seeing a sensitivity that compares to technology that costs approximately 6 times what our sensor will cost. The Fusion and Eagle platforms have been essential to our collaborative and fast passed atmosphere in the lab.

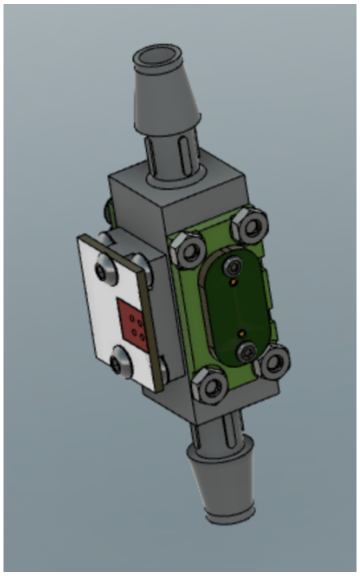

Figure 4. Fusion mockup of a sensor to monitor fecal contamination risk in drinking water