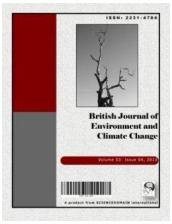

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Analyzing the Role of Poor and Developing Nations in Global Climate Agreements

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Authors' contributions

This manuscript was a collaborative effort of all authors and as such authors are listed alphabetically and authorship is equal among the authors. All authors read and approved the final manuscript.

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ABSTRACT

Increasingly, countries are gathering to address concerns surrounding climate change. The 2015 United Nations Conference of Parties, COP21, saw the emergence of a landmark agreement for collective global action. The tagline arising from this agreement was "Long live the planet. Long live humanity. Long live life itself." Indeed, this agreement should positively benefit the planet, but comes with myriad costs associated with such efforts. Just how these agreements are funded, managed, and regulated are crucial to understanding the broader impacts on individual parties. This paper evaluates the impacts of trade-offs made when considering long-term climate goals over short-term well-being for individual nations and citizens. The paper identifies considerations for officials in countries facing issues associated with energy poverty when crafting global climate agreements (GCAs). The primary question this paper asks is: "What role, if any, should poorer nations play in global climate agreements?" After reviewing the status of global CO_2 emissions and the efficacy of GCAs, we argue that involving developing countries in GCAs is not beneficial in accomplishing global CO_2 mitigation goals. In fact, when low-income countries are party to GCAs their role is either purely symbolic or works counter to other development goals.

Keywords: Climate change; global warming; developing countries; Paris agreement.

1. INTRODUCTION

For the last 35 years the discussion of human impact on the planet and its climate has taken center stage at numerous global summits as leaders have decided that global collective action is needed to avoid the projected negative impacts of climate change. Acknowledged by

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scientists to be a concerning threat as early as 1979, the United Nations began organizing to take action on the issue and has since held summits in locales like Kyoto, Copenhagen, Cancún, Rio de Janeiro, and most recently Paris [1]. Despite the emergence of climate change as a major political priority among citizens in most developed nations, finding enough common ground to reach a consensus agreement among world leaders has proven to be elusive.

The most recent agreement formed by the UN Conference of Parties at the World Climate Change Conference (COP21) in December, 2015 has been hailed as a landmark success by many. As Reuters reported, U.S. Secretary of State John Kerry said of the final agreement:

> "This is a tremendous victory for all of our citizens, not for any one country, or any one bloc, but for everybody here who has worked so hard to bring this across the finish line. It is a victory for all of the planet and for future generations. We have set a course here. The world has come together around an agreement that will empower us to chart a new path for our planet, a smart and responsible path, a sustainable path" [2].

European Commission President Jean-Claude Juncker agreed adding, "This robust agreement will steer the world towards a global clean energy transition." Unfortunately, even some of its strongest supporters have lamented its perceived shortcomings, with U.S. President Barack Obama noting, "…no agreement is perfect, including this one. Even if all the targets set in Paris are met, we'll only be part of the way there..." [2]. This lack of a 'perfect' outcome has been decried in many circles, with the use of inefficient economic tools like subsidies, non-binding voluntary agreements, and political appeasement of various interest groups cited as key weaknesses [3]. According to Brennan [4], various experts viewing the issue through different lenses misjudge the complex nature of reaching effective agreements. For some the issue is purely scientific, others view it as a moral problem, and additional actors see it as an economic exercise. This is all before the overarching difficulty of reaching political consensus by nearly 200 world leaders is factored in.

Nowhere has this political difficulty been more apparent than when discussing unique positions held by industrialized nations, developing nations in the midst of drastic economic growth, and non-developed nations. Identifying and understanding the issues of these various players and the associated expectations attached to any eventual agreement is essential for acknowledging the very different set of circumstances each nation finds itself in when deciding on climate action. Today the question is not whether something needs to be done--the scientific community has converged around agreement on that point--instead, the discussion has evolved to include a new set of criteria. These new questions ask things such as: just how much should be done? Who should be responsible to do it? Who will pay for it? How will anything be paid for? And how will such actions be implemented, monitored, and enforced?

Although general scientific consensus has been reached recognizing that the Earth's climate is changing and that there will necessarily be physical implications without taking some form of action, the projections on the more complex social and human impacts of this issue are highly contested and used frequently as a political wedge in broader discussions [5]. While global mitigation efforts are planned and implemented through these global climate agreements (GCAs), what seems to be neglected in the grander discussion is "what is the greatest good deliverable by collective action for non-developed nations?" In the case of the Paris accord, a proposed pool of aid set aside by industrialized nations totaling $100 billion dollars per year has been earmarked to provide "meaningful mitigation actions and transparency on implementation" for developing nations [6]. This annual sum will no doubt produce some form of beneficial return for both individual nations and the global community in both the short and long-term, but this Paris agreement (and inevitable subsequent GCAs) should be closely scrutinized and evaluated beyond its traditional narrow scope of climate action lowering CO_2 emissions.

2. METHODS AND BACKGROUND

This paper examines the existing research and literature to build on the discussion of just what considerations, if any, must be made by each country at various stages of development when negotiating global climate agreements. To begin, the paper will look briefly at the most recent global climate agreement forged in Paris and what it means for its signatories in the context of past efforts for global climate action. We will discuss the goals and challenges of this

agreement and how climate politics have historically impacted attempts for collective action. Next, we will offer a brief review of theories regarding economic development to identify traits of nations at various stages of growth that impact the larger climate discussion. The paper will also look at the current state of global CO_2 emissions along with cumulative emissions since the 19th century. We then proceed to evaluate the nexus between energy production and economic development in various types of economies to identify unique challenges related to balancing growth and well-being with CO_2 mitigation in developing and undeveloped nations. Finally, we aim to combine these variables to illustrate the complexity of development, the role of energy production in that process, the economic constraints that challenge developing nations, and the political considerations that must be totaled by policy makers when balancing global environmental health in the future with domestic economic and human development today.

By looking primarily at the situation of low-income nations and their incentives in pursuing various models of economic growth we can try to determine what variables should be considered by policy makers in this process. In combining the literature on developing nations, economic growth, and environmental status and improvement, this paper will contribute to a more holistic debate of the many issues and challenges developing nations face when they come to the table to negotiate GCAs.

Specifically, we ask: "What role, if any, should low-income nations play in these global climate agreements?" As a follow-up, it should also be asked: "What actions should developed nations take in aiding mitigation or adaptation efforts of poorer nations in the short and long-term?" Finally, we consider: "Of the whole spectrum of possible climate action, which individual efforts would lead to the greatest overall climate benefit?"

By sincerely evaluating the unique considerations of each nation traditionally party to GCAs and doing so through the lens of historic economic development, climate reality, future growth, and fairness--understanding the primary goal of developing nations is poverty alleviation and human well-being--we can identify additional criteria that should be included in any GCA aiming to be more than a symbolic gesture of collective action.

2.1 Climate Summits and the Paris Agreement

Since the creation of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, world leaders have repeatedly gathered in an attempt to collectively address the "urgent and potentially irreversible threat to human societies and the planet…" that is climate change [7]. From the first meeting in New York, to successive summits in Kyoto, Copenhagen, Cancún, and Rio, the goal has been to find collective ways to limit anthropogenic greenhouse gas emissions. While valiant efforts have been made to achieve legally binding agreements that can lead to meaningful emissions cuts, success has been elusive. Even the most promising climate action to date, the Kyoto Protocol, has been deemed ineffective due to lack of enforcement, different mitigation burdens for each country, lack of unanimous consent, and domestic political processes limiting ratification [8].

On December 12, 2015 world leaders finalized a climate agreement at the 21st annual Conference of Parties (COP21) in Paris, France. The treaty, crafted by 195 nations, including countries responsible for over 90 percent of global emissions, agrees to limit global temperature increases to below 2 degrees celsius, while urging action towards a more ambitious goal of 1.5 degrees celsius. All parties to the treaty will establish "nationally determined contributions" outlining their individual goals for limiting CO_2 emissions to be resubmitted and strengthened every five years.

The two overarching goals of the Paris agreement are for "global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country parties, and undertaking rapid reductions thereafter in accordance with best available science [...] in the context of sustainable development and efforts to eradicate poverty" [6]. To aid in accomplishing these goals, developed countries have agreed to continue funding the mitigation and adaptation efforts of developing nations to the tune of $100 billion per year from 2020-2025, and at least that much in years following. At COP21, U.S. Secretary of State John Kerry pledged that U.S. contributions to such a fund would reach $800 million dollars by 2020 [9]. The challenge of meeting the $100 billion goal is obvious when the U.S. has produced 27% of cumulative CO_2 emissions

since 1850 [10] 16% of global emissions in 2013 alone [11], and 22.5% of world GDP in 2014 [12], and yet is only willing to pledge 0.8% of the total funds outlined in the Paris treaty.

The language scattered throughout the agreement clearly acknowledges the existence of differences between nations in both economic status and their ability to act or comply. Frequently termed "differentiation," supporters of the COP21 treaty point out that this is the first time that a climate accord has opted to not implement such categorical labels on economic development of participating countries. At the first gathering of the UNFCCC it was acknowledged that national participation should be "in accordance with their common but differentiated responsibilities and respective capabilities and their social and economic conditions." The framework thus established labels of "Annex I" or "Non-Annex I" for its participants, that is, developed or developing [7]. The Paris accord takes a more nuanced approach towards differentiation by setting a framework of commitments for all parties with flexibility in compliance options.

It is here that climate deals tend to reach a stalemate. Just who should be responsible for past accumulations of CO_2? Who should be responsible for current CO_2 emissions? What sort of development 'window' should be offered to currently and future developing nations? Also how should the 'leakage' of emissions, or those shifted from a developed nation to a developing one to avoid domestic emissions, be counted? All of these are important, complex, and sensitive topics that must effectively be breached in any negotiation. Nearly 70% of historic emissions have come from developed countries and 23% of global emissions annually are now traded in the form of exports from primarily low-income nations [13].

There are other details in the Paris treaty which do not directly add to our conversation here, and, in fact, the final form and structure of putting this into practice will be agreed upon in further negotiations following the signing of this accord by at least 55 countries who represent at least 55% of global emissions. The current vagueness of language accompanying many of the essential portions of the agreement, the lack of hard targets and definitive accountability, along with concessions for differentiation, have left many on both sides of the discussion worried that the agreement will be ineffective, or worse, a net loss for the planet. For instance, a group of 12 leading climate scientists sent a letter to a British Newspaper publicly venting their frustrations that environmentally, the treaty has no chance of succeeding. A section of this letter read:

> "More ominously, these inadequate targets require mankind to do something much more than cut emissions with a glorious renewable technology programme that will exceed any other past human endeavour. They also require carbon to be sucked out the air. The favoured method is to out-compete the fossil fuel industry by providing biomass for power stations. This involves rapidly growing trees and grasses faster than nature has ever done on land we don't have, then burning it in power stations that will capture and compress the CO_2 using an infrastructure we don't have and with technology that won't work on the scale we need and to finally store it in places we can't find. To maintain the good news agenda, all of this was omitted from the agreement" [14].

Despite all of the questions surrounding the Paris agreement, what is clear is that no country is given a complete pass. All must do what they can, and those with little to offer will receive help in the form of financial, technological, and human capital. There is little mention of historic contributions to CO_2 levels by developing nations. Without addressing this precarious divide between the haves and have-nots, it may be that simple words in a non-legally binding agreement may have little absolute value for the poorest nations around the globe and stand a very real chance of doing more absolute harm than good. To get to that discussion, however, it is necessary to look at the nature of growth among nations in various contexts.

2.2 The History of Economic Growth and CO_2 Emissions

In his address to the 66th General Assembly of the United Nations in 2011, Secretary-General Ban Ki Moon made an ambitious statement to the world:

> "Saving our planet, lifting people out of poverty, advancing economic growth ... these are one and the same fight. We must connect the dots between climate change, water scarcity, energy shortages, global health, food security and women's

> empowerment. Solutions to one problem must be solutions for all" [15].

The difficulty of conquering even one of these three priorities at a national level has proven elusive for a majority of the planet. To simultaneously and successfully address all three seems nearly, if not completely, impossible. A closer look at the history of economic development alone illuminates just how we have arrived at our current state of inequality in the world. Sadly, there is no clearly defined roadmap, no outline, no rulebook that a developing nation can reference to guarantee successful growth moving forward. For decades the world's leading thinkers have sought to clearly define what it means to be a "developed" nation versus a "developing" one. They have tried to neatly label societies as "first world" or "third world", "core" or "periphery", even "north" or "south" in an attempt to determine how some countries have successfully built a robust economy capable of lifting their people out of poverty and into prosperity while others have not.

Various economic thinkers have presented theories of economic development. From Karl Marx and his treatise "Das Kapital" came the class based theory of growth that a society progresses from primitive communism to slavery, followed by feudalism, capitalism, and a conflict based return to socialism [16]. Rostow also presents a stage based theory of development centered around capital that has been criticized as too simplistic for ignoring the realities of institutions, cultural traits, political dynamics, social structures, and geographical peculiarities in impacting a national growth trajectory [17]. While his five stage model has proven useful in some ways to order the chaos of economic development, his approach is seen as a political rebuttal to communism during the Cold War with a decidedly western bias [18]. Others have added to these theories but the ever changing nature of each of the mentioned factors coupled with the unpredictable nature of globalization make determining any universal doctrine of economic growth difficult. As Charles Kenny of The World Bank and David Williams of Oxford University acknowledge:

> "Overall, attempts to divine the cause or causes of long-term economic growth, testing a wide range of possible determinants using statistical techniques, have produced results that [...] are frequently contradictory to results reported elsewhere. That is, empirical evidence is hardly unanimous in support of a particular view of the growth process [...] The empirical evidence, however, seems to provide little firm guidance for the universal efficacy of any particular policy prescriptions" [19].

Despite the challenges, the empirical analysis continues. The World Bank uses a four-tiered national income per capita based system to divide the world. The top 80 countries make over $12,736 per person and represent 1.1 billion of the world's population. The 53 upper-middle income nations earn $4,126 to $12,735 and have a population of 2.5 billion. Lower-middle income countries make up 51 nations covering about 2.5 billion people with an income of $1,046 to $4,125 per capita. Finally, the 31 low-income countries represent people making $1,045 or less per year [20].

Clearly, no matter what form or nature the labels of development stages take, there is a great divide in the world between the "haves" and the "have nots," the "developed" and "developing." Since the dawn of the Industrial Revolution around 1760, the gap in global income equality began to rapidly expand. As some of the world's largest economies (namely China and India) have begun swift development in the last 20 years, that expanding inequality has begun to slowly shrink. Despite this narrowing inequality gap, the impacts of such developmental disparity are felt across the globe as mortality rates, education and literacy levels, hunger, health care, disease control, and general poverty levels leave massive room for improvement. What a review of the larger issues of development tell us is that policy makers, NGO's, heads of state, and anyone involved in bettering global well being must realize and acknowledge that a unique blend of policy prescriptions will be needed for each individual country at any given time [19].

Predictably, as nations began further industrializing in the latter half of the 19th century, CO_2 emissions began to rise accordingly. In fact, between 1850 and 2011, CO_2 emissions multiplied to over 160 times their original level. Compared to GDP growth, that number is astronomical. For perspective, in 1820 the adjusted global GDP was about I$694 billion (1990 international Geary-Khamis dollars) while in 2003 that figure had grown to nearly I$41 trillion, a growth multiplier of merely 60 times [21].

What is also notable is how concentrated these historical emissions are to a relatively small number of countries. As you can see below, 83% of cumulative CO_2 emissions between 1850-2011 came from 37 countries. What's more is that the United States, the Russian Federation, and China alone account for nearly 50% of all CO_2 emissions in that timeframe.

When working to understand the impacts of GCAs on participating nations, an important consideration is not only who is doing the emitting, but also the source of those emissions. Presumably, because all participating nations at some point will work to limit their CO_2 output, it will be necessary to know where to focus their efforts to be most efficient. In 2013, over 42% of all global CO_2 emissions came from electricity/heat generation. Of that subsection, 72% of emissions came from coal [22]. It stands to reason that the form of energy production to avoid or limit if aiming to reduce a nation's carbon footprint would be coal-fired electricity generation.

A look at the data, however, shows that some of the world's fastest growing large economies, India and China, have clearly chosen coal to fuel their growth. Today, China uses about as much coal each year as the rest of the world combined. Despite recent efforts to curb coal use, highly developed nations still generate much of their electricity from the fuel, with the U.S. and OECD countries producing 38 and 31 percent of their electricity, respectively, from coal in 2014 [23]. Indeed, between 1980 and 2012 the world increased coal consumption by 107 percent [24]. Why? Warnings of the effects of burning fossil fuels have been around long before 1980. Clearly there is a national interest in pursuing energy production that may negatively impact the rest of the world. Any GCA that attempts to move developing nations directly to an energy mix void of coal power with a major focus on CO_2 mitigation will only do one of two things; either stunt that nation's economic development or be laced with incentives that must go far beyond $100 billion per year to offset those opportunity costs of displaced development.

This discussion about responsibility of emissions has been a major point of conflict in recent global climate negotiations. The argument centers around how to balance future economic growth for low-income nations and mitigating catastrophic future climate change for the globe as a whole.

3. THEORY AND APPLICATION

3.1 Economic and Human Development Nexus

Beyond the general consideration of economic development is a parallel conversation on human development. That is, efforts should be made to offer people a wider variety of choice in their existence allowing for longer, healthier, and more fulfilling lives [25]. While it is commonly believed that economic growth and human development share a bidirectional relationship, the number of variables involved and the inclusion of human decision making and prioritization along the way tends to cloud this nexus. These decisions are not only made by formal policy makers, but also citizens and institutions in their personal preferences. As each country follows inherently unique development patterns as discussed previously, there is no certainty that economic development necessarily leads to reductions in absolute poverty in these expanding nations, at least in the short term. When taking a longer view, however, it is generally accepted that poverty and inequality recede as economic growth advances [26].

This reduction in poverty and inequality leads to a larger set of rational options for citizens. Presumably, as people have greater flexibility in life choices, they have a better chance of improving their lives, leading to an overall increase in societal well-being, or human development. A two-chain relationship between human development (HD) and economic growth (EG) was presented by Ranis et al. [25] and offers a visual accounting for the various inputs, and their complex interactions, within the overall process.

Where this discussion takes on expanded meaning in the realm of GCAs is when looking closely at the role of energy development and consumption in low-income or developing nations. GCAs impose a certain course of action for participating nations, the main goal being (at least of the Paris agreement and those of the recent past) to limit CO_2 emissions to a level that will halt global temperatures from rising beyond a certain threshold. As shown, CO_2 emissions within most nations come primarily from energy production. Understanding, then, the relationship of energy consumption with economic development can serve policy makers well when evaluating trade-offs between economic

development with an eye towards human development, or emission mitigation efforts to comply with GCAs.

3.2 Understanding the Energy Ladder Theory

Based on the latest data, 17% of the global population has no access to electricity, and 38% rely primarily on biomass fuels for cooking [27]. In order to effectively prompt systemic green change in the low-income world, climate project financiers need a robust understanding of how fuel transitions occur. Energy researchers have identified a theory known as the energy ladder that explains how fuel choice changes with income. According to the energy ladder theory, as incomes rise, people purchase cleaner, costlier, and more convenient fuels. At the lowest portion of the energy ladder, households rely on burning animal dung or crop wastes for their energy needs. At the highest incomes, people transition to relying almost entirely on a well-diversified energy grid that may include a number of renewable electricity generation resources. Empirical evidence for the existence of an energy ladder has been found in India [28,29,30], Zimbabwe [31], Brazil, Nicaragua, South Africa, Vietnam, Guatemala, Ghana, Nepal [29], Burkina Faso [32], and Mexico [33], among others.

One important limitation of the energy ladder model is that household fuel transitions are often not complete. Instead, households that adopt a new cooking technology (such as a natural gas stove) still keep older biomass-powered stoves and continue to use them [33,30,34] This is done both for fuel security and for cultural reasons [33,34]. Additionally, other identified factors play a role in fuel switching, such as the external environment of a household, energy prices, availability of alternative energy sources, and home ownership [30,34]. This is certainly not an exhaustive list. The energy ladder theory of energy development affects global climate initiatives in a number of key ways, which will be discussed in the following sections.

1. Sustainable Development Requires Electric Grid Access

All lower rungs of the energy ladder use carbon-emitting fuels. The carbon emissions from wood fuels are made even worse by the associated deforestation resulting from heavy wood fuel use [35,36]. While biomass fuels at the lowest portions of the energy ladder do have the potential for being carbon neutral since biomass fuel sources sequester carbon out of the atmosphere when sustainably replanted, real-world fuel use is not that careful and often results in a significant carbon footprint [37]. In middle portions of the ladder, carbon intensity rises even higher as communities begin to rely on coal and other conventional fossil fuels [38]. Only when nations start transitioning to natural gas and renewable energy resources does carbon intensity begin to drop [38]. However, as experience in China has demonstrated, effective use of renewable electricity requires grid connectivity [39]. Grid connectivity is often prohibitively expensive, especially in rural areas where many of those who struggle with energy poverty reside [40]. Even when the energy poor are given access to easy electrification, the opportunity is ignored for a variety of reasons [41,42]. Often, electricity is more expensive than biomass fuels because the opportunity cost to collecting biomass fuels is not high for many impoverished families [43,44].

2. Programs to Increase Energy Penetration are Unlikely to be Maximally Effective

Providing increased access to a diversity of fuel types is an important step in raising energy poor communities out of poverty, but that process is unlikely to result in a complete fuel substitution. Mansera et al. [33] first pointed this out in examining rural Mexican communities, which had access to LNG, but often continued to use wood fuels even after purchasing an LNG stove. This phenomenon has been empirically noted in other areas as well [30,34]. The uncertainty involved in fuel usage will make it difficult for international organization to account for actual climate change mitigation effects.

3. Emissions in Low-income Countries Will Likely Get Worse Before They Get Better

Emissions in low-income regions are not likely to go down as they develop for two reasons. The first is that carbon intensity (measured as tons of CO_2 emissions per terajoule of energy created) rises until per capita income reaches a level of I$6000, roughly the level that Guatemala reached in 2010 [39]. Past this point, countries begin a

slow descent as energy production systems gain efficiency. The second reason is increased consumption. Low-income countries' energy consumption is slated to increase over the next decades, rising greenhouse gas emissions along with it, even if carbon intensity trends downwards [45].

3.3 Energy Consumption, Emissions, and Economic Development

From an even wider scope than that offered by the energy ladder model, there is a vast body of empirical work examining the relationship between emissions, energy consumption, and economic development. A paper by Mohammad Salahuddin and Jeff Gow [46] offers and extensive literature review on studies examining these interrelations and the potential for decoupling. Their analysis finds an intense academic debate regarding the direction of these relationships (whether energy consumption drives economic development, vice versa, or if the relationship is bidirectional), but also a general academic agreement that there is some sort of causal relationship. More recent studies have offered even more evidence for the existence of a causal relationship [47,48]. Further, they find no evidence for absolute decoupling, a phenomenon of increasing economic growth simultaneous to decreasing emissions. For countries that were able to slow (but not halt and certainly not reverse) their emissions increases during periods of growth, changing the composition of their energy mix was key. Perhaps the most troubling academic agreement that Salahuddin & Gow [46] uncover is the intense link between global energy consumption inequality and global income inequality--finding that inequality in incomes is the key driver for differences in global emissions. Therefore, any agreement that requires low-income countries to cap or cut emissions is effectually instructing them to forego much-needed economic development.

3.4 Can Fund Transfers Hurt Low-income Countries?

Aside from problems of efficacy and efficiency in implementation of GCA in low-income countries, there are also a number of potential pitfalls that can make GCA-related fund transfers to low-income countries not only ineffective, but also harmful. Among the risks facing low-income countries participating in GCA financing schemes are exposure to price volatility (for market-based carbon reduction schemes), rent-seeking and corruption (for non-market-based carbon reduction schemes), and Dutch disease [49]. Much of this risk can be mitigated by smart policy construction, but the vagueness of the COP21 agreement fails to meet that standard.

3.5 Cost of Electricity Development

As with any decision in a low-income nation, it is all about the trade-offs between resources on hand and issues to address. There is never enough of the former, and always too many of the latter. When debating investment options in the energy and electrification space it is no different. As with all other decisions, the form of any negotiations will vary greatly between each country depending on finances, existing infrastructure, industrial demand, political climate, investment and technological capital available, government credibility, and a host of other considerations. As the U.N. has acknowledged:

> "Much of today's prosperity rests on secure and stable access to energy. Without requisite energy infrastructure, modern production grinds to a halt, as can be witnessed in parts of the developing world...With few exceptions, countries that are rich have become so through industrial development...From this, the conclusion emerges that some countries are rich while others are not because the former have managed to ensure their access to energy by building infrastructure" [50].

While all nation's face their own unique blend of circumstances, we can look at some examples to develop a proxy set of recommendations for low-income nations. In Sub-Saharan Africa (SSA), lack of access to advanced electricity networks is nearly universal. Most electricity in this region is delivered via diesel generators that operate at a cost of 3-6 times that paid by grid consumers. While the demand for electricity is clearly present, the costs and lack of infrastructure lower GDP in the region from 1 to 3 percent annually. Finding sustainable ways to increase electricity generation and transmission while lowering costs will have major economic benefits [51].

Research by McKinsey and Company has shown that for developing nations to increase electrification rates from 20 percent to 80 percent, they can expect a timeframe of 25

years. The estimates from this study in SSA show that if every country were to build enough to meet its domestic needs by 2040, generation would increase about four-fold over 2010 levels, natural gas and coal would account for a majority of power, and the costs would exceed $835 billion dollars in investment. Of course, this focus on meeting demand and facilitating growth would lead to an increase in CO_2 emissions. If SSA countries instead pursued an aggressive renewable energy implementation plan, they could expect up to 27 percent less CO_2 emissions, but would see costs rise $153 billion dollars [51]. When developing electricity systems, determining the balance between cost, generation capacity, demand, and emissions is done on a generational scale. Clearly, cost considerations will be key to any economic and environmental decisions moving forward in developing nations. Where some nations will affordably and efficiently be able to implement large-scale renewable projects into existing infrastructure to meet strict climate goals, others will have to prioritize developing baseload capacity with coal and gas generation while making large investments into transmission infrastructure to industrialize and grow the economy before any talk of curbing CO_2 emissions could be considered. Because of the wide spectrum of current electrification and energy status between individual nations, prescribing any one path forward is impossible and denotes a major hurdle for efficacy and establishing consensus when crafting GCAs.

4. CONCLUSIONS AND POLICY SUGGESTIONS

Scientific consensus tells us that greenhouse gas emissions, especially CO_2, will be a threat to our planet moving forward if not mitigated. As the recent COP21 conference in Paris showed us, nations are eager to come together and take some form of action on this front. Unfortunately, as we have shown, many questions remain as to the efficacy of GCAs as currently pursued. This paper specifically aimed to answer the question: "What role, if any, should poorer nations play in global climate agreements?" The answer, according to the data and information reviewed in this paper, is "very little."

Yes, all countries should recognize the threat of CO_2 emissions and climate change. However, instead of agreeing to take action to peak CO_2 emissions as soon as possible, countries should be aiming to do what is best for their people. That is the duty of lawmakers and leaders to their citizens. We argue that five considerations must be made by parties negotiating GCAs before taking any concrete, legally-binding action.

1. Recognize the Unique Situation of Each Individual Nation

The language of the Paris agreement acknowledges that "Parties should, when taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity" [6]. Unfortunately, it assumes that taking action on climate change immediately allows the type of flexibility needed for all countries to simultaneously address all of these other issues as well. As the discussion on the energy-ladder and the nexus of energy consumption and economic development shows, each country is in a very unique place in regards to its energy mix. This is in addition to a host of other development and well-being priorities such as healthcare, education, poverty, homelessness, hunger, unemployment, safety etc. While GCAs allow for world powers to come together and craft a collective action agreement, it should not be expected that the poorest or least developed nations would, or should, prioritize climate change above the immediate needs of their people.

2. Address the Disparity of Current and Cumulative CO_2 Emissions among Nations

The top 10 emitting countries in the world in 2011 were China, U.S., India, the Russian Federation, Japan, Germany, Republic of Korea, Iran, Indonesia, and Saudi Arabia. Together they emitted nearly 65 percent of global emissions [20]. If these countries were to cut their combined emissions by just 10 percent, that would be the equivalent of eliminating *all* CO_2 emissions of the bottom 155 emitting countries in the world. Many of those 155 countries are well established, industrialized economies who have the means along with both the political capital

and environmental incentive to pursue emissions cuts. There are, however, dozens of nations on that list with a host of concerns to address before emissions cuts would become a priority. Instead of expending valuable time, funds, resources and manpower crafting nationally determined contributions for CO_2 emissions, they should focus their efforts elsewhere.

The same trend is visible when considering cumulative emissions. As noted, a mere three nations account for nearly 50 percent of all emissions since 1850. While it should not be expected that low-income nations exert themselves mitigating emissions in the CO_2, it is a very real possibility that many of these nations could face impacts of cumulative climate change in the near future. If this is the case, those nations responsible for creating the problem, should also be tasked with addressing it. World powers pledging money into a fund that they ostensibly control, with ill defined rules for distribution and lack of accountability hardly replace the very real discussion that should take place surrounding historic inequality.

3. Understand that Timelines of Economic Development and CO_2 Mitigation are not Necessarily Complementary

For developing nations, especially those in the lowest income brackets, the path towards economic development may not have even begun in earnest and is likely to carry on for generations. Recognizing that any efforts to expand GDP from current levels may not allow for GCA compliance in the prescribed timelines is crucial. Are there best practices that can be shared and implemented from other nations that will allow for more responsible and sustainable industrial growth moving forward? Absolutely. But is there a singular growth pattern that be followed for all global economies? Of course not. Instead, leaders and policy makers should ensure that all parties working with their nation in any capacity have the best interest of their country in mind always. Pursuing collective goals that promise returns in decades may not be feasible when citizens are starving now.

4. Recognize that Agreements May Not be Satisfied or Upheld

When dealing with GCAs, policy makers need to account for the real possibility that other parties will not uphold their commitments. This is especially true for low-income nations who see promises of financial, technological, or human capital as the only incentive to agree to action. The opportunity costs of pursuing one path of environmental or economic progression only to pivot in another direction when promised aid or allied action is withheld in the future is a costly lesson and could set countries back years in their efforts or place them at a disadvantage moving forward. For example, the 2005 Kyoto protocol was not signed or ratified by the three largest emitters, and today only regulates 15 percent of global emissions. Also, of the $100 billion annually to be distributed by 2020, only a fraction has actually been pledged with no concrete roadmap for obtaining full funding. While developing nations see the lure of money as an incentive to make concessions and major changes, the idea that the funding will be available until full compliance is achieved is uncertain.

5. Conclusion

In the Paris agreement, it was reaffirmed that world economic leaders would pool $100 billion per year beginning in 2020 to aid less developed nations with mitigation and adaptation. There were also a record number of signatories to the landmark treaty which many felt was a sign that the world was ready to tackle CO_2 emissions and climate change. The problem with such a public show, is that it often requires leaders to craft an agreement that can reach a much higher threshold for consensus which necessarily requires the weakening of overall prescriptions. While Paris became a symbolic gesture that may in and of itself facilitate meaningful future actions, the fact remains that a strong set of actions undertaken by the world's top 5 or 10 emitters would prove to be infinitely more productive at limiting global CO_2 emissions than a carefully worded, all encompassing, appeasement of 195 diverse nations. Politically speaking, this is understandable, but developing nations should use their voice

to demand real action over political grandstanding. This may mean several different climate agreements for groups of countries at various economic stages.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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