TOO MANY COOKS IN THE KITCHEN?

A COMPREHENSIVE COMPARISON OF NGO SPENDING AND DEVELOPMENT IN NEPAL

By

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Abstract: There are over 51,000 non-governmental organizations (NGOs) registered in Nepal, yet the country continually ranks low in various measures of human development. As is the case in many developing countries, NGOs operate with limited oversight and impact evaluations that document their progress are nearly non-existent. This research proposes a method for testing the efficacy and effectiveness of NGO presence in Nepal using the remote sensing technologies and foreign aid tracking provided by the country's government. By comparing data from validated machine learning methods that measure economic activity with NGO funding, this paper helps identify more accurately the effectiveness of NGO involvement in Nepal and provide a backcheck on its accuracy. The findings indicate that there is no significant relationship between provincial GDP, which acts as a proxy for economic development, and NGO funding. This implies that even though the provinces receive hundreds of millions of dollars each year, NGO and government aid are not the magic bullets for poverty alleviation and economic development.

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CHAPTER I

INTRODUCTION

The term “non-governmental organization” (NGO) is often linked with key phrases and themes such as development, human rights, and humanitarian aid. While there are many other types of NGOs, including firefighting, those most associated with the term are developmental. These organizations have been recognized as key actors in the endeavor to move toward a more sustainable and equitable future for all. However, the development aid that these organizations provide has not come without criticism from academics including Campbell et al., (2019), Walton et al., (2016), Tortajada (2016), Banks et al., (2015), and Howell (2013). Since the explosive growth of development-specific NGOs worldwide in the late 20th century, their effectiveness in alleviating poverty, promoting economic advancements, and increasing social capital has been deeply criticized (Edwards & Hulme, 1996; Gibson et al., 2005). These criticisms include the effectiveness and legitimacy of NGO work in low and middle-income countries (LMIC), the financial accountability that they face, and the loss of autonomy for the local people (Banks & Holme, 2012; Srinivas, 2009; Scott, 2008). Previous studies found the relationship between poverty and NGO activity to be unclear, while others suggested a negative relationship between economic development and activity (Galway et al., 2012; Khan & Ali, 2014). Despite scrutiny from academics, there is little criticism coming from the NGOs themselves, as well as the bilateral aid agencies they work alongside. Moreover, there is a lack of published impact evaluations assessing the effects that development NGOs have on the regions they operate within and the efficacy of their presence and spending (Gooding, 2017).

According to the Organization for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC), member nations spent a record-breaking $152.8 billion in international development aid in 2019, followed by another peak of $161.2 billion in 2020. As much as 30% of official development aid (ODA) is provided by NGOs (Riddell, 2007; Lewis, 2010). Despite these record increases, global poverty reduction is slowing. While extreme poverty, which the World Bank defined as living on $1.90 or less per day (as of 2015), only contributes to approximately 10% of the world's population and is decreasing (McCoy, 2017), there are still large groups of people in poverty (Benatar, 2016). According to the Pew Research Center, to cross the boundary between low and middle income, the daily per capita income must exceed $10, which 71% of the world's population lives below (McCoy, 2017; Dabla-Norris et al., 2015). By focusing on the marker of "extreme poverty", this demographic is largely ignored, even as it increases (McCoy, 2017). Motivated to better understand this large proportion of the population living in the low-income tier and how it is impacted by NGO work, this study investigates in what capacity NGOs that specialize in international development contribute to worldwide poverty alleviation and economic growth through the application of frontier methodology.

CHAPTER II

BACKGROUND

Defining NGOs

In the seemingly endless ocean of humanitarian organizations and affiliations, it is important to define what exactly an NGO is. The term was first coined in 1945, with the creation of the United Nations, where a "non-governmental organization" label was given to non-state organizations with consultative status in UN endeavors (Lewis, 2010; Lewis, 2001). NGOs began participating in UN deliberations through the Economic and Social Council in 1946 (ECOSOC). According to the Economic and Social Council, 6,110 NGOs currently have consultative status within the UN.

Summary of Four Waves of NGO Sector Evolution

Wave	Approximate Era	Defining Characteristics
I	WWII to late 1960s	• Small number of large, well established NGOs • Primarily involved in emergency and conflict relief • Religious and missionary affiliations commonplace
II	Early 1970s to early 1980s	• Role expanded beyond emergency and conflict relief • Community level work employing participatory approaches commonplace
III	Mid/early 1980s to late 1990s	• Rapid proliferation of NGOs around the globe linked to changing political and economic ideologies of the time • Significant increase in funding for NGO related projects • NGOs were considered development alternatives and become the 'favoured child' of development agencies
IV	Early 2000s- current	• NGO activity shaped by poverty reductions agendas and Millennium Development Goals • Funders increasingly channelling aid to and through NGOs • Increase in bilateral aid and global health initiatives (i.e.Global Fund, PEPFAR)

Table 1 Source: Galway, Corbett & Zeng (2012)

These organizations are considered important actors in the development, human rights, humanitarian aid, and public service landscape, yet confining the term to a single, modern definition has proven difficult (Lewis, 2010; Martens, 2002). Academics attribute this problem to these organizations "defying generalization" by having various forms of structure that change from one NGO to the next. These structures can include formality, size, and if they are bureaucratic or not (Lewis, 2010). Furthermore, since the 1946 conception of NGOs, the defining characteristics of the work they do has evolved with the needs of international development (Galway et al., 2012). This evolution is summarized in Table 1. Due to the increasing amount of non-state actors participating in international development, the term has evolved from the UN's 1946 definition to an ambiguous term describing "voluntary action in international development" and is used more indiscriminately, hindering the prospect of creating a heterogenic definition (Hailey, 1999; Lewis & Opoku-Mensah, 2005; Srinivas, 2009).

It is a difficult task to estimate how many non-consultant NGOs are operating worldwide (Lewis, 2010; McGann & Johnstone, 2006). This dilemma is accentuated by the lack of statistics maintained for organizations that fall under the all-encompassing term "non-governmental organization". There are estimates as high as in the millions if both formal and informal organizations are considered (Masefield et al., 2020). The UN estimated that 35,000 large NGOs operated in 2000 (Lewis, 2010; Lewis et al., 2020).

Structure of NGOs

In addition to the definition of an NGO, it is important to define the structure of development-focused NGOs and how their flows of funding operate. Similar to the definition of an NGO, the structure of these organizations is also ambiguous. Some NGOs operate as a "global hierarchy", with power being localized to a central entity and branching into various transnational subsidiaries. Alternatively, NGOs can function as "stand-alone" organizations (Raju, 2009). According to Mount, some NGOs' organizational structure reflects that of private-sector corporations (2022). However, each of these models tends to rely on collaborations with state and non-state actors (Boström & Hallström, 2010). These collaborations with various parties provide both financial and human capital (Mcloughlin, 2011). Some have gone as far as to falsely promote their representation of the poorest and most deprived communities as well as overstate their impact in order to fundraise more money (Kaldor, 2003). This money allows NGOs to expand their programs, increase staff, integrate more hierarchy, and most importantly, obtain even more funding (Schuller, 2009). By "scaling up" in this fashion, organizations can become even further removed from the communities they were designed to aid (Mount, 2022; Schuller, 2009). Additionally, these collaborations inherently tie NGOs to national and international politics, severing them from the idea of altruism that many of these organizations promote (Trent, 2013).

The funding the NGOs receive and subsequentially spend in recipient countries comes from a variety of sources including donor countries, which use NGOs as a channel to funnel money into specific development projects, multilateral aid agencies, such as the World Bank and Asian Development Bank, and fundraising efforts targeted at individuals and private donors (Werker & Ahmed, 2008; Nunnenkamp & Öhler, 2012). This funding is used to cover a variety of expenses, such as project spending, aid delivery, and administrative and management costs (Nunnenkamp & Öhler, 2012).

Because NGOs face criticism for their efforts in strengthening society, their overall impact remains underwhelming for the poorest and most deprived communities (Edwards and Hulme, 1996; Kaldor, 2003; Banks et al., 2015; Tortajada, 2016). Aid effectiveness studies conducted by Chanboreth & Hach (2008), Roka (2012), Ramachandran & Walz (2015), and Hilaire (2018) have further supported this consensus; however, these studies have been steered by conventional means of socioeconomic data collection. Currently, there remains a gap in the literature for the use of contemporary means of measuring NGO effectiveness. By presenting a new model of measuring the value that NGOs present in developing countries, the literature can be advanced further and provide a meaningful backcheck on the funding distributed to developing regions.

Nepal's Economic Status

Located in South Asia and landlocked between India and China, Nepal is a small country that lies in the southern region of the Himalayas and is home to 29,192,480 people (2021 Nepal

Census). Before 1950, Nepal was controlled by hereditary prime ministers and followed a policy of isolation from the outside world. After a palace revolt, Nepal was governed by a monarchy and parliamentary system. Between 1996 and 2006, a civil war broke out between the government and Maoist insurgents. After a decade of violence, Nepal was officially declared a democratic republic in 2008 (Proud, 2022).

Nepal is considered an LMIC by the World Bank, with a per-capita income of $1,090 in 2019, compared to the $1,045 that denotes low-income countries (Maharjan, 2021; The World Bank). Nepal is dominated by two industries: tourism and agriculture. Tourism in the country began to grow after the first successful ascent of Mt. Everest in 1953 (Bhandari, 2020) and contributes to the service sector's 59.5% composition of the national GDP (Central Intelligence Agency). Agriculture is also considered a mainstay of Nepal's economy, contributing 26.5% to the national GDP and employing approximately 60.4% of the country's population (Joshi et al., 2021). Another important factor in Nepal's economy is its heavy reliance on remittances. In 2020, remittance inflows totaled over $8.1 billion and accounted for approximately 24% of the GDP (The World Bank). This makes it one of the highest recipients of remittances globally, per GDP percentage (Sapkota, 2013).

Nepal is comprised of seven provinces: Province 1, Province 2, Bagmati Pradesh, Gandaki Pradesh, Lumbini Pradesh, Karnali Pradesh, and Sudurpashchim Pradesh. Bagmati Pradesh has the largest population, contributed 37.7% to Nepal's overall GDP in the 2020/21 fiscal year, and is home to the country's capital, Kathmandu (Ministry of Finance Economic Survey 2020/21).

Nepal Province Statistics

Province	Population	Population Share %	GDP Share %
Province 1	4,972,021	17.03%	15.6%
Province 2	6,126,288	20.99%	13.2%
Bagmati Pradesh	6,084,042	20.84%	37.7%
Gandaki Pradesh	2,479,745	8.49%	8.7%
Lumbini Pradesh	5,124,225	17.55%	14%
Karnali Pradesh	1,694,889	5.81%	4%
Sudurpashchim Pradesh	2,711,270	9.29%	6.9%

Table 2 Source: Nepal Central Bureau of Statistics

CHAPTER III

LITERATURE REVIEW

Foreign Aid and the Effectiveness of Development Aid

Broadly, foreign aid can be described as all types of resources, such as skills, physical goods, financial gifts, or loans, being transferred from a donor to a recipient (Riddell, 2007). More specifically, foreign aid can be considered the transfer of resources from one country or a donor to another in the form of loads, economic aid, trade funding, charitable aid, or political, security, or military aid (Elayah, 2016). Each of these avenues helps both the recipient country increase development and economic growth, while the donor reduces the risk of conflict, promotes peace, and achieves diplomatic goals (Elayah, 2016; Pronk, 2009). Additionally, aid is an important factor in domestic politics for the donor countries (Lancaster, 2007).

This aid could be used as a tool for soft power, which is the capability to acquire desired outcomes without the use of force or coercion (Nye, 2017). In turn, this would give donor countries the ability to promote a symbiotic relationship between themselves and the recipients. By alleviating hardship in developing countries, they could gain economic and diplomatic security (Blair et al., 2019). A prominent example of this was foreign aid during the Cold War (Lancaster, 2007). By sending foreign aid abroad, the United States created a degree of alliance between itself and its recipients in an effort to combat the international threat of communism (Boschini & Olofsgård, 2007).

The pillar of aid effectiveness theory stems from the two-gap model (Chenery, 1967), which proposes that aid can fill in the disparity between investment needs and domestic savings in countries that face budget and consequentially, growth constraints (Papanek, 1973; Irfan & Nehra, 2016). After foreign aid became a formalized method of foreign policy in the early 20th century, it was believed that economic growth would seamlessly transform into poverty reduction in recipient countries (Lewis, 1954; Nurske, 1966; Mahembe & Odhiambo, 2019). It was argued that foreign aid delivered the capital boost needed to create sustainable economic growth through a "trickle-down theory" (Aghion & Bolton, 1997). However, Todaro (1997) disputed the "trickle-down theory", arguing that general economic improvement does nothing to help aid the very poor. Rather, he believed that development was a multi-dimensional process that included both a restructuring of economic and social systems (Todaro, 1997). Empirical evidence also showed a weak link between foreign aid and its direct impacts on poverty (Feeny, 2003). Moreover, William Easterly, who is regarded as "one of the most contemporary" and vocal opponents of aid (Elayah, 2016), offered evidence in his 2006 book, *The White Man's Burden: Why the West's Efforts to Aid the Rest Have Done So Much Ill and So Little Good*, that countries where large amounts of aid had been spent had achieved minimal poverty reduction.

With inconsistent conclusions littering the discussion surrounding aid effectiveness, many researchers have hypothesized various explanations as to why aid may not contribute significantly to poverty reduction. In *The $138.5 Billion Question: When Does Foreign Aid Work (and When Doesn't It)*, Glennie and Sumner (2014) suggest that the conversations concerning aid have largely been polarized and contain very little nuance. Oversimplifications of the matter largely stagnate the solutions that will move the world toward poverty reduction. Claiming that aid is the sole catalyst for human development in past decades ignores the examples where it was largely unavailing or detrimental to recipient countries. In Sub-Saharan Africa, the annual economic growth rate remained below 3% in 2019 (The World Bank, 2019), despite receiving approximately 7.1 billion USD, from the United States alone, in the same year (Husted, et al., 2020). In *African Economies and the Politics of Crisis*, Van de Walle (2001) argues that lenders have ultimately undermined the capacity for African regimes to develop, leading them to balance between the limbo of receiving foreign aid, but not making substantial progress towards growth.

There are various reasons why developmental aid may be futile in the undertaking of poverty reduction. First, development aid can help expand both the geopolitical and economic goals of the donors, often called “donor interest.” By using targeted development, donors can both shield themselves from the negative spillovers of the underdeveloped world and expand their interests abroad (Bermeo, 2017). This type of strategic self-interest can be used to promote democracy, peace, or other foreign policy goals in the international political sphere and is commonly seen in bilateral foreign aid schemes (Bandyopadhyay & Vermann, 2013).

The second explanation for developmental aid failure is the conditions under which the recipient country is operating. In multiple studies (Kosack, 2003; Mahembe & Odhiambo, 2019) it was shown that democracy increased the effectiveness of foreign aid and was ineffective, if not detrimental, in autocracies. Moreover, Collier found that 73% of the poorest, least developed countries had recently been engaged or were currently in a civil war (2007). In cases where corruption runs rampant within a regime, aid helps enable that corruption to continue to flourish by freely providing cash for the administration (Moyo, 2009). Peter Bauer, a revered development economist who opposed the widely held belief that aid was the only road toward development, believed that foreign aid was ruining potential industry in developing countries by ending up in the wrong hands (Shleifer, 2009). In developing countries that are locked in a vicious cycle of corruption or conflict, additional aid is not the all-encompassing answer to fix the plague of poverty (Collier, 2007).

A third explanation for the lack of effectiveness of developmental aid is aid dependency.

The reliance that developing countries may have on foreign aid could be counterproductive to sustainable development and economic growth (Collier, 1999). By delivering social services that the government should provide, groups like development INGOs undermine the capacity of the country (Ell, 2008; Kalb, 2006; Karajkov, 2007; Campbell et al., 2019). After the devastation of World War II, the Marshall Plan was used as a short-term cash transfer to help bolster the western European economy, in conjunction with the Bretton Woods System. In subsequent years, nonetheless, it has been used as a precedent to send foreign aid across the globe. The difference between these plans and modern-day aid, however, is noted in Dambisa Moyo's *Dead Aid* (2009). The cash injection used in Europe was able to reinvigorate the already existing political, economic, and physical framework. Furthermore, the Marshall Plan was operational for a limited period of time. After 5 years, the money stopped, quite unlike the situation with some developing countries that have been receiving a continual cash flow for decades. Without the need or incentive for long-term financial planning on the donor's behalf, aid dependency is enabled and allowed to flourish without limits.

The Rise of NGOs in Development Aid

In the late 20th century, NGOs rose to prominence as actors in international development, as entities that brought fresh solutions to the longstanding problems faced by developing countries while promoting the idea of "bottom-up", participatory processes in development projects (Lewis, 2010; Reimann, 2005). Seen as both a cost-effective alternative to the public sector and a complement to the new policy of "good governance", NGOs quickly became a key factor in the emerging "civil society" (Lewis, 2010; Howell & Pearce, 2001). Yet, similar to bilateral foreign aid, NGO presence and aid can also hinder the development of the country they operate within. By entering developing countries with weak political institutions, the organizations run the risk of not only overriding the local government's agenda but also removing agency from the leadership and citizens of the country (Tvedt, 1998; Green, 1987).

By doing this, NGOs can threaten the legitimacy of the government and override the theory of social contract between a country's government and its citizens as they expand (Fowler, 1991; Schuller, 2009).

Additionally, the flow of NGO funding may distort the accountability that these organizations have to the communities in which they are operating and further threaten their legitimacy (Edwards & Hulme, 1996). Funding flows are generally unilateral which increases an unequal power dynamic between donors and recipients (Mount, 2021). While some organizations deem themselves on a "mortal crusade against poverty" (Makuwira, 2013), many academics criticize these organizations for trading the local communities' autonomy for the solutions of their financial supporters (Banks et al., 2015; Mount, 2021). In William Easterly's The Tyranny of Experts (2014), international organizations threatened sustainable and successful development in developing countries with technocracy, or the rule of experts, treating poverty like an issue that can be solved through the newest technological advances rather than systemic change. Instead of individuals having the autonomy to create solutions to their problems, a technocracy believes that the experts can produce better results through the concept of a "benevolent autocrat." Development aid NGOs have also been rumored to invent projects that are not necessarily applicable to the community they are serving because the availability of funding is either limited or restricted to certain development project categories (Mount, 2021; Parks 2008).

Furthermore, NGO presence can produce a "brain drain" within the country it operates by poaching skilled workers to work for their organizations (Birdsall, 2007). By attracting the most talented human resources out of the public system, NGOs can not only cause disillusionment and demotivation for government employees but strip away talent from government programs without providing additional support for said programs (Karkee & Comfort, 2016; Gilbert, 2020). Lastly, due to limited available funding, NGOs may not continue work once cash flows are stopped. This leads to short-term projects rather than long-term, sustainable changes within the country (Karkee

& Comfort, 2016).

Foreign Aid in Nepal

In Nepal, NGOs began making an appearance as early as 1950, and by the mid-1990s, were increasing at an exponential rate as depicted in Figure 1 (Karkee & Comfort, 2016). Between 1978 and 2019, NGOs registered in the country skyrocketed from 17 to 50,358 (Social Welfare Council). This exponential increase can be attributed to the instability of governance that Nepal faced in the late 20th century, coupled with poor resources and social turmoil (Karkee & Comfort, 2016).

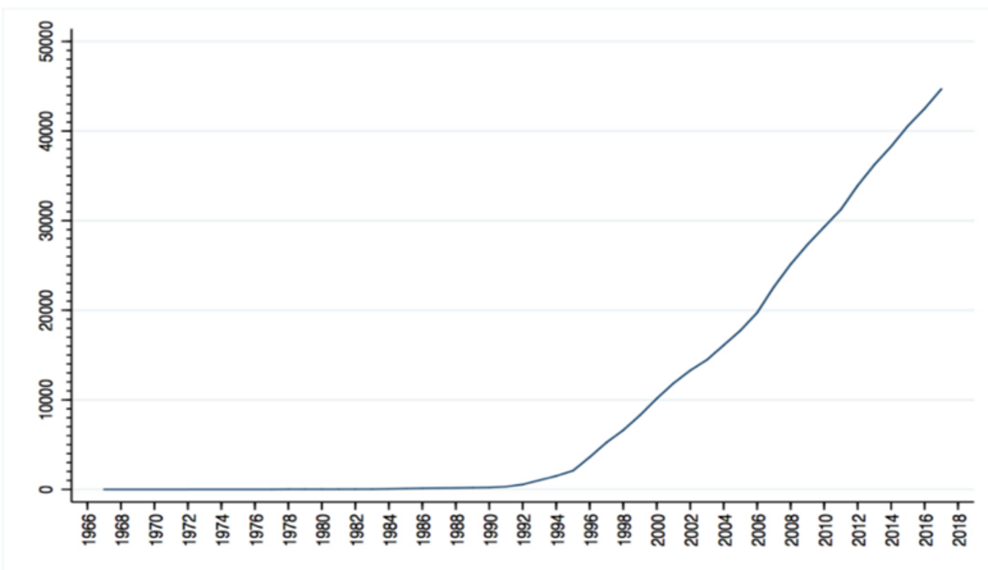


Figure 1 Growth Rate of NGOs in Nepal (Source: K.C. & Lorsuwannarat, 2019)

However, even with over 51,000 NGOs and international NGOs operating in the country, Nepal still ranks poorly in human development in comparison to other South Asian countries, only surpassing Pakistan and Afghanistan on the Human Development Index (HDI).). It also ranks poorly in mean years of schooling and gross national income (GNI) per capita (Nepal Human Development Report, 2020). Between 2010 and 2019, Nepal had less than a 10% increase in its HDI, only growing from .529 to .587. Yet, during the same period of time, ODA to development projects within the country grew 77%, from $767,349,975 to $1,360,739,990 (World Bank, 2022; OECD, 2022).

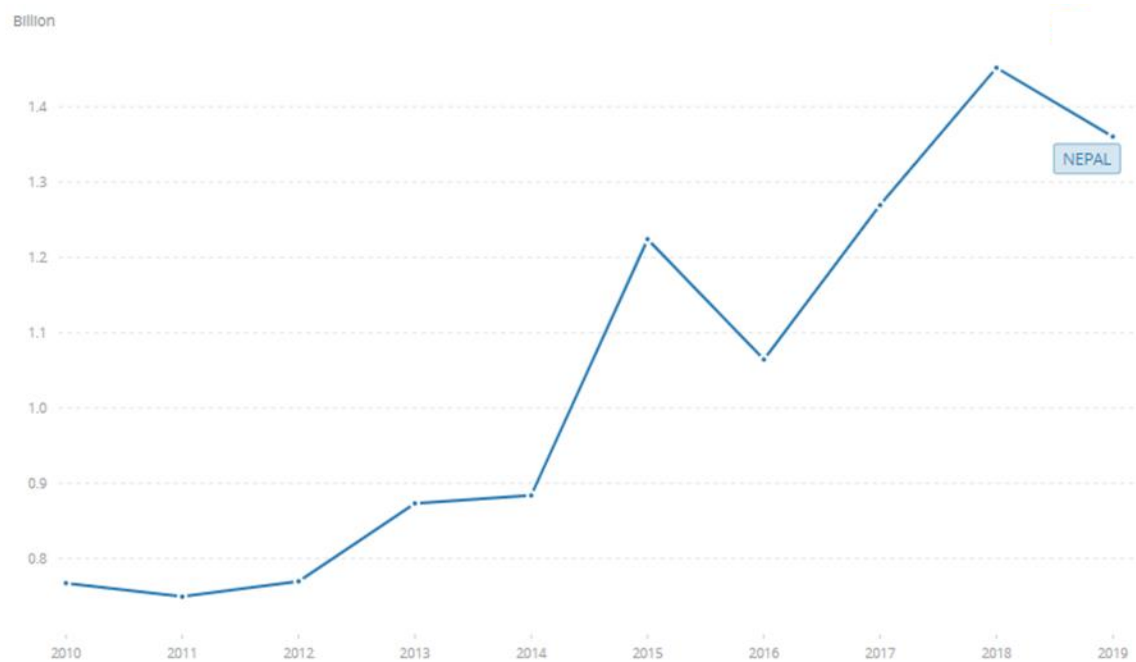


Figure 2 Net ODA Received (Source: World Bank, 2022; OECD, 2022)

For over 60 years, Nepal has relied on foreign aid as a means for budget support and non-budgetary aid (Karki & Pappas, 2020) and is considered an extremely aid-dependent country (Khadka, 1997; Karki & Pappas, 2020; Dangi et al., 2021). Multilateral development partners account for 71% of the country's foreign aid disbursements, with the largest disbursements coming from the Asian Development Bank, the World Bank, the International Monetary Fund, the EU, and the UN (Prasain, 2021).

Table 3 Source: Nepal Ministry of Finance

Foreign Aid Disbursement to Nepal (In Millions)

Donors	2015/16	2016/17	2017/18	2018/19	2019/20
ADB	$217.68	$253.89	$291.69	$292.48	$611.45
World Bank	$243.69	$345.96	$533.51	$528.31	$461.31
IMF	–	–	–	–	$214.00
EU	$ 29.48	$ 83.88	$116.17	$ 26.17	$ 49.84
UN	$113.57	$120.72	$ 65.62	$ 64.07	$ 44.38

Even though Nepal relies heavily on foreign aid arrangements, significant progress in development has not been reported in the country (Karkee & Comfort, 2016). Moreover, the measurement of the effectiveness of foreign aid has been difficult. The country has not developed a method for systematic evaluation of foreign aid efficacy, like the Evaluation Criteria developed by the OECD, which measures characteristics such as relevance, effectiveness, efficiency, impact, and sustainability, rather than a single measurement such as cost-effectiveness (Clements, 2020; Dangi et al., 2021). It is only through recent research studies that the impact and efficacy of foreign aid in Nepal have been seriously scrutinized. Hence, it has been shown that aid is not a sustainable source of economic growth for the country, and in some instances, harms growth (Karkee & Comfort, 2016; Karki & Pappas, 2020).

Extending the Literature

In an effort to extend the literature surrounding the measurement of NGO aid effectiveness, this research study proposes the use of validated machine learning methods coupled with satellite imagery in a way that has not been explored before. This thesis suggests a solution that can improve the way that development aid NGO spending and its effectiveness is measured by replacing conventionally collected socioeconomic data with machine-predicted economic activity levels that will act as a proxy for human development in underdeveloped regions.

By replacing the way socioeconomic data is collected, this thesis can potentially offer an answer to how impactful NGO activity is. Given past literature's findings and the incentive structure of NGOs, I hypothesize that *there will be no statistically significant relationship between gross domestic product (GDP) and NGO spending distributions*, with both variables being aggregated to the yearly and provincial level.

CHAPTER IV

METHODOLOGY

Data and Research Design

Conventionally collected socioeconomic data has historically been expensive, with timely and accurate figures challenging to obtain (Head et al., 2017). In an attempt to acquire a more comprehensive means of measuring development, growth, and poverty in developing areas where data is unreliable and not up-to-date, researchers have turned to remote sensing technologies. Earlier versions of remote sensing technology relied on “night-light” (NLT) satellite data, which could be used as a proxy for economic development (Head et al., 2017; Weidmann & Schutte, 2017). Research showed that locations that produced higher levels of artificial light produced higher levels of economic output (Chen & Nordhaus, 2011; Henderson et al., 2012). However, the limitations of NLT imagery made it hard to distinguish between the poor and ultra-poor regions in the Sub-Saharan locations they were employed, due to low luminosity levels and the lack of variation between them (Jean et al., 2016; Head et al., 2017). To correct this shortcoming, researchers have developed a new method that combines nighttime satellite data with daytime satellite data in deep learning models to more accurately and with a greater degree of specificity remotely measure poverty levels (Jean et al., 2016; Yeh et al., 2020). Jean and colleagues (2016) combined both daytime and nighttime imagery with survey data to measure household assets and consumption, both of which are difficult to obtain in developing countries.

Yeh and colleagues (2020) created and trained learning models that could predict asset wealth across Sub-Saharan Africa using publicly available satellite imagery. This learning model was able to outperform preceding benchmarks and had comparable statistical errors to existing ground data (2020). This approach to poverty and economic measurement established that data could be collected in an inexpensive and largely scalable format, with results corroborating the accuracy of the research.

By following the process laid out by the Asian Development Bank in A Guidebook on Mapping Poverty Through Data Integration and Artificial Intelligence (2021), while also referencing Jean and colleagues' (2016) framework for Combining satellite imagery and machine learning to predict poverty, I used convolutional neural networks (CNN) models to estimate the economic activity of Nepal on a provincial level . CNNs use machine learning to assign importance to various aspects of an image using learned weights and biases. It can then use these trainings to differentiate objects in the images from one another. This project required the use of daytime satellite images, NTL satellite images, and economic survey data. The daytime satellite imagery was sourced from Google's Earth Engine, a cloud-based geospatial processing tool, using the Sentinel 2 Satellite. This satellite is operated by the European Space Agency and is capable of high-resolution multispectral imaging. I obtained Level-2A orthorectified images that were corrected for atmospheric surface reflectance. This data set had images available as far back as 2016, corresponding to when the satellite went online. The NLT satellite imagery was sourced from the Earth Observation Group at The Payne Institute for Public Policy at Colorado School of Mines. The Earth Observation Group produces these nighttime images using the Visible Infrared Imaging Radiometer Suite (VIIRS) Day/Night Band (DNB) instrument. This instrument is preferable to previous satellite technology because of its radiometric accuracy, spatial resolution, and geometric quality (Jing et al., 2015). Additionally, the DNB data is filtered to exclude data affected by stray light, lightning, lunar illumination, and cloud-cover (Elvidge, 2017). The on-the-ground survey data from 2016 came from the Demographic and Health Services (DHS).

In this project, there were two major deviations from the ADB's guide. First, the DHS survey data for Nepal only included gross cell product (GCP) in the geo-referenced dataset, instead of poverty metrics. However, this deviation does not affect the overall mission of the research project because the goal is to determine changes in economic activity and the measures provided have been calibrated by DHS experts using other economic activity measures that have been merged with important demographic and geophysical data, such as climate, population, and terrain. The second difference is that this study used only certain portions of satellite images from each year, rather than compressed yearly data. This deviation helps capture the differences in economic activity from year to year by introducing a gap between measurements.

For daytime imagery, this project employed images ranging from September to December of each year. This technique was required because the Sentinel 2 satellite, which captured the daytime imagery, is sensitive to cloud coverage. By combining multiple images into a single file, I was able to create an image that is mostly free of cloud coverage and allowed for the clearest possible image. For the NTL, images were retrieved from the month of October. I chose October because it was the middle point between September and December. By using this monthly data, rather than preprocessed yearly data, my sample size increased to include 2020 and 2021, rather than ending in 2019, which at the time of data collection, was the last yearly dataset reported. Additionally, by only using September through December for daytime imagery and October for NLT imagery, this research project introduces the largest gap possible between measurements while also balancing the need for cloud-free daytime imagery. After retrieving the daytime and NLT satellite images, the final time sample is restricted to 2016 to 2021.

The process of predicting GCP involves three key steps. First, luminosity levels can be retrieved from NTL images by using a raster with the same resolution as the daytime imagery. The second step trains the CNN by extracting features from the daytime satellite images to predict NTL. Lastly, the DHS survey data trains and validates the features obtained from the CNN to train a ridge regression model to predict GCP. The models used for predicting NTL with daytime images had an accuracy between 92 and 95 percent. The ridge regression model had an RMSE of approximately 2.5, indicating that the variable, which has a maximum value of 1,200, was reasonably accurate.

The final model provides GCP estimates with a granularity of 4km-by-4km. I then aggregated GCP into yearly, provincial levels and ran a regression analysis using NGO and Nepalese governmental spending to determine if there was a statistically significant relationship between the two variables. In addition to provincial NGO spending, I also used provincial Nepalese government spending as a control variable. The spending data was retrieved from the Nepal Aid Management Information System (AMIS), which is sponsored by the Nepal Ministry of Finance. The AMIS is an online database that was launched in 2013 to promote foreign aid transparency and accountability. The platform serves as a repository of information for projects supported by foreign aid in the country. To calculate the yearly expenditures within each province, I summed project spending disbursements rather than the aid commitments.

Limitations

Due to the developing nature of Nepal, the online database in which funding was obtained is prone to glitches and gaps in recordkeeping. With the Sentinel 2 satellite going online in 2016, this study was limited in terms of the time frame sample. Because of this, this thesis has certain limitations that can only be solved with continued time.

CHAPTER V

RESULTS

Machine Learning Model Results

In Figure 5, the models used for this project were able to predict the 2016 GCP throughout the provinces of Nepal. While this map can illustrate general population density variations, it also accurately shows economic activity in less-populated areas, only showing zero activity in uninhabited regions, such as mountaintops. The map also illustrates that economic activity is lessened in poorer, more rural areas of the country, while areas, like Kathmandu, are more active. This helps visualize that the CNN model created worked and shows accurate economic activity around the country.

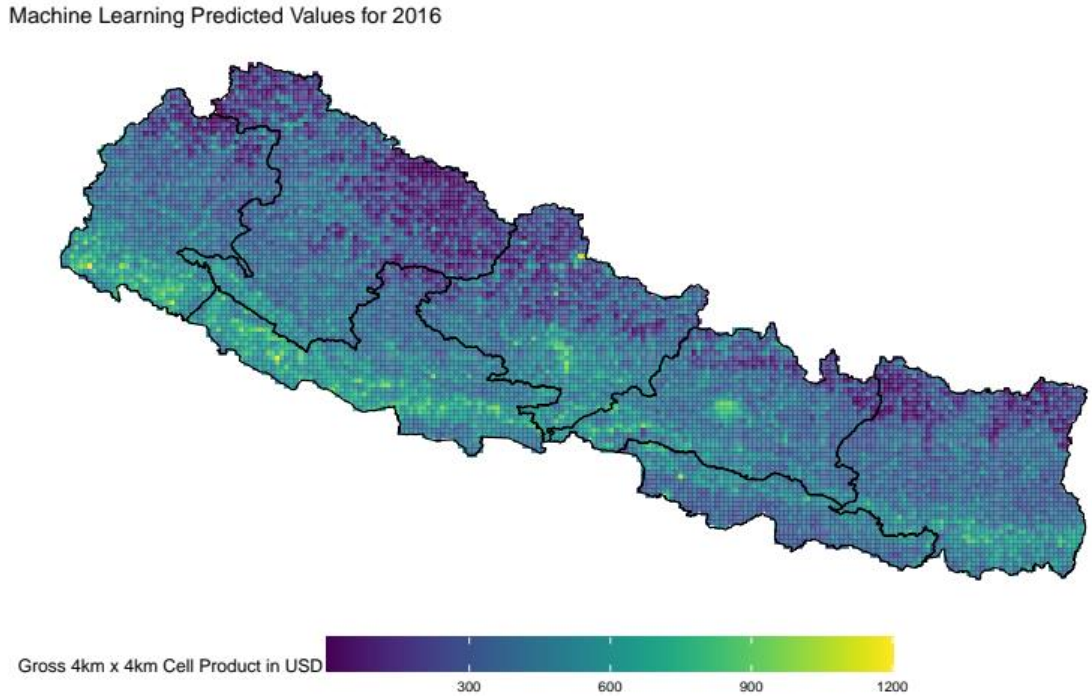


Figure 3 Predicted Provincial GCP

This map implies that economic development is more common in areas that are more populous and easier to access, whether that be by geographical location or infrastructure. This also suggests a proximity bias and shows that NGOs are not so much functioning in the regions that are the most deprived, but in regions that are the most convenient to access.

Figure 5 also provides evidence that economic development measurements can be taken without using the conventional methods of data collection. This allows for more timeliness, cost-effectiveness, and quicker backchecks on the efficacy of aid initiatives.

Regression Results

	Dependent variable:		
	GDP, ln	GDP, ln	GDP, first diff (Cube Root)
	(1)	(2)	(3)
NGO Funding, ln (lagged)	−0.002	−0.003	−0.327
	(0.013)	(0.005)	(1.350)
Govt Funding, ln (lagged)	−0.016	−0.003	-0.614
	(0.011)	(0.003)	(1.050)
Constant	13.695***	13.411***	63.070*
	(0.215)	(0.110)	(32.884)
Observations	42	42	35
Fixed Effects	No	Yes	Yes
R^2	0.063	0.967	0.857
Adjusted R^2	0.015	0.952	0.778
Residual Std. Error	0.343	0.076	21.515
F Statistic	1.315	62.957***	10.954***
Note:			*p<0.1; **p<0.05; ***p<0.01

Table 4 Regression Results

After running the regression between provincial GDP and spending, both for Nepal's government and NGOs, it can be determined that there is no statistically significant relationship between the variables. The results indicate that even though the provinces of Nepal receive hundreds of millions of dollars in aid every year, NGO and government aid cannot be relied on as a single solution for economic development and poverty alleviation within the country. Other factors, such as a donor interest, lack of good governance, or aid dependency are all elements that should be taken into consideration for the lack of significant development.

Robustness Tests

During the investigative process, I began looking at agricultural import and export value indices. Because the agricultural sector is considered a mainstay in Nepal's economy, the comparison of foreign aid spending and staple crop trade indices appeared to be a relevant diversion, to determine if there was a relationship between the two values.

In order to accurately compare the values, I used both import and export indices with 2014-2016 = 100. I then created an NGO spending index using the same years to create an average. By doing this, the data was able to share both an x and y-axis, furthering its continuity.

Figure 4 Agricultural Import Indices

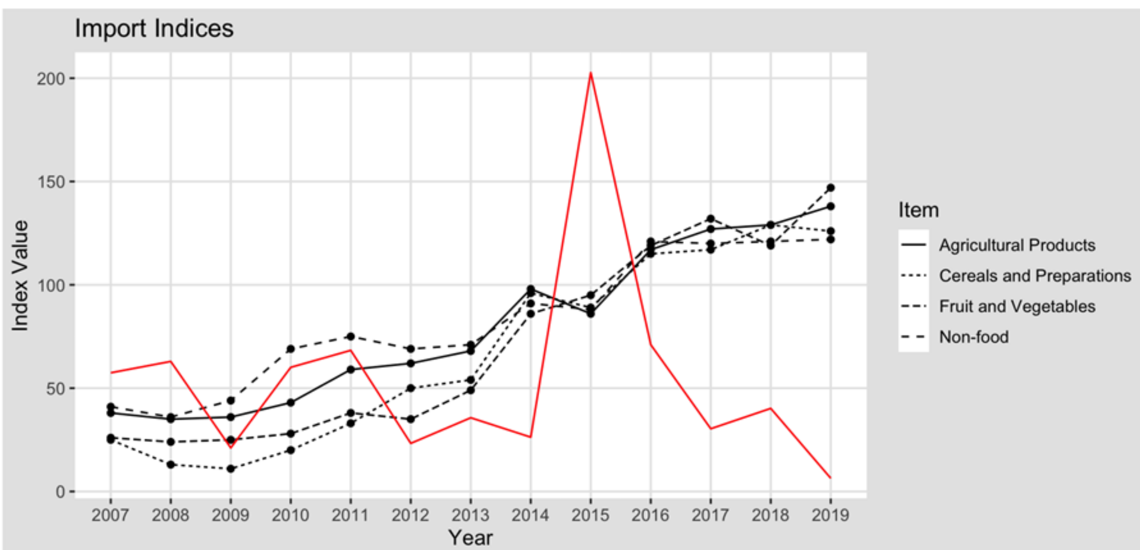
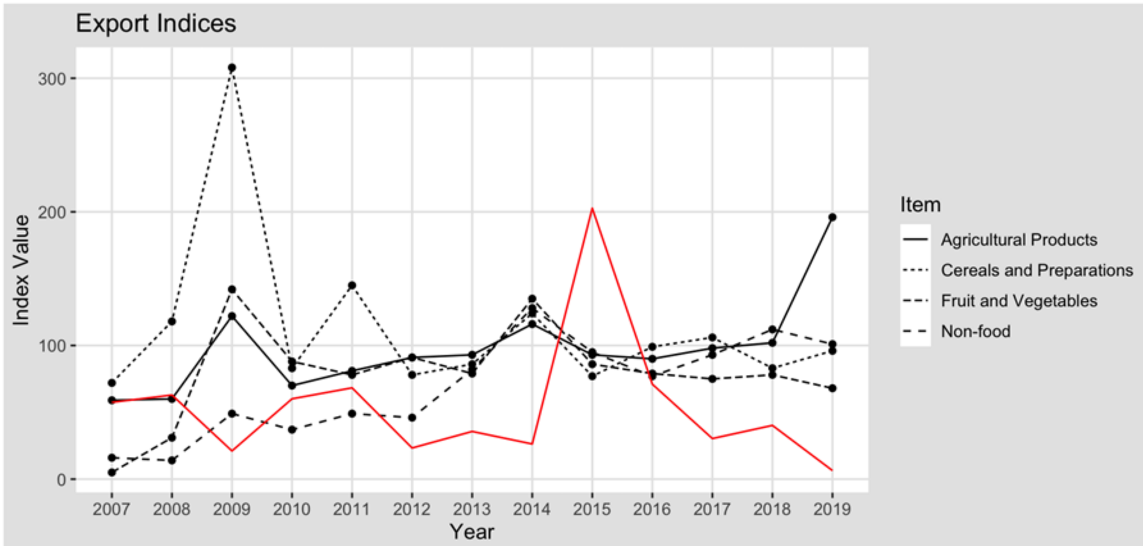


Figure 5 Agricultural Export Indices



While a visual relationship was not present for the commodities I chose for my secondary project, there were notable trends I observed. First, it was interesting to see the dramatic increase in NGO spending in 2015, as a result of the Gorkha earthquake, and how agricultural exports and imports remained generally static. The second item of note was that agricultural exports have stagnated while imports have increased more than 500% since 2000. Although trade deficits are not inherently good or bad, they can be harmful to developing countries if there are major swings in the global markets, especially when staple crops are involved. The indication of an increasing reliance on imports without the corresponding increase in exports can be detrimental to domestic markets by making them vulnerable to the volatility of global markets (Meyer, 2021). Additionally, trade deficits can cause jobs to be outsourced, which can hurt the growth of industries within a developing country (Amadeo, 2022). Even though these projects are not directly linked, economic growth and trade are indicators of economic development.

CHAPTER VI

CONCLUSION

Despite the considerable NGO presence and foreign aid funding in Nepal, the country still faces issues of stagnating poverty alleviation, human development, and GDP growth. With limited oversight and published impact evaluations being virtually non-existent, there has been no formal model to determine the efficacy and effectiveness of NGOs operating in Nepal. This gap has left NGOs unchecked, with very little obligation to promote transparency and accountability in their work.

In this research, I have applied a method for measuring economic activity on a micro level that would capture development within the country. While these methods have been used in regions, such as Sub-Saharan Africa and Southeast Asia, this study is the first of its kind for Nepal. By proposing the use of both daytime and nighttime satellite imagery over multiple years as a new and improved way of collecting socioeconomic data from developing countries, this thesis has the potential to pave a new direction toward timely and cost-effective measures of development. Moreover, this research has proposed a new means of backchecking the impact that NGOs have on developing regions, further insuring the transparency and social responsibility of these organizations. By creating a highly accurate method of predicting economic development, this thesis can serve as a model for measuring both NGO efficiency and overall impact, as well as delivering a timely and cost-effective means of socioeconomic data collection. This type of research has the capability of radically transforming the way NGOs and other means of foreign development aid operate in developing countries.

Future Research

While this thesis proposes a novel way of measuring the effectiveness and impact that NGOs have on developing regions, future research can expand upon the literature to create an even further geo-located impact report. This can be accomplished by exploring economic development and development aid NGO spending aggregated to the district level. Additionally, the use of poverty indicators would allow researchers to see the scope of NGO impact on an even wider scale than just economic activity. Future research can also use survey data, as it becomes available in Nepal, to create a mixed-methods approach that combines both quantitative and qualitative research measures. Finally, future research projects should prioritize isolating variables to further determine the reasons behind the lack of a relationship between development aid and development in Nepal. These variables will offer an important insight into the development that occurs in underdeveloped nations by third-party actors, such as NGOs. By ensuring both accountability and transparency in NGO activities, effectiveness studies can pave the way toward sustainable development in countries like Nepal.

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