**Building Footbridges: Addressing Seasonal Isolation in Rural Bolivia**

(Technical Paper)

**Combatting Seasonal Isolation Given the Climate Change Crisis**

(STS Paper)

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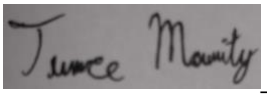
On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Approved  Date 11/20/2022

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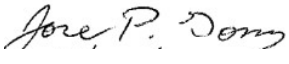
Approved  Date 11/20/2022

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## Introduction

In many rural parts of the world, the rainy season leads to flooding that makes rivers impassable, isolating communities from schools, healthcare, and markets. Individuals in these areas sometimes attempt to cross the rivers to access the infrastructure on the other side, resulting in injury or even death. However, there is an organization that has identified this issue, and their work has led to tangible benefits for roughly 150,000 people in these rural communities.

The Engineers in Action (EIA) Bridge Program works with students from universities across the United States and Canada as well as these seasonally isolated communities to design and build footbridges over rivers to improve access to necessities such as hospitals and markets. Among many positive impacts, the footbridges have resulted in a 12% increase in children enrolled in school, an 18% increase in healthcare treatment, a 30% increase in labor market income, and a 75% increase in farm profits for the previously seasonally isolated areas (*Why Bridges?*). Along with my capstone team, I will be working to design and provide relevant construction documents for a footbridge to be built over Rio Coilolo in Zudañez, Bolivia, with hopes of achieving similar success as previous EIA projects. For my technical discussion, I will elaborate on the project, and what my team is hoping to achieve. As for the STS discussion, I will analyze how the focus of EIA and similar organizations may need to shift soon in response to climate change.

## Building Footbridges: Addressing Seasonal Isolation in Rural Bolivia

Isolation caused by swollen rivers creates barriers between communities and essential services, as people would be risking their lives attempting to cross these rivers during portions of the rainy season (*Why Bridges?*). For this reason, my team is committed to creating the best design possible for our site in Zudañez.

There are a multitude of relevant factors throughout the process of designing a footbridge over one of these rivers that flood during the local rainy season. Firstly, EIA provides support in the form of several generic options for design, based on the span of the bridge and the ground slope profile at the site. Teams begin by choosing the appropriate "standard design" for their site, with consideration for where the bridge will be placed in relation to the river. Then, several design checks are performed, such as ensuring there is enough freeboard, or distance between the bottom of the bridge and the river, so the bridge cannot get destroyed in a storm. However, the design is not sufficient if it only accounts for standard conditions. Instead, the design must account for 100-year storms, which are becoming more common and more powerful across the globe in recent years (Water Environment Federation, 2019).

By choosing a standard design and making some design choices such as the location of the abutments, the team can be confident that their design would be successful if built. Still, this does not yet mean that they have found the best and most efficient design. Considering EIA's status as a nonprofit organization, there are limits to the financial resources present for bridge construction. Similarly, by nature of the site being in rural Bolivia, there is not easy access to required construction materials, such as steel cables. For this reason, teams must work toward a non-standard design, which will not be as conservative as the template standard designs. Overly conservative designs cost more, require more labor, and take longer to build, which according to EIA, "negatively affects not only the communities we are trying to support, but also the local government, EIA, and the student teams themselves," (*Introduction to Non-Standard Design*). For instance, a team may start with an abutment from a standard design that is intended for bridges up to 120 meters in length. If the bridge is only 105 meters in length, an abutment of this size may not be necessary. The team would then make the proposed abutment smaller, while

ensuring it still meets the various factors of safety, which are ratios between designed loads for structural elements and maximum expected loads during the footbridge's existence.

While repeating the process of making minor design alterations, performing calculations, and rechecking all the factors of safety can be tedious, this is how the team can arrive at the best solution for the people in the community, which is what engineers do. Finding the most efficient design by factoring in constructability and cost while preserving safety, durability, and serviceability is a practice done by civil engineers every day. In this case, the design and construction of the footbridge will have a lasting impact on the people of Zudañez, allowing them to safely access schools, healthcare, and markets at all times of the year.

**Combatting Seasonal Isolation Given the Climate Change Crisis**

Communities around the world are built upon connection. In their early years, children form connections with their classmates and teachers in school, allowing them to learn and evolve socially. As adults, most people have a connection to a job, or at least some place where they can be paid for their labor. Similarly, people need a place to exchange this payment for goods to provide for themselves and their families. When they get older, people typically encounter health issues, and need a connection to health care. For individuals in communities that experience seasonal isolation due to swollen rivers, these connections are severed for several months each year. Considering the effects that climate change has already created and will continue to cause, it is expected that the problem of seasonal isolation due to swollen rivers will only be exacerbated in the coming years and decades (Davenport, 2022). Currently, the EIA Bridge Program seeks to provide a solution to the problems associated with seasonal isolation by designing and building pedestrian footbridges. Considering what environmental disasters may be

on the horizon, EIA and other similar organizations should consider being initiative-taking in their work by identifying future problem areas and collaborating with local communities before the seasonal isolation ever occurs.

Given that the outreach of nonprofits like EIA have limits, both with financial and material resources, as well as in terms of qualified engineers to help design and construct these bridges, they must be wise with how they allocate their time. Considering that communities being isolated during rainy seasons is already a pervasive problem around the world (O'Neill, 2010), it makes sense that they focus on communities where their efforts will make a tremendous difference immediately. However, given that the issue they are trying to combat may become much worse in the near future, it would seem foolish for companies like EIA not to plan for what will be on the horizon. Finding the balance between these two options will be a challenge for these companies. I will explore the relevant ethical factors in this process and conclude about what is the best course of action moving forward.

Given the massive benefits that result from solutions to seasonal isolation, researching this topic is worthy of attention. EIA's footbridges result in a 12% increase in children enrolled in school, an 18% increase in healthcare treatment, a 30% increase in labor market income, and a 75% increase in farm profits for the previously seasonally isolated areas (*Why Bridges?*). These changes are obviously massively impactful for the communities in which they come about. Not many of us have had to wonder if we could get to school on a given day, and thus cannot fathom what life would be like if that were the case for months at a time. Due to the severity of the issue of seasonal isolation and the lasting impact that an answer can provide, deciding where solutions can best be implemented as the issue of flooding and seasonal isolation grows (Davenport, 2022) is critical.

## Research Question and Methods

For my STS research, I will seek to answer how EIA and other similar organizations should divide their efforts between areas that are already experiencing seasonal isolation and locations that could face more serious seasonal isolation as climate change persists. There are significant ethical questions in play, and I will strive to use available information and research to come to a conclusion. For instance, I will weigh the existing effects caused by seasonal isolation with the forecasted severity of seasonal isolation in other locations and elaborate upon what factors should be considered by the leaders of EIA and other similar organizations.

## Conclusion

Seasonal isolation due to swollen rivers affects many individuals in rural communities each year. Flooding during rainy seasons separates communities from essential infrastructure, such as schools, hospitals, and markets. For my technical deliverable, my team and I will be collaborating with the Engineers in Action Bridge Program to design a pedestrian footbridge to be built over Rio Coilolo in Zudañez, Bolivia, which will ensure that the Zudañez community is no longer isolated in the rainy season. For my STS deliverable, I will analyze what approach EIA and similar organizations should take, given the ever-growing climate change crisis. I anticipate concluding that a balance must be found between the two options strictly focusing on communities that currently experience seasonal isolation and locations where the issue will be heavily prevalent soon.

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