IASS STUDY

Institute for Advanced Sustainability Studies (IASS)

Sustainable Solutions for the Global South in a Post-Pandemic World

Potsdam, 14 May 2021

Artur Sgambatti Monteiro, Vinod Ramanarayanan, Nadeem Abdelgawad, Rowan Alumasa Alusiola, Kelechi E. Anyaoha, Sina Ardabili, Natalia Burgos, Melissa Cuevas Flores, Enzo Leone, Amir Mosavi, Minh Anh Nguyen, Morteza Nikravan, Charles Kofi Owusu, Emily Montserrat Castro Prieto, Magaly Ines Beltran Siñani

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IASS POTSDAM

Preface

More than a compilation of short opinion pieces and essays, this publication collects a range of views on this unique year and considers the implications for our work in the field of climate change mitigation. The authors are experts from different fields and backgrounds, including engineers, environmental managers, social scientists, and activists from Argentina, Bolivia, Brazil, Colombia, Egypt, Ghana, India, Iran, Kenya, Mexico, Nigeria, and Vietnam.

Most of the authors are recipients of the 2020/2021 International Climate Protection Fellowship of the Alexander von Humboldt Foundation. Supported by the German Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), this special programme fosters emerging leaders in the fields of climate change mitigation and adaptation, ecosystem and biodiversity conservation, and the sustainable use of the seas and oceans.

We are united by a shared understanding of our realities and interconnected problems and the desire to work towards a better world. The idea for this publication arose in the course of a lunchtime discussion that left us surprised at the similarities in our thinking and the diversity of the solutions proposed, which ranged from urban planning approaches to create more equitable cities, sustainable and renewable energy systems, governance frameworks to preserve rainforests, and international cooperation tools that are fair and sound.

Voices from the Global South are under-represented in the discourses around climate change and sustainable development. The ICP Fellowship empowers young scholars from the Global South to develop their projects and engage with cutting-edge European and international institutes working in the field of climate change protection. The programme gives us a voice in an attempt to bring more evenness to climate change discussions. This publication has been an opportunity for us to work together and contribute to the voice that needs to be heard, especially in such testing times.

The Covid-19 pandemic added a layer of complexity to our stay in Germany that affected not only our personal and project-related goals, but our entire shared human existence. The pandemic has impacted on all our lives in different ways at the personal and professional levels and, more broadly, on the international political stage. As we prepare these texts for publication there is little sign that it will abate soon.

More than a collection of short academic essays, this publication outlines visions of transformation for a post-pandemic world and invites readers to consider the challenges that we must overcome together.

Finally, we wish to acknowledge the support of the Institute for Advanced Sustainability Studies (IASS), which kindly prepared and published this study, as well as the tireless efforts of our editor at the Institute, Damian Harrison. Special thanks also go to Matthias Tang (Head of Press & Communications, IASS) and Achim Maas (Head of the Fellow Programme, IASS).

We hope you enjoy this glimpse of the world as seen through our eyes.

With gratitude to our colleagues,

Vinod Ramanarayanan & Artur Sgambatti Monteiro.

Foreword

The Centre for International Postgraduate Studies on Environmental Management (CIPSEM) has been a partner organisation of the Alexander von Humboldt foundation since the inception of the International Climate Protection Fellowship Programme and organises the yearly two-week study tour seminar for the ICP Fellows. CIPSEM has organised and conducted postgraduate training for key stakeholders from developing countries since 1977 and nearly 2,500 people have participated in a CIPSEM course to date.

Normally, CIPSEM would organise the onsite midterm study tour in which the fellows meet, converse, and get fresh motivation and ideas to take back to their host institutions, where they continue work on their research projects. But due to the pandemic the midterm study tour for 2020 was conducted as a virtual programme for the first time. Instead of gathering in Dresden at the outset of a two-week-long "road show" of meetings and discussions with key actors in climate adaptation policy, we hunkered down at our computers to meet online. Virtual meetings were our daily routine for three and a half weeks in September.

Online formats struggle to compete with in-person meetings. But fully virtual formats do offer some advantages and can facilitate cooperation across multiple locations. This year, for example, we launched a new module as part of the study tour, which focused on the visualisation of data on topics relating to climate change. The fellows chosen to approach these issues through the lens of the Covid-19 pandemic and established three working groups: renewable energy, land use, and ecological services and economics. The groups met online regularly to discuss and work on their topics. The idea of a joint publication boosted their motivation and the quality of the outcome. This very timely publication is unique in that it gathers knowledge – including grey literature – from climate protection experts from all over the world. I am both overjoyed that we were able to include this work package in our study tour and impressed by the tremendous work and dedication that the fellows have shown in preparing their contributions in such short time.

With this publication, the International Climate Protection Fellows make it very clear that the global Covid-19 pandemic and the climate crisis are the most significant problems that humanity face today. The fight against these two global crises is a challenge we can only overcome together, one that calls for a united effort in which every single one of us will contribute a little piece. I am convinced that this publication, which explores different approaches to tackling Covid-19 from various interdisciplinary perspectives, is a part of this broader effort. It is an open invitation to further collaboration, discussion, and research. Most of all, it highlights the passion with which the International Climate Protection Fellows pursue these urgent issues. You are welcome to contact them and to add your piece in the fight against these crises.

Dr. Angela Francke

CIPSEM, TU Dresden

Zusammenfassung (DE)

Albert Einsteins Erkenntnis, dass man Probleme niemals mit derselben Denkweise lösen kann, durch die sie entstanden sind, war nie wahrer als heute, da die Welt mit der globalen Gesundheitskrise der Covid-19-Pandemie zu kämpfen hat.

Im Juli 2019 versammelten sich Vertreterinnen und Vertreter von 142 Ländern beim Hochrangigen Politischen Forum für Nachhaltige Entwicklung (HLPF), um die Fortschritte bei der Umsetzung der Agenda 2030 für Nachhaltige Entwicklung der Vereinten Nationen zu überprüfen und Bereiche zu identifizieren, die dringend der Aufmerksamkeit bedürfen. Die Fortschritte bei der Erreichung der UN-Nachhaltigkeitsziele (SDGs) waren schon vor der Pandemie uneinheitlich, aber der Ausbruch der Pandemie hat die Umsetzung vieler dieser Ziele abrupt unterbrochen und in einigen Fällen Jahrzehnte des Fortschritts rückgängig gemacht. Die Krise hat alle Bereiche der Gesellschaft erfasst und Volkswirtschaften auf der ganzen Welt erschüttert. Es überrascht nicht, dass die ärmsten und verletzlichsten Bevölkerungsgruppen am meisten leiden. Die Pandemie hat tiefgreifende gesellschaftliche Ungleichheiten offengelegt und verschärft die Unterschiede innerhalb von und zwischen den Ländern weiter.

Obwohl es sich bei den SDGs um breit angelegte globale Ziele handelt, findet ihre Umsetzung ganz wesentlich auf lokaler Ebene statt. Die Autorinnen und Autoren dieser Publikation repräsentieren gemeinsam den Globalen Süden und bringen Fachwissen zu einigen der wichtigsten Herausforderungen mit, vor denen wir heute stehen: Wasser und Sanitäreinrichtungen (SDG 6), Biodiversität (SDG 15), Energie (SDG 7), Wirtschaft (SDG 8), Armut (SDG 1), Ungleichheit (SDG 10), nachhaltige Städte und Gemeinden (SDG 11), Klimaschutz (SDG 13) und mehr.

Die Herausforderungen, die die Pandemie mit sich bringt, sind zu unseren Lebzeiten ohne Beispiel. Als die Welt aus den Fugen geriet, beschlossen die Autorinnen und Autoren dieser Publikation, ein tieferes Verständnis für die Auswirkungen dieser Krise auf die nachhaltige Entwicklung, den Klimaschutz und unsere jeweiligen Forschungsschwerpunkte zu erlangen. Sie überlegten, wie sie zusammenarbeiten und dazu beitragen können, Wege zu einer nachhaltigeren und gerechteren Welt zu entdecken.

Die fünfzehn Autorinnen und Autoren dieses Sammelbandes lassen sich in drei Gruppen einteilen, die ihre verschiedenen Schwerpunkte widerspiegeln: Erneuerbare Energien, urbane Resilienz & ökologische Dienstleistungen, Klimawandel & Wirtschaft. Jede Autorin, jeder Autor beschäftigt sich mit drei zentralen Fragen und versucht, eine gemeinsame Basis zu finden und neue Perspektiven für die Welt nach der Pandemie zu entwickeln:

1. Welche Fortschritte wurden bei den SDGs in Ihrem Fachgebiet vor der Pandemie gemacht? Wie hat Ihr Gebiet auf die Pandemie reagiert?

2. Was sind Ihre Vorschläge/Beobachtungen für den weiteren Weg?

3. Wie kann Ihr Land Lösungen in Politik und Praxis herbeiführen, um den Klimawandel nach der Pandemie zu bekämpfen?

Erneuerbare Energien

Im ersten Kapitel dieser Publikation betrachten die Autorinnen und Autoren die Energiemärkte und insbesondere den Ausbau der erneuerbaren Energien (SDG 7). Sie untersuchen die Auswirkungen der Pandemie auf das Wirtschaftswachstum, die Lebensgrundlagen der Schwächsten, globale Ungleichheiten und Investitionsströme zum Nachteil verschiedener Regionen und Länder. Die Krisenreaktionen in Nigeria, Ghana, Argentinien und Iran sind ein besonderer Schwerpunkt dieses Abschnitts.

Nachhaltige Städte und Gemeinden und ökologische Dienstleistungen

Mehr als die Hälfte der Menschheit lebt in städtischen Gebieten. Dort sind die sozialen und wirtschaftlichen Ungleichheiten am stärksten ausgeprägt. Die Vulnerabilität ist besonders hoch und die Menschen sind Problemen wie Wohnraummangel, schlechten Wassermanagementsystemen und Infektionskrankheiten ausgesetzt. Auch auf dem Land gibt es gravierende Probleme, wie zunehmende Abholzung, Verseuchung des Bodens und Wüstenbildung. Die Covid-19-Pandemie hat diese Probleme verschärft. Die Autorinnen und Autoren analysieren in diesem Abschnitt Themen wie 1) Wassermanagement-Probleme und ihre Verbindung zu Gesundheitsmaßnahmen während der Pandemie; 2) Herausforderungen in Bezug auf Migration und zunehmende Verwundbarkeit während der Pandemie, 3) die Abholzung in den südlichen tropischen Wäldern seit Beginn der Pandemie und 4) die Wahrnehmung der immateriellen Bedeutung des Amazonas-Regenwaldes - mit Fokus auf SDG 1, SDG 6, SDG 11 und SDG 15.

Klimawandel und Wirtschaft

Die Covid-19-Pandemie, die Klimakrise und die Weltwirtschaft sind zusammenhängende Phänomene. In diesem Kapitel analysieren die Autorinnen und Autoren die Auswirkungen und Herausforderungen der Coronakrise aus der Perspektive von Wirtschaft und Klimawandel und diskutieren mögliche Lösungsansätze, darunter: 1) einen Fahrplan, um die Klimaziele des Pariser Abkommens in die Konjunkturprogramme zu integrieren; 2) eine Mehrebenen-Klimagovernance für einen grünen Wiederaufschwung; 3) Lektionen für eine nachhaltige und resiliente Erholung und 4) radikale Ansätze, um sozioökonomische Ungleichheiten und den Klimawandel abzuschwächen.

Zusätzliche Beiträge

Schließlich enthält diese Publikation zwei Beiträge, die nicht in diese Kategorien fallen, aber mit dem übergreifenden Thema des Klimawandels und der Coronavirus-Pandemie zusammenhängen. Der erste liefert einen spezifischen Ansatz zu den Auswirkungen und Veränderungen im Bereich der Abfallwirtschaft in Bolivien. Die internationale Zusammenarbeit unterstützt dort positive Veränderungen. Der letzte Beitrag konzentriert sich auf die Vorhersage zukünftiger Pandemien auf der Grundlage modernster maschineller Lernmodelle.

Summary (EN)

Albert Einstein's assertion that we cannot solve our problems with the same thinking that we used to create them has never been truer than it is today as the world grapples with the global health crisis of the COVID-19 pandemic.

In July 2019, representatives from 142 countries gathered for the High-Level Political Forum for Sustainable Development (HLPF) to review progress towards the United Nations' 2030 Agenda for Sustainable Development and to identify areas in urgent need of attention. Progress towards achieving the Agenda's sustainable development goals (SDGs) had been uneven prior to the pandemic, but its outbreak abruptly disrupted implementation towards many of these goals and, in some cases, reversed decades of progress. The crisis has affected every segment of society and has rocked economies around the world. Unsurprisingly, it is the poorest and most vulnerable populations that will suffer the most. The pandemic has exposed harsh and profound inequalities in societies and is further exacerbating disparities within and between countries.

Although the SDGs are broad global goals, their implementation is rooted in action at the local level. The authors of this publication collectively represent the Global South and their expertise touches on some of the key challenges facing us today: water and sanitation (SDG 6), biodiversity (SDG 15), energy (SDG 7), economics (SDG 8), poverty (SDG 1), inequality (SDG 10), urban sustainability (SDG 11), climate action (SDG 13) and more.

The challenges presented by the pandemic are without precedent in our lifetimes. Robbed of our equilibrium, we decided to focus our thoughts on achieving a deeper understanding of the implications of this crisis for sustainable development, climate protection, and our respective areas of focus. This led us to consider how we could work together and help to forge pathways towards a more sustainable and equitable world.

The fifteen authors contributing to this anthology fall broadly into three groups that reflect their various areas of focus: Renewables & Energy, Urban Resilience & Ecological Services, Climate Change & Economics. Each of the authors engages with three central questions in their writing in an attempt to find our common ground and shape new perspectives for the post-pandemic world:

1. What progress was made on the SDGs in your area of focus before the pandemic? How has your area responded to the pandemic?

2. What are your suggestions/observations for the way forward?

3. How can your country bring about solutions in policy and practice to tackle climate change in the wake of the pandemic?

Renewables and energy

In the first chapter of this publication, the authors consider the state of energy markets and renewables in particular (SDG 7) and explore the various impacts of the pandemic, which is dampening the prospects for economic growth, threatening the livelihoods of the most vulnerable, exacerbating inequalities, and reshaping investment flows to the detriment of different regions and countries. Responses to the crises in Nigeria, Ghana, Argentina, and Iran are a particular focus of this section.

Urban resilience and ecological services

Over half of humankind lives in urban areas, where social and economic inequalities are often heightened. Vulnerabilities are felt the worst, and people are exposed to different problems such as lack of housing, poor water management systems and exposure to diseases. The countryside, also, represents staggering issues such as the accelerated growth of deforestation, land contamination, desertification, among others. The Covid-19 pandemic accentuated such issues. This way, in this section the authors take a deeper look at some issues such as 1) water management problems and its relationship with the pandemic health measures; 2) challenges regarding migration and increasing vulnerabilities with the pandemic, 3) how deforestation in southern tropical forests has being evolving since the beginning of the pandemic and 4) a perception of the immaterial importance of the Amazon rainforest – focusing on SDG 1, SDG 6, SDG 11 and SDG 15.

Climate change and the economy

The COVID-19 pandemic, the climate crisis, and the global economy are interdependent phenomena. In this chapter the authors analyse the impacts and challenges thrown up by the coronavirus crisis from an economic and climate change perspective and discuss potential solutions, including: 1) A roadmap to incorporate the climate goals of the Paris Agreement within recovery programmes; 2) Multi-level climate governance for a green recovery; 3) Lessons for a sustainable and resilient recovery and 4) Radical approaches to address socio-economic inequalities and climate change.

Additional contributions

Finally, this publication includes three contributions that fall outside these categories but connect with the overarching theme of climate change protection and the coronavirus pandemic. The first delivers a specific approach of the impacts and changes occurred in the solid waste management field in Bolivia and how international cooperation has being supporting positive changes. The last is focused on the future outbreak predictions based on cutting-edge machine learning models.

Contents

1 The Covid-19 Pandemic and Renewable Energy

The Covid-19 pandemic continues to ravage countries, overwhelming health systems, threatening food security, and accelerating job losses while reducing household incomes and raising household energy consumption. Its impact on economies have caused investments in both conventional and renewable energy systems to plummet. The pandemic threatens the prospects for economic growth and the livelihoods of the most vulnerable, exacerbates inequalities, and reshapes investment flows to the detriment of commitments to the Paris Climate Agreement in regions such as sub-Saharan Africa (SSA) and South America.

This section discusses the ramifications of the current health crisis for poverty, energy access, and renewable energy demand and utilization as well as investment in the Global South. It also discusses briefly what the current disruptions mean for the economies of countries in the Global South, most of which are already reeling under the pressure of various climate risks. The section also highlights the importance of green buildings and the refuge provided by housing during lockdowns occasioned by pandemics, using Iran as a case study.

Investment in renewable energy is expected to stall in 2020 due to the pandemic. This will lead to further increases in greenhouse gas emissions, further exacerbating the global climate crisis. The contributions in this section include a variety of policy measures aimed at facilitating the sustainable and robust recovery of economies in the post-pandemic world, with a particular focus on supporting clean energy transitions. Increased investment in renewable energy technologies is expected to directly impact the lives of millions of people in rural areas, which have been badly affected by the pandemic. Policy changes to promote green construction are also needed more than ever to reduce energy consumption, safeguard human health, and assist in the prevention and control of infectious diseases.

Photo by Science in HD on Unsplash

1.1 Nigeria, the Covid-19 pandemic, and renewable energy

Kelechi E. Anyaoha

The impact of the pandemic on Nigeria

Accounting for 2.64% of the global population, Nigeria is the seventh most populous country in the world and has the lowest media age (18.4 years) among the seven most populous countries in the world (Worldometer Nigeria Population 2020). Nigeria is a mono-economy and is heavily dependent on crude oil exports, which account for as much as 90 % of foreign exchange earnings. Import flows were dampened by the pandemic, leading to increases in the costs of imported commodities (Otache, 2020, p. 177). There is near zero use of E-business and E-learning models. This implies that most businesses and academic institutions affected by the nation-wide lockdown have been unable to make any significant progress. As of 15 September 2020, universities, secondary and primary schools in Nigeria have remained closed since March due to the pandemic. This impacts negatively on the education of millions of young Nigerians, and on businesses and families dependent on these institutions for survival.

The first case of Covid-19 was reported by Nigeria's Centre for Disease Control on 27 February 2020 and, as of 12 October 2020, 60,430 cases have been confirmed, with 5,1943 patients discharged and 1,115 deaths (COVID-19 Nigeria 2020). As of 12 October 2020, Qatar, Kuwait, Oman, UAE, Belarus, Venezuela, Bahrain, Singapore, and Costa Rica have recorded more cases of Covid-19 than Nigeria, yet the number of deaths from Covid-19 is greater in Nigeria than in these countries (Worldometer COVID-19 Coronavirus Pandemic 2020). This fact is not unconnected to Nigeria's poor performance in the 2017 World Health Organization's Joint External Evaluation of International Health Regulations Core Capacities, which measures a country's capacity to prevent, detect, and respond to public health risks (Dixit et al. 2020). The country scored poorly in the categories prevent and respond, indicating a limited capacity to prevent and respond to sudden health risk. The shortage of human resources, testing kits, and laboratories has constrained Nigeria's ability to detect Covid-19 infections, which is important in its control.

Energy demand and supply in Nigeria

Nigeria holds the world's ninth largest natural gas reserves and accounts for 3% of total confirmed natural gas reserves worldwide. In terms of production, Nigeria is 12th in the world but 38th in consumption. Evidently, Nigeria is a key player in the production and consumption of natural gas and emitted some 31.5 million tonnes of CO2 from this source in 2018 (Our World in data 2020). It is worthy to note that Nigeria's CO2 emissions contributions from gas, oil, cement, coal, and flaring have increased steadily since the 1980s. Within the foreseeable political and economic situation, Nigeria will continue to rely on exports of petroleum and natural gas as main source of foreign exchange. Regrettably, Nigeria's total renewable energy capacity was static between 2016 and 2018 (Figure 1). Although there are efforts to increase hydropower capacity as a major renewable and clean energy, the country's growing population and improving standard of living means energy demand will continue to rise. Investments in renewable sources will continue to be parallel to energy demand for a long time.

The 2003 Nigeria National Energy Master Plan placed emphasis on the exploration of coal for energy generation. That has not changed with the issuance of licences and increasing investments in coal power plants including Itobe, Enugu Coal, Gombe Coal, and Benue Coal Power Plants, which in total will contribute 4,800 megawatt (MW) of electricity (Emodi and Boo 2015). However, Nigeria's

renewable energy potential is very promising. About 734.2 MW of small hydropower has been identified with 4.4 % developed and 30 MW of installed capacity. The Renewable Energy Master Plan of 2005 by the Energy Commission of Nigeria estimated renewable electricity of 23 % in 2025, and 36 % in 2030 of the total electricity generation (Emodi and Boo 2015). The total output of reported installed power plants in Nigeria is 17,988 MW; of this 64 % is gas fired turbines, representing a significant contribution to Nigeria greenhouse gas emissions (Emodi and Boo 2015). This number is more likely to increase over the short and long terms because of the limitations of hydropower (currently 29 % of installed capacity). Many Nigerians own electric generators because of the low level of electricity generation and distribution from the national grid. It has been reported that 60m units of diesel/petrol generators are in operation in Nigeria (Giwa et al. 2019). This represent a significant contribution in fossil fuel use and greenhouse gas emissions.

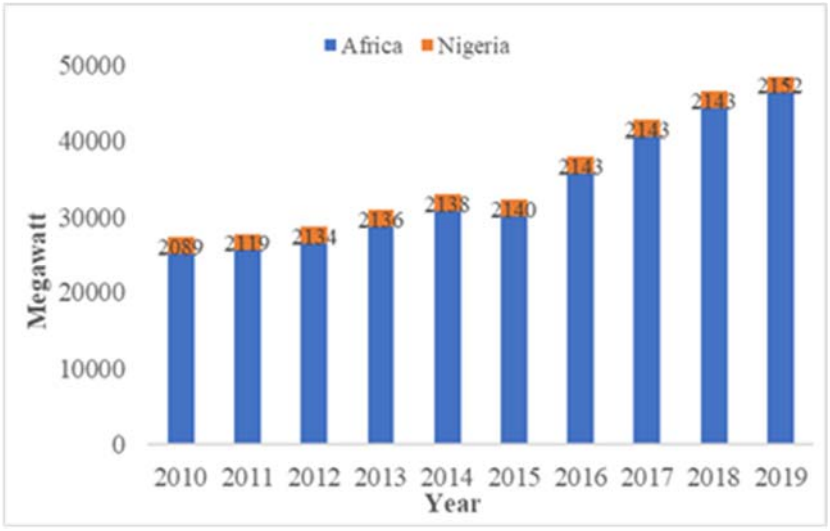

Figure 1. Total renewable energy in megawatt for Nigeria and the rest of Africa

Source: Author, based on IRENA (2019)

Inefficient energy use through older appliances with high power consumption is common in Nigeria. There is little awareness of the need to save energy and most Nigerians find it normal to leave lightbulbs and other appliances switched on when they are not needed as electricity billing is not metered for most households.

The pandemic's impact on energy demand and supply

The Covid-19 pandemic has significantly affected renewable energy supply and demand, though it is expected that renewed investment following the pandemic will create more jobs, improve the economy and reduce emissions. Globally, renewable energy growth will slow in 2020, down 13 % from 2019, due to delays in construction, supply chain disruptions, lockdown measures and social distancing guidelines, as well as emerging financing challenges (IEA 2020).

The pandemic slashed over 800 million dollars from Nigeria's national budget for 2020 (Otache 2020). This was occasioned by low demand and the falling price of oil. The shutdown of most business has

reduced the energy demand of major consumers. The result is a significant drop in revenues, especially among distribution companies. This has improved the availability of energy for households in Nigeria, which pay far less per kWh electricity consumed than commercial and industrial consumers. It is expected that the situation will improve with the lifting of restrictions and resumed economic activities, however revenue losses are unlikely to be recovered. The economic setback will more likely affect planned investments in the energy sector, especially on renewables.

Looking forward

Under the Paris Climate Agreement Nigeria has pledged to limit global temperature rise this century to well below 2 degrees Celsius above pre-industrial levels. This can be achieved by conscientious efforts to promote investment in renewable and clean energy sources. The challenges arising in connection with the pandemic reflect those that the country will face as the climate crisis gathers pace. More than ever, it reminds us to act to reduce greenhouse gas emissions, protect ecosystems, and improve biodiversity. As a growing economy, Nigeria is in a pole position to rethink its energy policy. There is a need to increase the share of renewable energy in the overall energy mix over the short and long terms and to increase awareness of energy efficiency and climate change. The long term economic and social impacts of the pandemic can be reversed with increased investment in renewables, especially off-grid systems, which will have a direct impact on the lives of millions of people in rural areas hit harder by the pandemic. While Nigeria is expected to remain a net exporter of natural gas in the foreseeable future, it is important that the country takes advantage of advancements in hydrogen energy technology. Though hydrogen from natural gas is not renewable, unlike natural gas its utilization does not generate any emissions. The conversion of natural gas to hydrogen offers the opportunity to eliminate emissions from point of use and enhance the ability to capture all emissions resulting from the conversion process. Investments in no-battery and battery storage solar energy systems, and wind energy technology would significantly reduce Nigeria’s dependency on fossil fuels and generate employment opportunities for youth.

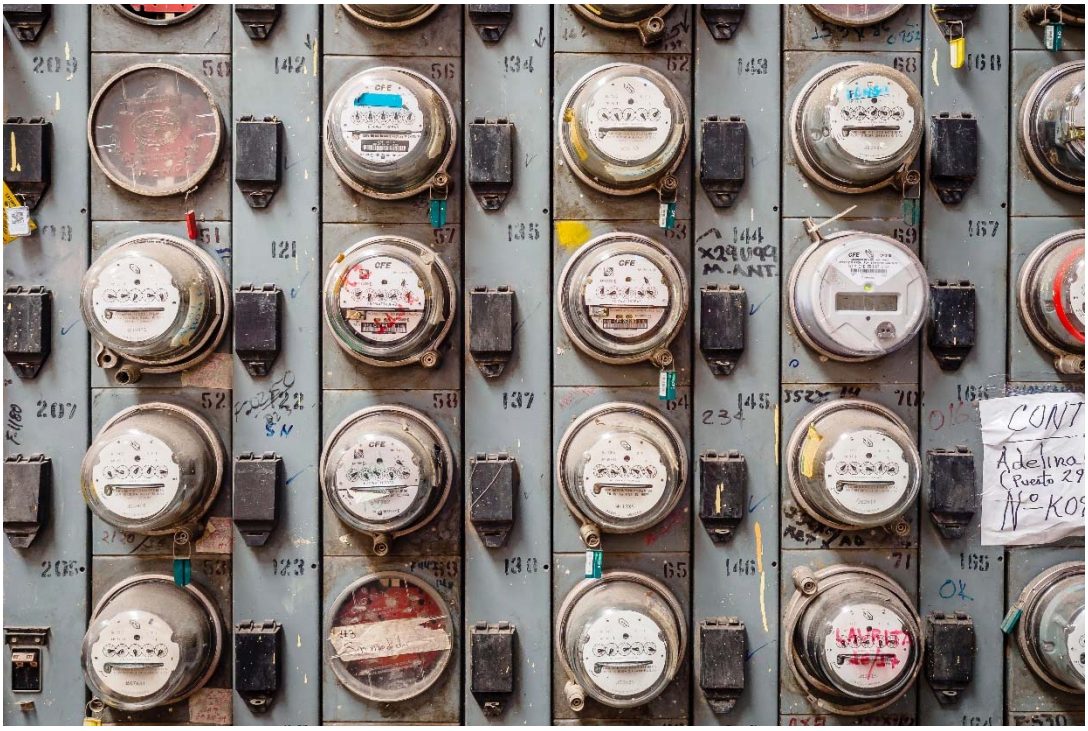

Photo by Alexander Schimmeck on Unsplash

1.2 The role of renewables in building resilience to climate change and pandemic impacts in sub-Saharan Africa

Charles Kofi Owusu

Poverty projections indicate that the economic and social impacts of the Covid-19 pandemic are likely to be quite substantial (World Bank, 2020). According to the June 2020 Global Economic Prospects report, between 70 and 100 million additional people could be pushed into extreme poverty in 2020 due to the pandemic (World Bank, 2020). As shown in Figure 1, more than a third of the projected new extreme poor will be concentrated in sub-Saharan Africa[1] (Lakner et al., 2020), where countries are already struggling with heavy climate impacts and risks.

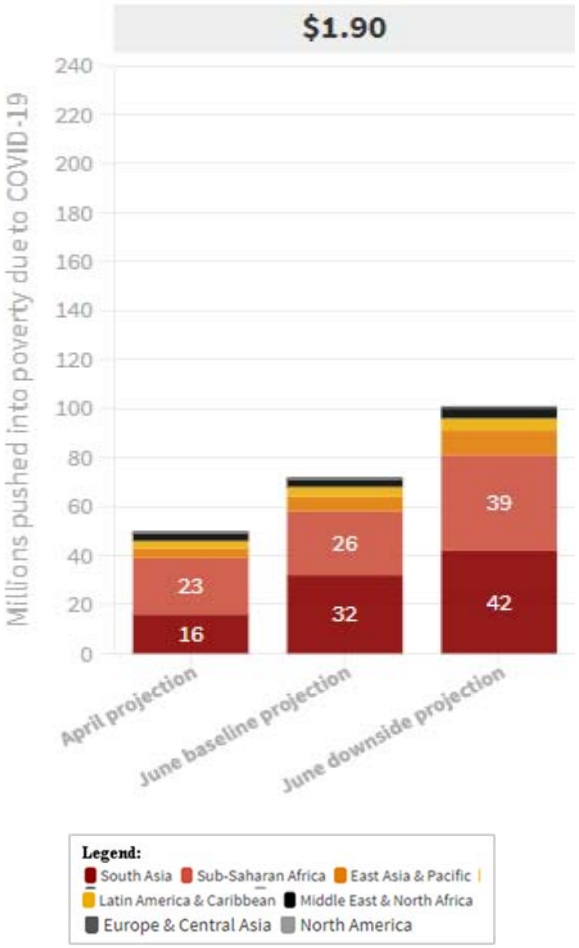

Figure 1: Regional distribution of pandemic-related new poor
Source: adapted from Lakner et al. (2020)

[1] https://www.worldbank.org/en/topic/poverty/brief/projected-poverty-impacts-of-COVID-19

More striking are the deep-rooted global inequalities highlighted by the pandemic in terms of access to (sustainable) energy, a critical lever to facilitating a robust recovery. For instance, although it has played a pivotal role, underpinning the global response to the pandemic in health care delivery, water supply and information technologies, over a billion people around the world still lack access to electricity (IEA, 2017; World Bank, 2018), with a majority of these domiciled in sub-Saharan Africa (see Figure 2). The magnitude and scale of the health crisis, having exposed the inadequacies of the current system both in terms of the massive electricity access gaps and socio-economic impacts, will continue to take a heavy toll on development (growth prospects) and poverty reduction efforts and will exacerbate the climate change impacts on Sub-Saharan economies. This will lead to a worsening in the living conditions of energy have-nots – especially in sub-Saharan Africa – who desperately need better energy access to turn the tide. This in turn suggests that we must fast-track efforts to accelerate cleaner and affordable energy for all and particularly in sub-Saharan Africa, where the need is greatest in order to build more prosperous and resilient economies (IRENA, 2020).

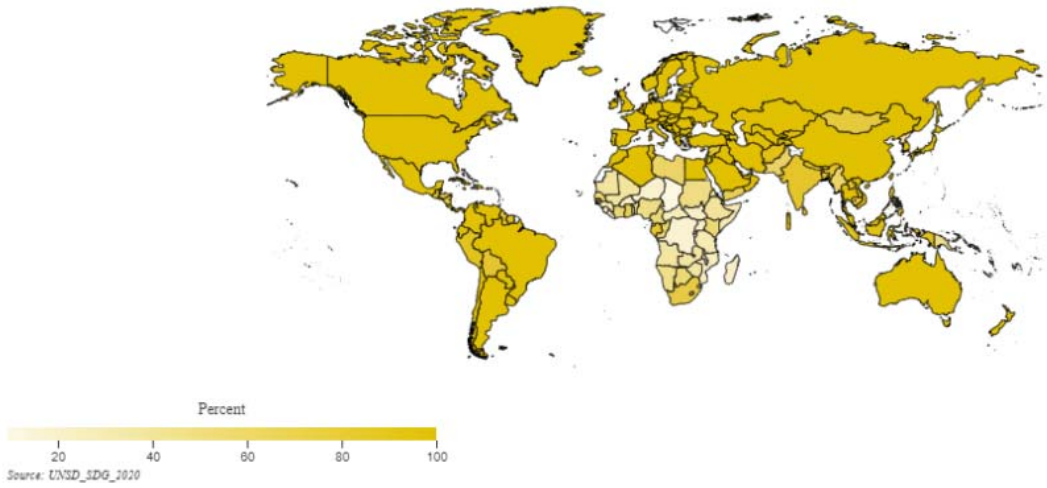

Figure 2: Proportion of population with access to electricity around the world

Source: Adapted from UNSD-SDG, 2020

The current health crisis offers an opportunity to close the energy access gap and place renewable energy sources at the heart of recovery measures and economic stimulus packages. The ability of renewables to weather the economic storm has already become apparent. A few months into the health crisis, their resilience relative to conventional fossil fuel industries is clear. While suffering alongside the entire global economy, renewables have proved to be more resilient relative to other sectors (IRENA, 2020). The fossil industry has been hit hard; with falling oil prices raising deep concerns about sector volatility and long-term viability. Meanwhile, renewable-generated electricity systems continued to function effectively (IRENA, 2020). Aligning recovery measures with the clean energy transition can help to address the Covid-induced economic slump and create much-needed jobs in SSA.

The range of distributed renewable energy livelihood applications spans diverse sectors (e.g. agriculture, food processing, textiles, services and retailing, carpentry, pottery and cottage industry) (SELCO,

2019). These applications have been either cut off or impacted by disrupted logistics and travel restrictions occasioned by the pandemic (SELCO, 2020). In order to strengthen and facilitate the recovery of rural livelihoods, governments and development partners must embrace measures that scale up the adoption and use of affordable and reliable distributed renewable energy technology solutions, including energy efficient appliances (IRENA, 2020).

Financing and cross-sector policies targeted at enterprises and households along the value chain for various goods and services will play a crucial role in this process. Critical policy measures such as fiscal incentives are essential to kick-start industries and bolster demand among rural households and should be coupled with additional financial support for mini-grid and distributed renewable connections for rural households. Concessional financing for productive use appliances and equipment could spur local economic activity, create jobs, and reduce dependence on highly inferior and polluting energy forms (IRENA, 2019). Efforts to strengthen livelihood applications with renewable technologies must guarantee equitable access for both men and women to optimize socio-economic development (ENERGIA, 2020). Women-run businesses must be supported and encouraged in the clean energy sector; financing and skills development programmes should be top of the list and accessible to all (Matser et al., 2020).

Without a doubt, the pandemic has caused and continues to wreak havoc on families. However, policy measures and stimulus investments focused on renewables adoption could speed economic recovery, deepen sustainable development, and drive a broader structural shift towards building resilient societies and economies in Sub-Saharan Africa.

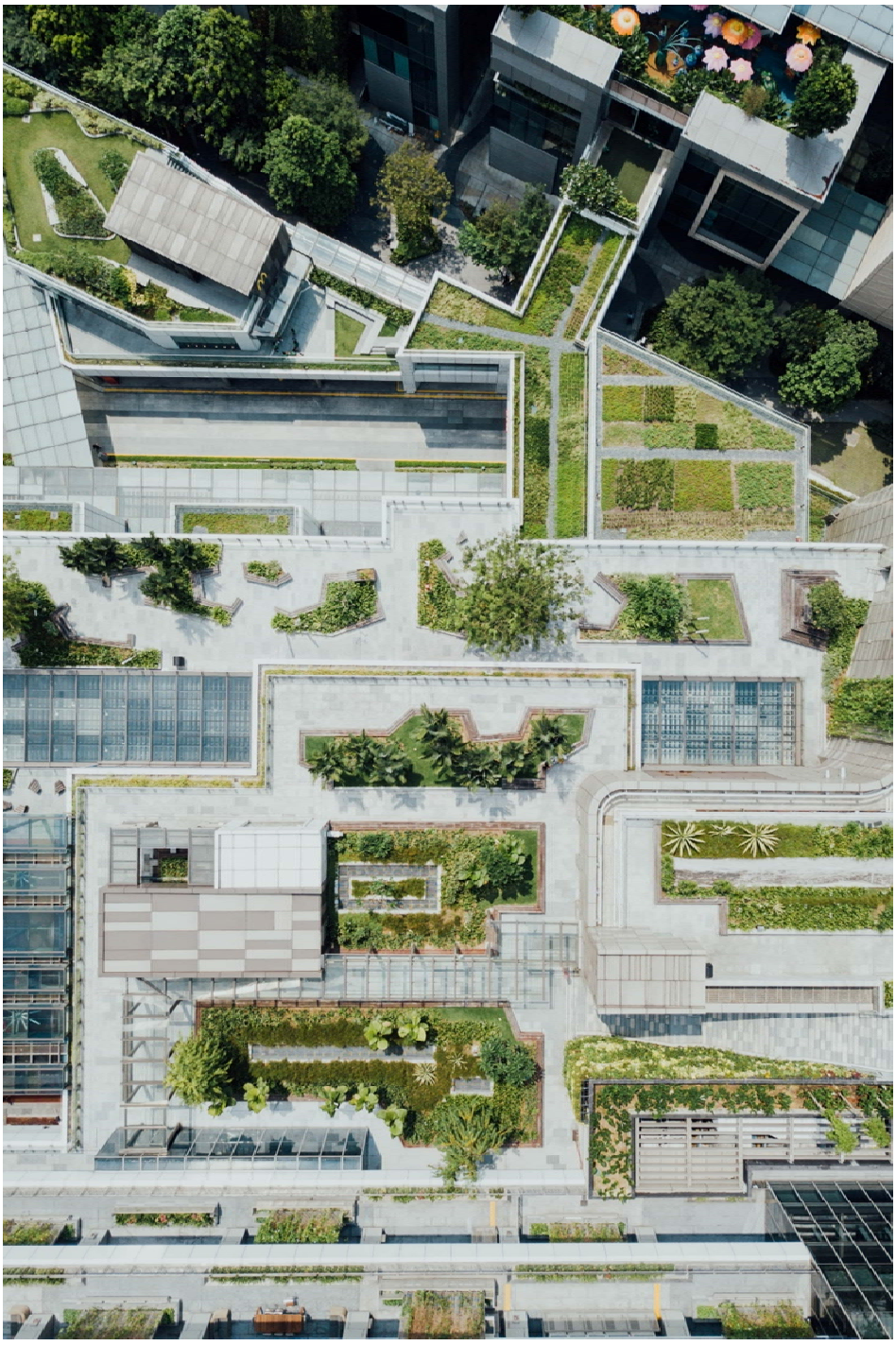

Photo by CHUTTERSNAP on Unsplash

1.3 Iran, sustainable buildings, and the Covid-19 pandemic

Morteza Nikravan

The first outbreak of coronavirus (Covid-19) was observed in December 2019 and the virus is now widespread worldwide. Iran is also one of the countries that have faced a high prevalence of this disease, with over 30,000 deaths to date (Johns Hopkins, 2020). States and cities around the world are desperately allocating resources to prevent, control, or curb the virus. Governments have reacted by imposing restrictive measures of various degrees. Research has shown that people spent on average around 90 percent of their time in roofed environments prior to the outbreak (Steinemann, Wargocki, and Rismanchi 2017), about 70 percent of this time at home. With the spread of the coronavirus, the average time spent indoors has increased and buildings, as the mostly commonly used gathering places for most people, now play an essential role in preventing and controlling the coronavirus.

In 2019, Iran became the 10th largest energy consumer globally (Statista 2020b). According to the Key World Energy Statistics Year 2020, Iran, a country of 82 million people, has used a total of 258,000 tons of oil equivalent in one year (International Energy Agency 2020). Iranian households' daily energy consumption is equal to the energy produced by burning 1 million barrels of oil (per day), which is almost eight times that of the most energy-rich countries. Approximately 30% of energy consumption in Iran is construction-related, according to the latest statistics reported by the specialized committee of Section 19 of the National Building Code (Alvand et al. 2017). According to the USGBC(U.S. Green Building Council 2020), green buildings can reduce carbon emissions by 34 % and consume 25 % less energy than conventional buildings. The global number of green building licensed projects completed from 2008 to 2019 based on the type of certification divided is shown in Figure 1-1 (Statista 2020a).

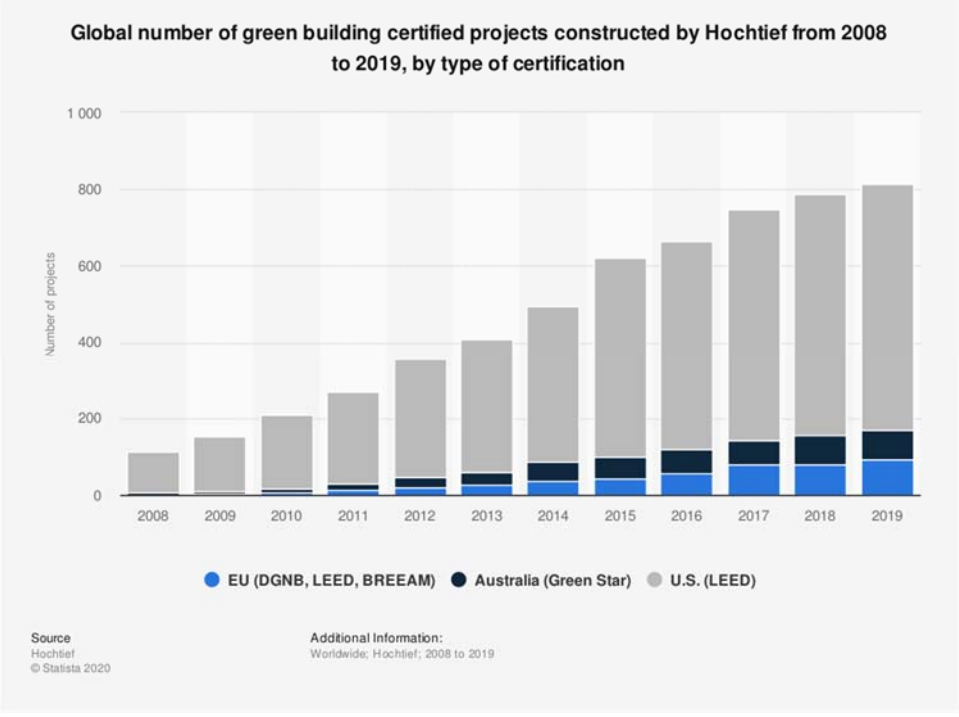

Figure 1. Certified green building projects implemented by Hochtief worldwide 2008 – 2019, by certification type (Statista 2020a).

In addition to the abovementioned benefits, green buildings have positive effects for efforts to prevent and control of Covid-19 and various diseases (see Figure 2).

Water restoration and reduction of surface water and domestic wastewater flow	Provide proper ventilation	Controlling the amount of pollution in the building using building management systems
Improving the quality of mental health of residents	Sound absorbing, speaking softer and thus reducing the emission of bioaerosols	Suitable orientation to maximize adequate sunlight
Use of renewable energy and reduce air pollution caused by fossil fuels	Use of green materials free of volatile organic compounds and materials with antiviral and antibacterial action	Better management of waste generated in the building (especially infectious waste)

Figure 2. Health benefits of green buildings

Source: Author

The current construction methods in Iran are not in line with sustainable development methods due to energy consumption and environmental impacts. Given the low cost of energy and the consequent low return rate, there is no reason for investors to engage with renewables unless tariffs can be raised or green building legislation or other policies are implemented to incentivize more sustainable practices. Government-led recovery efforts should accordingly include relevant policies to improve the sustainability of the construction industry in the post-pandemic era and deliver quality of life benefits by reducing negative health impacts and energy and water consumption. Some useful measures have already been initiated, including efforts to establish a national system to monitor buildings' energy information, an update to Code 19, and the development of a green building certification scheme at Amirkabir University. Nevertheless, a more consistent approach will be needed in post-pandemic Iran.

1.4 The post-pandemic recovery package: Is Argentina flattening its emission curve?

Enzo Leone

Scheduled to take place in November 2020, the 26th UNFCC Conference of the Parties (COP) would have been a historic milestone for the international climate and development agenda. The climate summit was to have seen countries review and strengthen their Nationally Determined Contributions (NDCs) submitted under the Paris Agreement in an attempt to align these with the 1.5°C target recommended in the special report of the International Panel on Climate Change (IPCC, 2018). In April, with the Covid-19 pandemic gathering pace, the UNFCC COP Bureau announced that COP26 would be postponed until 2021.

The pandemic has impacted the climate agenda in many other ways, both positively and negatively. Some countries are taking advantage of this moment to reassess their climate plans and accelerate energy transitions. For instance, the European Parliament has set more ambitious targets to reduce GHG emissions by 2030 (EP news, 2020). In contrast, the pandemic has jeopardised the efforts of countries in the Global South that are already struggling to balance their economies with their climate goals. Argentina has been hit hard by the health crisis and is now heading into a second consecutive year of economic recession. But even in this challenging situation, the country could still pursue a green economic recovery.

Priorities and the Covid-19 stimulus package

Argentina's oil and gas industry was born in 1907 when oil was first discovered in the southern city of Comodoro Rivadavia, leading to the founding of oil company YPF. Since then, the industry has been a cornerstone of the Argentine economy, providing energy sovereignty and substantial revenues (Capello & Grión, 2013; Secretaría de Gobierno de Energía, 2019). Its importance also explains how the industry came to be the largest source of GHG emissions, accounting for 53% of Argentina's overall emissions in 2016 (SADS, 2019).

The sector's role within the Argentine economy also goes some way to explaining the unambitious NDC submitted by the country. Argentina has pledged to reduce its GHG emissions by 18 % as an unconditional target compared to the business-as-usual scenario(BAU) and an additional 19 % as a conditional target if the country is granted access to funding and technology transfer (UNFCCC, n.d.). These targets have been appraised as critically insufficient in the international arena. Indeed, if all government NDCs were this unambitious, humankind would face a global temperature rise of 4°C (Carbon Tracker, n.d.).

However, delivering on even this timid NDC will prove challenging. Argentina's GDP shrunk by 2 % in 2019, but the recession triggered by the pandemic slashed an additional 12.6% from the economy by August 2020 (IAE, 2020). Moreover, the oil and gas sector has failed to buck this downward trend, with year-on-year production down by 10,7% (oil) and 14,1% (gas) in August 2020 (IAE, 2020).

The government has launched a battery of measures in response, putting the climate agenda on hold as it attempts to strengthen the sector. These include the allocation of 13 % of total subsidies granted to the energy sector to the exploitation of the main oil and gas reservoir, Vaca Muerta. This represents the second highest allocation of subsidies after those granted to the power sector (FARN, 2019). In addition to this, the barril criollo[2] programme has set the price of crude oil at US$45 price/barrel even

[2] Barril criollo in Spanish

as it entered negative territory on the international market. A new programme (Plan Gas 4) was also launched to boost shale gas production by providing subsidies to producers. This prioritization of oil and gas exploitation and other measures adopted by the government are leading the Argentina along a climate pathway that will see it fall short of its already unambitious conditional NDC (Carbon Tracker, n.d.).

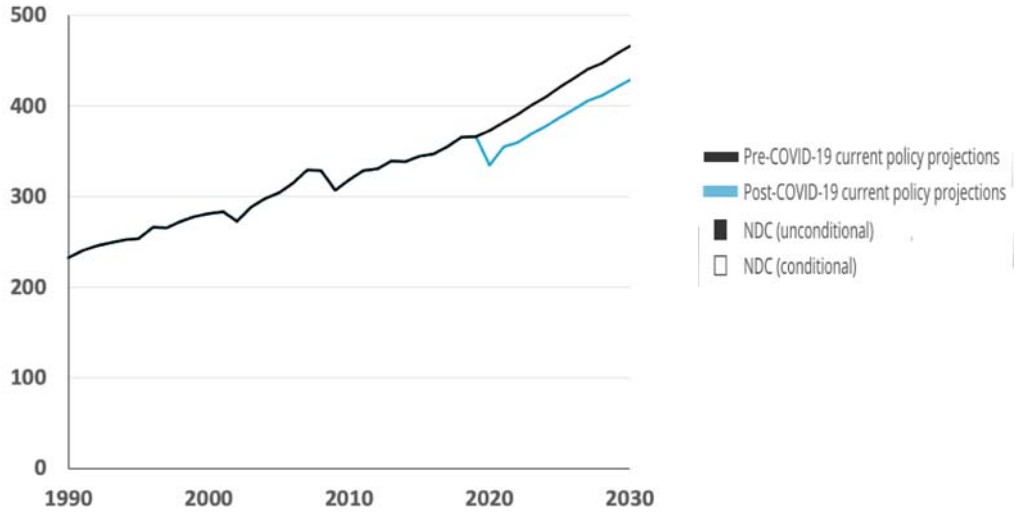

Figure 1: GHG emissions trends pre- and post-Covid-19[3]

Source: Author

But even with this support the oil and gas sector has been unable to revive the Argentine economy. Revenues across the sector, which are monopolised by a handful of corporations, have had little impact at the regional or national levels. In August 2020, just six companies accounted for over 86 % of natural gas production and 82% of oil production (IAE, 2020). Moreover, the oil and gas sector is not labour-intensive. In Neuquen, for example, the government, and not the O&G sector, is the main source of employment and accounts for 30 % of the labour market (Giuliani, 2017).

Transitioning to a green economic recovery

Given that the oil and gas sector is neither helping Argentina to meet its climate targets nor contributing to its economic recovery, there are good grounds to ask why the government continues to place such importance on it. Would it not be wiser for the country to push for a green and sustainable recovery?

In 2016, Argentina launched the RenovAr programme, which aims to increase the renewables share of the energy mix to 20% by 2025[4]. In less than three years, RenovAr has promoted the growth of a new industry and awarded power-purchase agreements to 147 large-scale renewables' projects, totalling almost 4.5 GW of installed capacity (MINEM, n.d.). The latter figure represents more than 10 % of the current installed capacity of the power sector by 2020 (CAMMESA, n.d.; IAE, 2020,). According to the estimates of the Argentine Secretariat of Energy, the construction, operation, and

[3] Based on data from Carbon Tracker, n.d.

[4] According to the Act 27.191 renewables include hydropower plants that have a total installed capacity of less than 50 MW

maintenance of these projects will generate nearly 15,000 new direct jobs (Ministerio de Energía, 2018). To understand the relevance of this number, it is important to say that, by 2017, it represented 10 % of the total number of new jobs created in the country within the private sector (Ministerio de Energía, 2018). Additionally, renewables could boost a fast-green recovery as nearly 85 % of the direct jobs are created during the construction of the sites, providing a timely response to the current macro-economic recession (Ministerio de Energía, 2018). Furthermore, renewables are located across the country so that benefits are spread among local economies (see Figure 2).

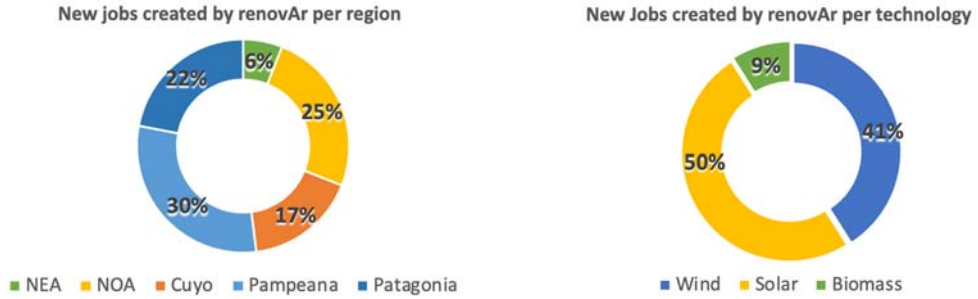

Figure 2: Distribution of jobs created by RenovAr

Source: Ministerio de Energía, 2018

But setting a new course towards a green recovery based on renewables will not be easy. On the one hand, the oil and gas companies wield enormous economic and political power in Argentina and will certainly seek to defend their interests. On the other hand, renewable projects are capital intensive and require access to private financing: a major challenge for Argentina, with the current economic crisis and renegotiation of the country's external debt already hampering access to finance.

One possible way forward for Argentina would be to use next year's COP26 as a forum to discuss the challenges facing developing economies. Initial financial support for a green agenda might help Argentina and other countries in the Global South to meet their NDCs, boost weakened post-pandemic economies, and contribute to the global struggle on climate change.

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2 Reflections on the Covid-19 Crisis: Challenges for Urban Resilience and Ecological Services in the Global South

The great diversity and regional differences of our world are imprinted on our landscapes. They reveal how differently we are organized and how diverse historical processes have led to the uneven distribution of resources among different populations and regions. When it comes to the material reality of our regions, for instance, the quality of housing, waste management and transportation systems in our cities has a huge bearing on how long and how well we live. The Covid-19 pandemic has brought our differences into stark relief and also exacerbated the already challenging living conditions of vulnerable populations. Once again, it is the already vulnerable populations and groups that are most at risk.

Different settlement and production patterns are shaped by inequalities within countries, and the pandemic has shown how many people are left vulnerable in the process. Our spaces bear witness not only to inequalities, but also to our inclination to challenge or accept them. We are motivated to take a multinational approach to this topic that considers the uneven distribution of power and resources and how this has influenced different governments worldwide; the worsening of already pressing problems related to housing, waste management and access to land; the important role of self-organization in peripheral territories; the urgent need to structure ecological services and understand how they can improve quality of life; and the need for more commitments from decision-makers to take account of the poor living conditions of the majority, and so on. Rather than an exhaustive study on the topic, we explore how Global South countries are being impacted and also connected by shared and connected issues.

In this context, the following chapter gathers reflections on how the current Covid-19 pandemic interacts with the dynamics around the conservation of ecological services and the achievement of urban resilience. We focus on the impacts of the crisis on vulnerable populations in the Global South and reflect on possible ways forward in three different world regions: Latin America, Eastern Africa and India.

The first part of the chapter focuses on the impact of Covid-19 responses on the dynamics of urban resilience. Here we explore how the lack of access to the formal city and urban services affects vulnerable populations such as people displaced by disasters. We also investigate how efforts to conserve tropical rainforests may be impeded and the vulnerability of forest-dependent communities increased as a result of the Covid-19 crisis.

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2.1 What does it mean for handwashing where there is no water?

Vinod Ramanarayanan

On its website, the WHO advises people to "[r]egularly and thoroughly clean your hands with an alcohol-based hand rub or wash them with soap and water" as one of the basic measures to protect themselves from the Covid-19 virus (World Health Organization, 2020). However, in many parts of the world access to water is a problem, especially in densely populated cities in developing countries. A recent cross-cultural study of household water insecurity found that nearly 25% of 8,081 randomly sampled households across 29 cities/states in 23 low- and middle-income countries (LMICs) were unable to wash their hands (Hannah et al., 2020).

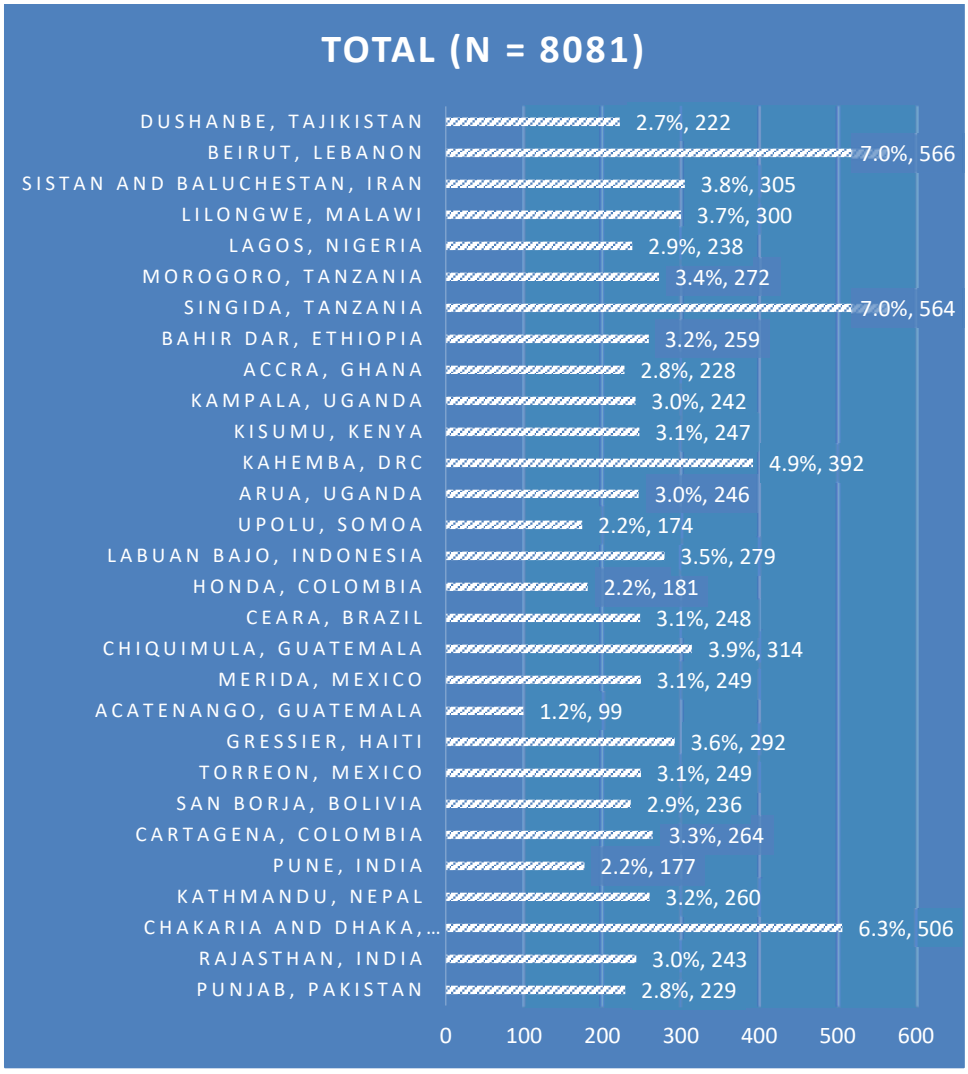

Figure 1: Proportion of households across 29 sites in 23 low- and middle-income countries that were unable to wash their hands in the previous month because of problems with water[5]

Source: Author

[5] Based on Hannah et al., 2020

The water crisis before COVID-19

In early 2018 officials in Cape Town announced that the city of 4 million had 3 months to go before it ran out of municipality water on what was termed "Zero Day". Though the term Zero Day was new, the possibility of a city running out of municipal water was not unique to Cape Town.

For instance, in Chennai, India – the city I hail from – multinational corporations asked their employees to work from home even before the outbreak of Covid-19. In the midst of a severe water crisis in 2019, they introduced emergency "work-from-home" days to battle water shortages in the city. Water tankers are the lifeline of Chennai. To compensate for an insufficient supply of municipal piped water, approximately 15,000 water tankers deliver water to the residents of Chennai every day. Water from a tanker truck can be 52 times more expensive than piped water (Trivedi and Chertock, 2020). Chennai is not the only Indian city that is experiencing water crises. According to the 2011 Census, only 32 percent of households have a tap-water supply from treated sources. About 18 percent or 625,000 households in the capital city, Delhi, do not have a piped water supply (Nagpal, 2020).

Access and economic inequality

While the rich could afford their own solutions, the poor had to wait for the government's help. In Chennai, the rise in demand for water tankers led to soaring water prices and a shortage of tankers. Accessing clean water became unaffordable for lower-income households and people living in slums (Gunjtoju, Alam and Sikka, 2020). To put this in perspective, the cost of a month's supply of water was equivalent to almost half the monthly income of the economically poor. And there were many other intangible costs associated with accessing water. For example, in the process of collecting the water women lost more than an hour's sleep/leisure time per day – with knock-on effects on their job opportunities and health (Ramesh, 2020).

Due to rapid urbanisation and encroachment, the number of water bodies in Chennai has fallen to 28 (2017) from 60 (1893), and the total area under these water bodies has shrunk from 12.6 km2 to just 3.2 km2, significantly affecting the city's capacity to recharge depleted groundwater (Gunjtoju, Alam and Sikka, 2020).

The water crisis and Covid-19 go hand-in-hand (pun intended)

How is quality of life affected when water becomes essential to tackling a pandemic, but there is no water? How will the most vulnerable people be impacted? How can we deal with a pandemic that is in many regions compounded by a lack of infrastructure, economic vulnerabilities, and governance inefficiencies? The water crisis has magnified the effects of Covid-19 in many cities and communities. As UN-Water Chair Gilbert F. Houngbo has remarked, "It is a disastrous situation for people living without access to safe water and safely managed sanitation."

Water for Covid-19 recovery – A stable supply of water for all will be essential to avoid the overlapping of shocks. Water security is threatened by natural disasters—including drought, extreme weather, and flooding. When they strike in the midst of a pandemic, such disasters threaten long-term recovery, especially where vulnerable populations are concerned. People displaced by disasters are typically relocated to densely populated camps or shelters, where authorities may struggle to meet basic water, sanitation, and hygiene needs. The struggle is harder when there is a constant lack of WASH services and social distancing (Democratic Republic of the Congo: Caught between COVID-19 and water shortages in Kinshasa, 2020). After floods in October 2020 in Hyderabad, India, 19 people from a relief camp of 2000 inmates tested positive for Covid-19, magnifying the spread of the virus. (Covid patients identified in Hyderabad flood relief camps, 2020).

Water for long-term resilience – As governments and international organizations work to address complex, overlapping challenges, it's important to come up with long-term solutions. Water connects multiple ecosystems, health, food systems, climate change, nature, energy, and finance. Water security depends on a combination of effective governance, knowledge and skills, connectivity across systems, and investment in infrastructure and technologies to 1) build a circular water system; 2) foster citizen awareness and engagement; 3) reimagine waterways; 4) make data-powered decisions; and 5) manage waste water (Sadoff & Smith, 2020 and Think Tank Resources, 2020).

In the light of the current Covid-19 pandemic, I would like to start a discussion that emphasizes the importance of making progress to "ensure availability and sustainable management of water and sanitation for all" (United Nations Sustainable Development Goal (SDG 6)). Please share your views (as an expert, researcher or citizen) here on how the water crisis is affecting you/your region and how it can be managed after the Covid-19 pandemic. I strongly believe that the answer to the question "What does it mean for handwashing where there is no water?" starts with us – share your thoughts here (https://forms.gle/hvEWXspQqzJYbZw99).

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2.2 Multiple impacts: A brief discussion on vulnerability, human mobility and Covid 19 interactions

Natalia Burgos

Eight months after the World Health Organization (WHO) declared the Covid-19 outbreak a pandemic, the crisis has not abated, and we are confronted with a global infection rate in excess of 37 million cases (JHU, 2020). It's also clear that the virus is hitting the Global South particularly hard, with India, Brazil and Colombia among the countries with the most confirmed cases and related deaths[6] and the worst economic and social fallout.

World leaders have made strong calls for solidarity with the virus victims and improved preparedness for future crises.[7] They have also frequently stated that the pandemic will have wide-ranging and long-term humanitarian and socio-economic impacts on vulnerable societies, and that these impacts have yet to be fully assessed (IOM, 2020).

As a pandemic, Covid-19 can potentially disrupt almost everyone's lives, but not everyone is vulnerable to the virus in the same way. Therefore, diversified and context-specific analyses are key to improving our pandemic response and preparedness mechanisms.

This article explores the advantages of approaching Covid-19 impacts from a vulnerability perspective. Emphasis is placed on the interactions of Covid-19 responses and the levels of vulnerability of populations that are at risk of displacement or are already "on the move" in these challenging times.

A growing number of people are currently forced to leave their homes by disaster events (many of them climate-related). These displaced people are not fully protected by international and national legal frameworks. In 2019 alone, there were 33.4 million new displacements due to conflict, violence and natural disasters. Disasters stand out as a key driver of displacement. For example, in 2019 more people in the Americas were forcibly displaced due to disasters (329k) than due to conflict and violence (24k) (IDMC,2020). During the Covid-19 pandemic disasters didn't stop: droughts, floods and storms have affected 51.6 million people in 84 unique events (Walton et al, 2020). These people face "multiple impacts" as they suffer the consequences of disasters and the pandemic, and their situation requires special attention.

Vulnerability is defined as "the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (UNISDR, 2009). Thus, the creation of vulnerability depends on various processes, such as patterns of migration and settlement, the urban political economy, and political issues (Pelling, 2003, p. 22).

This applies to the analysis of the Covid-19 crisis, since even if some aspects of susceptibility to the virus relate to individual conditions (age, genetics), these conditions are exacerbated by socially constructed conditions as well as macro-political and economic processes (Alcàntara et al, 2020).

[6] By October 2020, according to JHU, India had more than 7M cases and 100k deaths; Brazil around 5M cases and 150k deaths; and Colombia more than 900k cases and 27k deaths.

[7] For more information, read Antonio Gutierres general remarks on Covid-19: https://www.un.org/sites/un2.un.org/files/sg_remarks_on_covid19_english_19_march_2020.pdf.

The Pressure and Release (PAR) model explains the construction of risk as a function of the relationship between hazard and vulnerability (Wisner et al., 2004:50). It helps to show interesting interactions between Covid-19, disaster vulnerability, and human mobility (see Figure 1).

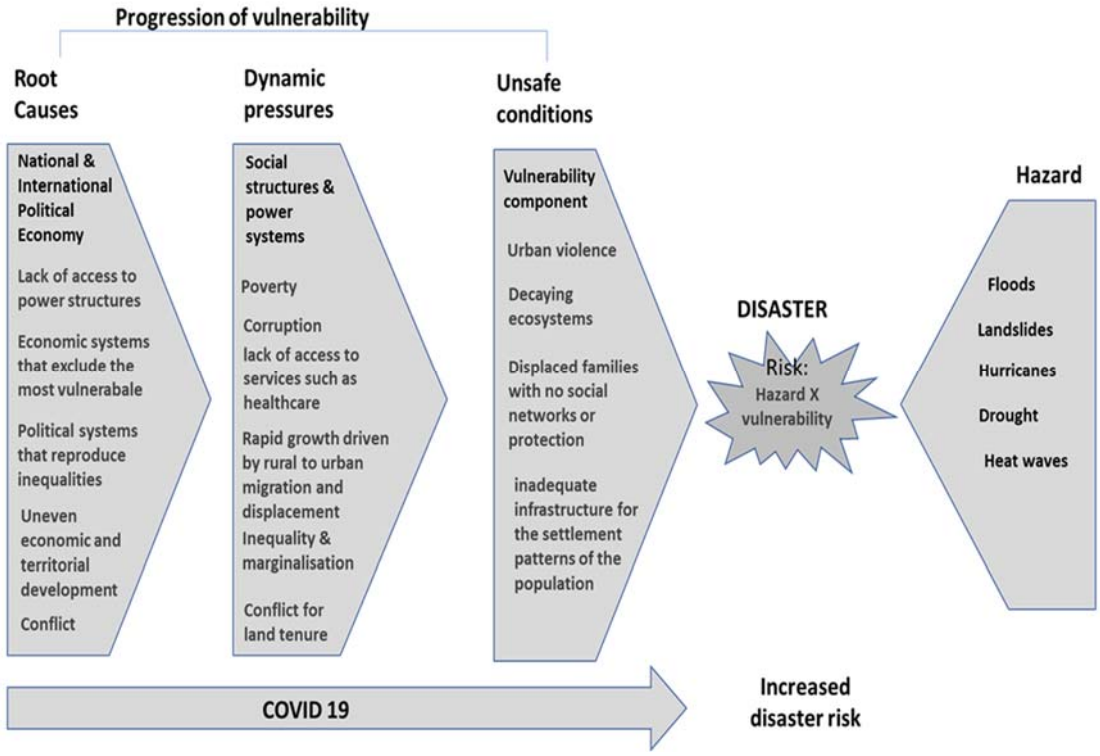


Figure 1: PAR Model

Source: Author, based on model by Wisner et al., 2004, p. 51

It is important to mention that the above PAR Model presents some general challenges faced by vulnerable societies in the Global South, particularly the urban poor. This general picture of vulnerability needs to be deepened depending on context-specific challenges. Nonetheless, this PAR model provides a useful theoretical framework for discussing how responses to Covid-19 interact and exacerbate vulnerability.

To start with, we can say that the impacts of Covid-19 and the responses implemented by governments added a new layer of vulnerability (Ionesco et al., 2020), not least because the responses focused on curtailing people's mobility through quarantines and border closures to limit the spread of the virus.

Seen from the perspective of vulnerability, we observe that those living in densely populated, marginalized, and informal settlements with limited public space are less likely to isolate, and this can lead to the virus spreading rapidly. In these conditions, water supplies may also be limited, making handwashing more challenging.

The predicament of people on the move or at risk of displacement is even worse, given that they usually have no access to formal housing and reduced social networks. Moreover, as the International Organization for Migration (IOM) has pointed out, the pandemic has led to increased levels of discrimination against migrants, particularly in the case of Venezuelan and Central American Migrants in Latin America.

Furthermore, the incomes of the most vulnerable people are very low and their savings non-existent. As Mitlin (2020) argues, most of the one billion people living in informal settlements have very little savings and nearly all of them work in the informal economy. In this context, it is extremely difficult for these workers to self-isolate and stop working. Coupled with the lack of access to affordable health services and health insurance, this makes staying healthy a huge challenge for vulnerable populations.

In the case of seasonal migrants who move away as a form of adaptation, the fact that they can't work as a result of Covid-19 restrictions means that their own day-to-day income as well as the remittances they would normally have sent to their families have been lost (Sidney, 2020).

As a final point, an imminent economic crisis can affect government efforts and investments to protect people from disasters and climate change impacts. This in turn can lead to increased vulnerabilities, reduced resilience and adaptation capacity, and a higher risk of displacement.

This article attempts to encourage reflection on possible ways forward in the current crisis. Approaching this crisis from a vulnerability perspective is useful since it highlights the need to pay special attention to more vulnerable populations and acknowledge the complexity of Covid-19 responses. In addition, acknowledging complexity implies recognizing the importance of promoting crisis responses that encourage good governance and improved relationships between citizens, their organizations, and the state.

In addition, we need to better understand human mobility processes and promote further research on how they interact with Covid-19 and on the role played by social networks, economic opportunities, and protection measures in improving migrants' living conditions.

Lastly, it is important to say that the pandemic is another clear sign of our interdependence and that raising empathy is crucial to making societies think and act differently when facing global crises.

Photo by Souro Souvik on Unsplash

2.3 Is Covid-19 an opportunity for forest conservation in developing countries?

Rowan Alumasa Alusiola

In this article I highlight some of the identified and perceived impacts of the Covid-19 pandemic on the forest sector in developing countries, with a focus on increased levels of deforestation across tropical forests, and the vulnerability of forest-dependent communities. I also make recommendations and point to potential opportunities for forging a green recovery and developing inclusive policies for a sustainable future. The forestry sector has a huge role to play in social and economic recovery post-Covid. Throughout the pandemic, forest products, including non-wood forest products, have supported livelihoods while also delivering essential items, such as biomass for heating, ethanol for sanitizer, respirator paper, and packaging for parcels

Loss of forests during the pandemic

COVID-19 and its aftermath could reverse decades of progress in the area of forest conservation. However, although countries have experienced increased deforestation rates, the global response to the pandemic with strict restrictions and close cooperation with scientists and researchers could also be a blueprint for tackling this problem. The Covid-19 crisis has offered countries an opportunity to embark on a green recovery and develop inclusive policies for a sustainable future.

Anybody who has spared a thought for forest ecosystems during the lockdowns and curfews necessitated by the pandemic may have assumed the forests were safe. But they were wrong. According to a report by the WWF, deforestation in the world's rainforests rose significantly (WWF,2020). In March 2020 alone, the rate was 150% higher than the 2017–2019 average for the same calendar month. This translates into around 6,500 square kilometers of rainforest felled in 18 countries around the globe. Indonesian forests topped the list (more than 1,300 km2 lost), followed by the Democratic Republic of Congo (1,000 km2), and Brazil (950 km2) (figure 1). Furthermore, in April the Amazon recorded a 171% rise in deforestation compared to last year (DW,2020). Other countries that have experienced increased deforestation during the pandemic include Colombia, Cambodia, Indonesia, Nepal, and Madagascar, with more sketchy reports emerging from Myanmar and Peru. The Cambodian government reports that it discovered 399 cases of illegal logging during 511 patrols in a period of four months (Mongabay,2020). This deforestation is unfortunate and alarming because our health — and the health of our economies — is inseparably linked to the health of our planet.

Figure 1. Monthly deforestation in Brazil since 2015 by km2 (INPE, 2020)

During the pandemic, greater food insecurity and falling household incomes have increased people's reliance on forests and forest products for survival. Disruptions to the supply chain of other energy sources and a decrease in other income-generating opportunities has led to greater dependence on forest biomass energy. In Madagascar, for example, a rise in charcoal production has resulted in the increased deforestation of mangroves(Mongabay,2020). Growing unemployment has led many people to return to their home villages from the cities, and they are cutting down trees for firewood or as a source of income. There has also been a dramatic fall in revenue from all sectors (e.g., tourism) that help to sustain forest reserves and community conservancies across the continent. Given the strict lockdown measures, forest guards have stopped or reduced their patrols, and illegal loggers have used this situation to their advantage. There are reports that activities to monitor the implementation of forest policies by enforcement authorities have been reduced, making it more difficult to detect illegal logging activities. Non-governmental organizations have also temporarily stopped implementing their forest programs. It is important to note that since many of these activities support human health and conservation efforts, cutting them during a public health crisis is counterproductive.

Increased vulnerability of forest-dependent communities

Forests provide a livelihood for rural populations, particularly indigenous people, smallholders, and other forest-dependent communities (UN/DESA,2020). According to the FAO, forests provide food, income, and nutritional diversity for about 20 percent of the global population, comprising the most vulnerable segments of society (Luttrell et al., 2013; McDermott et al., 2013; Holmes, 2014 FAO,2014) that are often highly dependent on forest resources for their livelihoods. Increased deforestation during the pandemic will lead to the degradation of natural habitats, thereby increasing the risk of forest fires, with devastating effects on the health and well-being of the local community and on biodiversity(WWF.2020). These fires are already being experienced in the Brazilian Amazon, where 1,650 major fires have been documented, over 60 percent of which occurred in the month of September 2020, and 40 percent of which occurred in areas that were recently deforested (MAAP,2020). In addition, a recent study by the School of Earth, Energy & Environmental Sciences at Stanford University indicates that deforestation will lead to increased transmission of zoonotic diseases(WEF,2020).

Mayers (2016) estimates that 80 to 90 percent of forest enterprises are small and medium forest enterprises (SMFEs), while approximately 75 percent of forest production is informal (FAO, 2014). According to a report by Tropical Timber Markets, legal trade in tropical hardwoods witnessed a huge decline during the pandemic(Atibt,2020). China's imports of tropical hardwood logs, for example, fell by 26 percent in volume and 37 percent in value compared with the same period in 2019. The pandemic has exacerbated problems associated with the lack of adequate social safety nets in developing countries: unemployment, poverty, and food insecurity. This has resulted in the increased vulnerability of forest-dependent communities.

Conclusion

The UN Strategic Plan for Forests 2030 and the sustainable development goal encompasses a global vision and plan of action for forests and people (UN/DESA,2019). It should be adopted by all countries in their post-Covid recovery strategies.

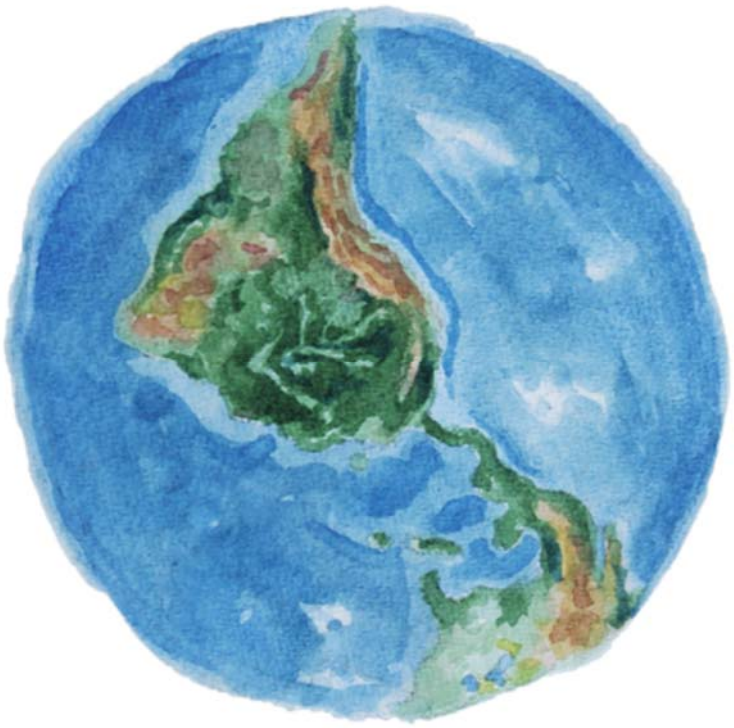
According to Hepburn et al. (2020), green fiscal recovery packages are the most promising for Covid-19 recovery. They suggest that the following policy areas should be prioritized: clean physical infrastructure, efficiency retrofits, investment in education and training, clean research and

development spending, and natural capital investment. There is significant job creation potential in the forest sector, for example in the areas of agroforestry, afforestation, improved management of tropical forests, protection of forests from fires, and new programs that involve forest-dependent communities. Governments need to strengthen forest law enforcement and governance systems at global, national, and local level. These measures will help combat illegal logging. A lot of research is needed to evaluate the impact of Covid-19 on forests and forest-dependent communities and formulate appropriate post-Covid measures. In addition, more must be done to align public- and private-sector efforts to address commodity-driven deforestation and conversion, and to develop policies that address both production and consumption. Given the fact that many of the world's most vulnerable communities are totally dependent on forests during the pandemic, the international community needs to reaffirm its commitment to sustainable management of forests and the trees located outside of forests.

Photo by David Clode on Unsplash

2.4 The Amazon – From the periphery to the center of discussions

Artur Sgambatti Monteiro



Source: Author

Humankind's behavioural and production patterns have put the world on a collision course. Global warming is leading to a disaster on a global scale, our remaining ecosystems are becoming more fragile every day, and social inequalities are abysmal. The challenge of building a more sustainable and equitable collective existence is pressing, and this text focuses on the individual and societal response to this challenge, rather than in its consequences or causes. Since it is impossible to cover all aspects of the problem in just a few paragraphs, this essay approaches it in a more subjective way. The first section explores how we – either as individuals or governments – interpret complex realities and how such interpretations could lead to appropriate responses. Then I argue that the Brazilian Amazon encompasses elements that make it a crucible of opportunities for a potential new human existence. Its continued existence is essential to the success of climate change efforts, and Brazil is thus critical to paving a way that leads us back from the abyss. However, the conservation of the Brazilian Amazon is hindered by the seemingly irreconcilable views of different stakeholders.

Inner fears and crossroads

An interesting approach to our times can be found in a book by Bruno Latour (2018), who explores the idea of science denialism as escapism from the reality of climate change. In his "Down to Earth: Politics in the New Climatic Regime", he makes clear, on the one hand, that climate change has shown us that we share only one planet and are thus interdependent; on the other hand, he highlights the role of science and its influence on the international political stage. To address a pressing real problem, Latour argues, actions should be taken based on a deep understanding of reality.

These facts influence key aspects of our personal and political existence, our relationship with reality, and the acceptance of our faults and the need for change. The world is structurally unfair; parts of our society are designed to exclude, while the natural world is being destroyed at an ever increasing rate. This is as frightening as it is evident. We are part of a system, and global justice is an ethical imperative that cannot be denied or postponed. Ideally, the ethical and empathic charge of this fact should be enough motivation to pursue a fairer existence. However, the understanding of a structural change comes at a price we are hardly willing to pay: an acknowledgement of error and the need for change.

The understanding of our own role and responsibility for the well-being of the global collective is key to sharing a finite habitat. Thus, dialogue and multilateralism are the only possible ways to rise adequately to the challenges we face. However, new overarching and alternative agreements, such as the Paris Climate Agreement, show the high cost of accepting new views, abandoning old beliefs and evolving. This led me to think about how individuals and social structures respond in psychoanalytic terms. For example, how the failure to acknowledge our own faults and the need for positive transformations has led us to a post-truth reality. In some cases, the reality is so unpalatable and demanding of action that it makes even delusional realities preferable. Put simply, the key point here is the balance between the attachment to old beliefs (e.g. fossil fuel usage in a climate change scenario) and how bearable a lie is (e.g. how long can we accept destroying the world).

When the truth is inconvenient, new communication strategies have made it possible to create personalized on-demand content and, thus, realities. For some people, control over information, regardless of its factual content, is an imperative and a strong manifestation of raw power. By understanding reality from a confined, personal point of view and believing it to be universally valid, one does not accept any alternative and is not open to dialogue. At an extreme, this leads to the rise of escapist movements, political extremism, and stronger protectionism. "The Amazon isn't burning"; "The virus doesn't exist"; and "The earth is flat" are all arguments that can easily be found, although the truth is different. Living on Mars seems, sometimes, like a more realistic option than living in a viable, inclusive world.

We, as human beings, reflect on individual torments and escalate them. The reality has never being so imposing, and our personal and collective action so hindered. The ethical imperative leads us to the inevitable: facing the problem and awakening from our lethargic denialism. The big challenge is to ponder, decide, move, and accept the costs of the new. After this conceptual overview, I will now discuss how the Brazilian Amazon plays a key role in connecting us.

Where beliefs come together

Given its potential to destabilize the global political structure, climate change is the most all-encompassing fear and is central to the global multilateral agenda. Regardless of the boldness of studies and clarity of analysis, due to the price of solving it, the acceptance of climate change is often a matter of convenience and the particular narrative people subscribe to. As the biggest extant forest on Earth, with huge carbon-storage potential, the Brazilian Amazon reflects this discussion and also embodies

the possibility of finding a way out of the crisis.

Since the Rio-92 UN Conference, Brazil has been a key player in global discussions of climate change and the structuring of international conservation tools. Much of REDD+, the Kyoto Protocol, and the Paris Agreement have been influenced by Brazilian positions and expertise. Brazil's enormous biodiversity and vast rainforests (~5M km2) have determined the country's prominent role in multilateral climate policy arenas.

To some extent, the forest represents a material stratum in need of urgent change, and its continued existence depends on our ability to reach agreement. However, as Carlos Rittl has pointed about, the forest is facing its worst moment in 30 years, especially due to the anti-environmentalist rhetoric of President Bolsonaro (The Guardian, 2020). However, the increase in land grabbing, the persecution of activists, and deforestation should not simply be attributed to Brazil's supposed lack of political coordination or to the holier-than-thou interests of the international community. While these factors do play a minor role, the conflicts must be understood as the result of a direct confrontation between different, irreconcilable belief systems. The belief in limitless progress versus an awareness of the finitude of resources and the imperative to conserve the climate and biodiversity.

The continuity of the forest and the narratives that support it are the tipping point between an attachment to ancient vicious practices and the unknown human practice that will allow it to be sustained (Monteiro et al. 2020, Franco et al., 2020). Even on the periphery of the globalized world, the Amazon is at the center of global discussions and can be a test case for reconciling different development patterns and building agreements to solve concrete conflicts of humanity. The Brazilian Rainforest is more than just a cradle of biodiversity with great potential for climate protection. Its conservation can mean the triumph of agreement-building and dialogue over fear.

The Brazilian Green Deal

Bearing in mind the challenges presented by the Covid-19 pandemic, different countries are debating the form their economic recovery packages should take. In the case of Brazil, any such package should put the Amazon Rainforest first. As proposed by Ismael and Carlos Nobre (2018), the Amazon Third Way Initiative should be based on the promotion of science, the inclusion of indigenous populations, the strengthening of non-wood-product value chains, and incentives to boost the bio-economy. This could be supported by international cooperation projects coordinated in and by Brazil.

Brazil is a country where social problems overlap in an extreme way, and creating a viable alternative for the Amazon is of vital importance for humanity. Not only because of what its conservation implies objectively, but also because of the strong clash of belief systems, whose escalation results in persecutions, deforestation, and violence. Finding a way to conserve the Amazon is just as important as actually conserving it, because the process forces us to enter dialogue and acknowledge our personal responsibilities. Brazil could, again, become a key player in conservationism and multilateralism. However, dialogue and empathy are prerequisites for that. My remarks could lead me to be seen as a denialist given the recrudescence of nationalism (as in Brazil); however there is no time or room for pessimism. The practice of change is a daily duty. Our personal beliefs are central, and there is so much to be changed, and for that we need to put the Amazon and our beliefs in the right place, at the center.

Photo by Elizabeth Lies on Unsplash

3 Climate Change and the Economy

The Covid-19 pandemic has significantly affected healthcare systems and economies worldwide. The Asian Development Bank (ADB) estimates that the global economy could suffer between $5.8 trillion and $8.8 trillion in losses, equivalent to 6.4 – 9.7 % of global gross domestic product. The impact of Covid-19 is likely to exceed that of both the 2008-09 Global Financial Crisis and the Great Depression and will unfold against the backdrop of the ongoing climate crisis.

This economic slowdown precipitated a temporary drop in greenhouse gas emissions during the first months of the pandemic (NewClimate, 2020). With economies rebounding and a return to business-as-usual on the cards, this reduction is likely to be short-lived and a sharp uptick in emissions could follow in its wake. This would exacerbate global warming and potentially put the Paris Agreement's 1.5 °C target beyond our reach (NewClimate, 2020).

The Covid-19 pandemic has highlighted the vulnerability of countries with fragile health systems, weak economies, high inequality, and underdeveloped welfare systems. The following diagram reveals the close links and interactions between Covid-19, climate change, and economies.

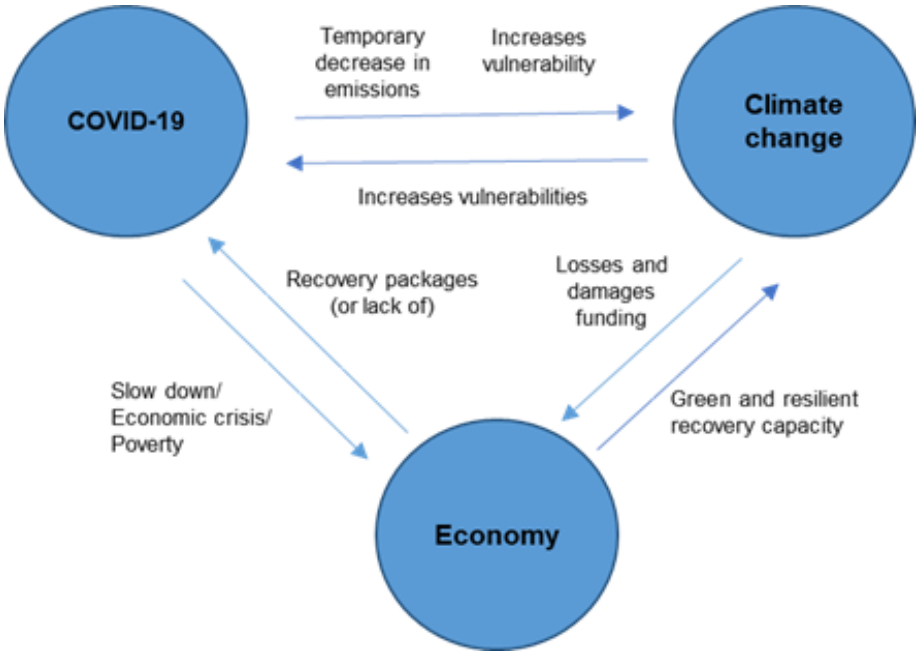


Figure 1. Interactions between the Covid-19 pandemic, economy, and climate change

While the top priority for governments facing a pandemic is naturally to put in place measures to protect lives and livelihoods, the next step will be to develop and implement recovery plans. Ideally, these stimulus programmes should contribute to efforts to limit climate change and protect lives and livelihoods into the future by decoupling economic development from greenhouse gas emissions.

This chapter analyses the challenges for the Global South from an economic and climate change perspective and discusses various potential solutions or pathways. All four contributions advocate for people-and planet-centred recovery strategies that respect planetary boundaries and aim to deliver the climate goals of the Paris Agreement by fostering climate, social and economic resilience. The first contribution – **Two birds, one scone: Using green recovery measures to boost economic growth and help the climate** – highlights the opportunities that could be created by aligning recovery programmes with the Paris Agreement's climate targets and outlines a long-term roadmap to achieve this. **Multi-level climate governance for a green recovery** discusses the effects of the Covid-19 crisis in the urban areas from an economic and climate perspective and describes what could be done to deliver greener, more resilient, fairer and collaborative recovery strategies. **Covid-19: Lessons for a more resilient future** reflects on key aspects of the global health and climate crises and suggests how we could emerge from the current crisis more resilient and better prepared to confront climate challenges. Finally, **A world in crisis: On inequality, democracy, climate change and what realistic solutions mean** explores the connections between rising economic inequality, the concentration of economic power and the climate crisis in the light of the Covid-19 pandemic and explores the Green New Deal (GND) and degrowth models as potential solutions.

3.1 Two birds, one scone: Using green recovery measures to boost economic growth and help the climate

Minh Anh Nguyen

The Covid-19 pandemic has given rise to a whole host of challenges for health systems, economies, and societies worldwide. Global carbon emissions have also been affected by the pandemic: With almost half of the global population in lockdowns or facing restrictions on movement during the first wave of the crises, energy demand fell dramatically. According to the Global Energy Review (IEA, 2020), global total energy-related CO2 emissions in 2020 are expected to be down by 8% compared to 2019 (almost 2.6 GtCO2), falling to 306 GtCO2. This would be the largest reduction ever, six times larger than the reduction that accompanied the (0.4 GtCO2) Global Financial Crisis in 2009 (Dafnomilis, 2020).

However, lessons learnt in past global crises suggest that while greenhouse gas emissions may significantly decrease over the short term, a rapid rebound of emissions post-crisis is likely (OECD, 2020). Unless strong climate action is taken, this temporary drop in emissions is not expected to alter the current trajectory of climate change. Forster et al (2020) estimated that the direct effect of the pandemic-driven response will be negligible, with a cooling of around 0.01°C by 2030 compared to a baseline scenario that follows current national policies (Forster, 2020). Another projection from NBL Netherlands Environmental Assessment Agency and the New Climate Institute indicates that the fossil fuel rebound is likely to result in a smaller reduction of emissions by 2030 (-3.0 instead of -4.5 GtCO2e in the mitigation scenario) and could even translate into an increase (+0.5 instead of -2.5 GtCO2e in the Baseline scenario) (Dafnomilis, 2020).

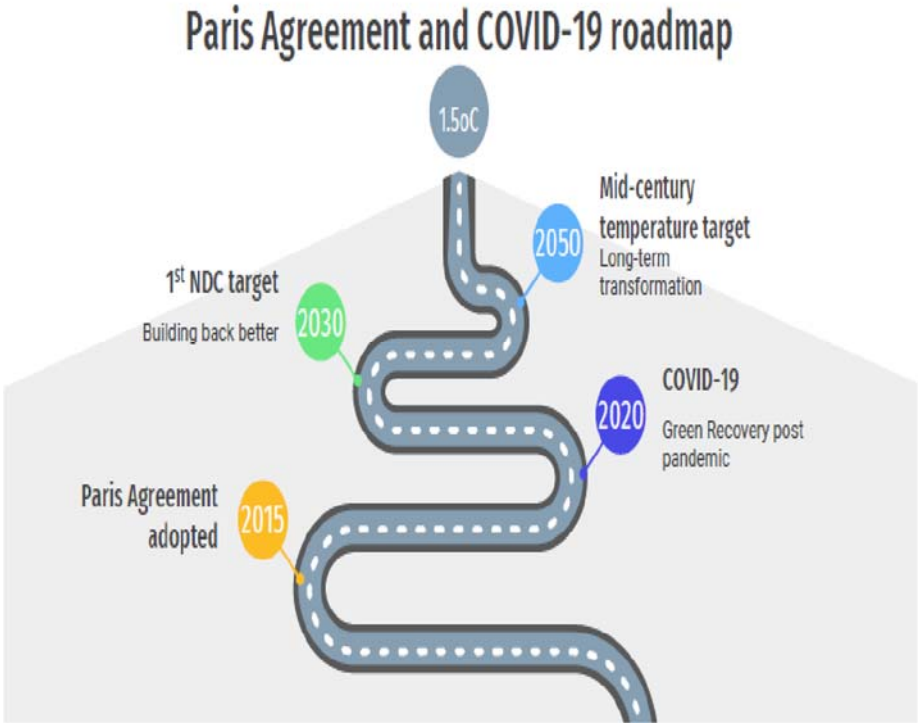


Figure 1. Aligning Paris Agreement goals with a Covid-19 recovery roadmap.

Source: Author

2020 is an important milestone for the Paris Climate Agreement, with governments due to update existing Nationally Determined Contributions (NDCs) or submit new pledges for climate action. However, the pandemic has seen governments delay their NDC submissions and postpone international climate negotiations. While the effect of the pandemic on projected emissions commitments under the NDCs has been limited so far (Dafnomilis, 2020), it is anticipated that countries electing to revive their 'brown' economies with a business-as-usual approach will fail to meet their mitigation targets. This could challenge the effective implementation of the Paris Agreement, which is the only international emission reduction agreement existing today.

Green recovery post Covid-19: Feeding two bird with one scone

Designing and prioritizing green recovery measures will play a crucial role in addressing this situation. These measures present a win-win opportunity to tackle both the economic malaise triggered by the pandemic and the climate crisis. Since mid-2020, countries have launched various economic recovery packages with a view to reviving economies that have been flattened by the pandemic. This is a great opportunity to reshape economies rather than merely returning to business as usual. Instead, countries should seize the opportunity to move towards low-carbon and resilient development pathways aimed at achieving the long-term temperature goal defined under the Paris Agreement.

A study by Forster et al (2020) suggests that future warming of 0.3oC by 2050 could be avoided if economic recovery plans were skewed towards a green stimulus agenda and investments in energy generation from fossil fuels were significantly reduced (Forster, 2020). Other research shows that recovery policies could deliver on economic and climate goals by capturing co-benefits (Hepburn, 2020). Significantly, a green stimulus approach that integrates strong climate policies and sustainable investment can create valuable jobs, revitalize economies, and get the world on track to meet the 1.5°C target of the Paris Agreement (Climate Action Tracker, 2020). Different climate policies such as the NDCs and long-term strategies are building blocks to mainstream climate targets into the economic recovery by boosting economic growth, technology transformation, job creation and addressing social inequality (UNDP, 2020). However, a recent report by Vivid Economics shows that governments have a largely failed to harness this opportunity to date (Vivid Economics, 2020).

A roadmap for aligning post-pandemic recovery programmes with climate targets established under the Paris Agreement

A range of policy recommendations for action over the near, medium, and long term offer a pathway to integrate efforts to reduce emissions and strengthen resilience within a broader economic recovery agenda (see Figure 1).

Near term efforts: Greening of existing or emerging recovery packages

- A lot of green recovery frameworks/ guidance/ checklists (see Box 1) are available and feasible to apply. Governments should orient investment toward sectors and technologies that can accelerate the transition and strengthen resilience to future climate-related shocks.

- NDCs and green recovery can be mutually enhanced by integrating NDC targets and measures into existing economic recovery plans. Lessons learnt from the NDC process, inter alia, the ambition enhancing mechanism, stakeholder consultation, and socio-economic assessment could be considered once countries prepare and enhance their economic stimulus programmes.

- Co-benefits such as job creation through the expansion of renewable energy generation offer a good starting point for communicating green recovery measures.

Medium term efforts: Build back better by effectively implementing NDCs

- The coronavirus pandemic has shown us the importance of healthy, well-connected and resilient societies; long-term and collective climate action will play a crucial role in achieving this goal over the longer term. Countries should be encouraged to explore opportunities to enhance the fairness and ambition of their NDCs as well as the National Adaptation Plan (NAP) process. This will be helpful in reshaping economies towards more sustainable and resilient development pathways.

Long-term efforts: Low-carbon and resilient transformations to achieve the long-term temperature goal of the Paris Agreement

- Investments in a workable and affordable Green New Deal to transition from fossil fuels to a low-carbon economy could support the post-pandemic recovery, accelerate the green transition and contribute to the Paris Agreement's goals. The European (EU) Green Deal is a great example of a comprehensive plan to transform the Union into a modern, resource-efficient and competitive economy aimed at achieving net zero GHG emissions by 2050 (EU, 2019). Other countries such as Germany and Republic of Korea are also designing Green New Deals together with their economic recovery packages. Developing countries and emerging economies will inevitably have to restructure their economies towards sustainability and and Green New Deals could offer achievable and affordable solutions.

Some feasible and applicable green recovery frameworks/ guidance/ checklists for reference

COVID-19 Recovery – A Pathway to a Low-Carbon and Resilient Future (ADB). Link: https://rb.gy/hrvkzg

A government roadmap for addressing the climate and post COVID-19 economic crises (Climate Action Tracker). Link: https://rb.gy/rteef9

Seven priorities to help the global economy recover – While building a healthier, more resilient, net-zero-emissions economy (Energy Transitions Commission). Link: https://rb.gy/sbl24h

Achieving Green Growth and Climate Action Post-COVID-19 (GGGI). Link: https://rb.gy/gwbdtm

Green Deals to Accelerate Climate Action Post-COVID-19 (GGGI). Link: https://rb.gy/lloaev

The POST-COVID Recovery – An agenda for resilience, development and equality (IRENA). Link: https://rb.gy/qxqqwx

Exploring the impact of the COVID-19 pandemic on global emission projections – An assessment of green versus on-green recovery (NBL Netherlands Environmental Assessment Agency and the New Climate Institute). Link: https://rb.gy/tz7tf1

OECD series of policy briefs on post COVID-19 and green recovery. Link: https://rb.gy/mnldvs

Green Stimulus Index – An assessment of COVID-19 stimulus by G20 countries in relation to climate action and biodiversity goals (Vivid Economics). Link: https://rb.gy/lcezdv

Proposed Sustainability Checklist for Assessing Economic Recovery Interventions, April 2020 (World Bank). Link: https://rb.gy/nijja8

3.2 Multi-level climate governance for a green recovery

Emily Montserrat Castro Prieto

To think of a green recovery plan that does not consider the urban areas as a gear for mobilising economic, social, and environmental development would be incomplete. The Covid-19 crisis unveiled or exacerbated historical challenges of the urban world but at the same time the changes that it has brought include unique opportunities to reconfigure and accelerate transitions towards low-carbon urban economies that are more resilient and fairer.

The importance of cities in shaping the climate future can be understood in five facts: 1) to date more than half of world's population lives in urban areas and this share is expected to reach more than two thirds by 2050 (UN, 2020); 2) cities and urban populations account for 80% of global gross domestic product (UN, 2020); 3) they are the responsible for about 70% of global carbon emissions and two thirds of resource and energy use (Coalition for Urban Transition, 2019); 4) they are a vital solution, with the potential to reduce almost 90% of their GHG emissions by 2050 (Coalition for Urban Transition, 2019); however 5) their action is limited, since their primary authority covers only 1/3 of the urban mitigation potential (excluding decarbonisation of electricity), with the remainder shared equally between national governments and the interactions of various actors (Coalition for Urban Transition, 2019).

Unlocking the full potential of cities will accordingly require a collaborative approach or multi-level climate governance. These terms are understood as the intentional and strategic linkage and coordination across levels of government in climate planning, implementation, monitoring and evaluation (UN-Habitat, 2020). This implies simultaneous bottom-up and top-down approaches in order to adequately consider local contexts in upper policies, while providing the guidance and means (e.g. finance and capacity building) to implement local actions aligned with the global climate and sustainable development goals.

In this sense, cities aim to reach net-zero emissions by 2050, which would imply investing US$1.83 trillion yearly in low-carbon measures (about 2% of world GDP), which could yield positive returns due to savings and job creation (Coalition for Urban Transition, 2019). With an unprecedented global financial mobilization of over US$11 trillion of fiscal stimulus to combat the economic downturn due to the coronavirus (BMU, WRI, 2020), cities will be key to accelerating a shift in this direction if joint efforts are put in place.

Impact of the Covid crisis within urban environments

Cities have been in the eye of the storm of the COVID-19 pandemic, with over 95% of the global cases occurring in urban areas (UNHabitat, 2020a). With cities paralysed by quarantine measures, the consequences of historical poor urban planning in combination with deficient economic and social systems became more evident than ever. In turn, the blue skies and reduced trafficflows offered us a vision of what cleaner cities could look like.

Evident urban impacts of the pandemic include: 1) deepening of social and spatial inequalities especially in vulnerable societies in densely and informal settlements; 2) unprecedented unemployment and business closures; increased pressure on public services; 3) and dwindling tax revenues, which are estimated to fall by 15 – 25 % in 2021 (UN, 2020). This could hamper investment in improved public services or greener infrastructure and stymie the efforts of cities to achieve climate goals.

The challenges intensified in regions such as Latin America and the Caribbean, which depend substantially on threatened sectors such as tourism, hospitality, and services. However, it is the informal economy that puts the most pressure on governments, which must grapple with the threat of economic paralysis if they choose to implement more stringent containment measures. So far, this region has seen the highest coronavirus case fatality rate (Reuters, 2020). The following diagram attempts to visualise the positive and negative correlation of the elements discussed.

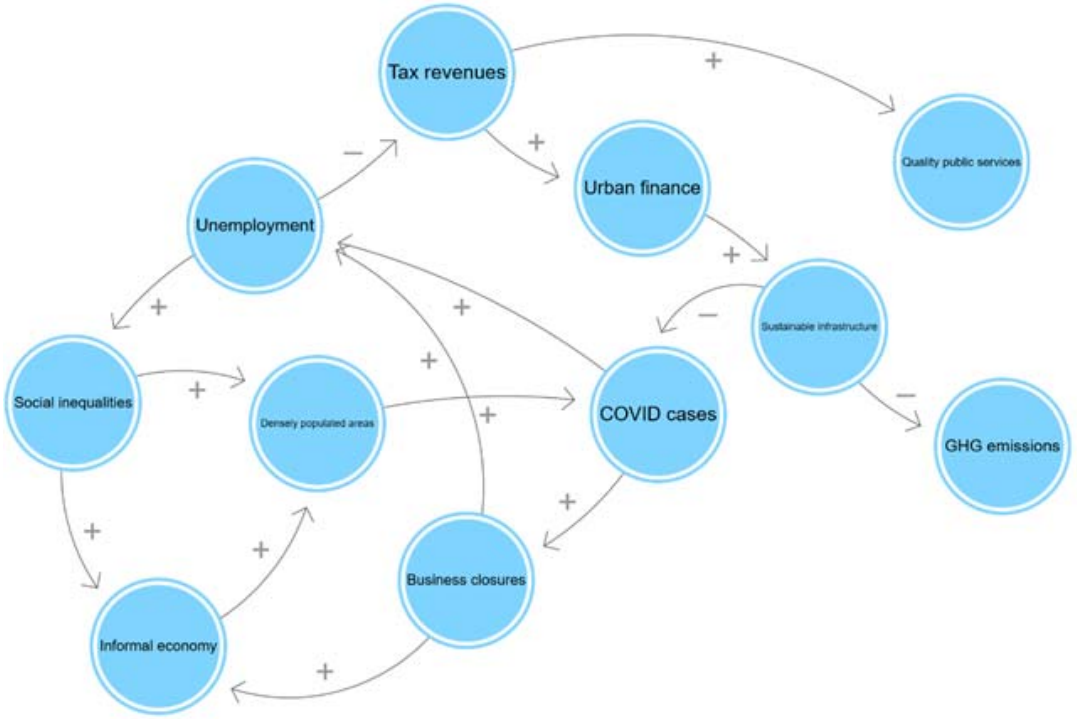


Figure 1 Causal chain of urban challenges and Covid impacts related to the economy and climate change.

Source: Author

Despite these burdens, this could also be a chance to drive positive urban transformations, much as previous health crises (the Spanish flu, tuberculosis, cholera) drove the introduction of sewerage systems, housing regulations, or public parks in cities (UN, 2020).

Opportunities for future-proof cities

As governments prepare in parallel their ambition to increase the Nationally Determined Contributions by the end of 2020 and stimulus packages to combat the economic turndown, this is a key moment to integrate sustainable urban strategies with innovative and redistributive approaches that better alleviate immediate pressures and prepare cities for future shocks.

A first step is to **reconfigure local recovery and development plans** so that these are centred on people and nature, address inequalities, prioritize vulnerable societies, build social, economic and climate resilience transparently, and deepen multi-level collaboration while remaining aligned with the climate and sustainable development goals (SDGs).

With the lack of capacities and finance a central challenge for cities, it is key to **improve their budgetary systems and mobilisation of resources by innovative forms**, e.g. by gross savings, fiscal reforms or modification of existing subsidies (OECDa, 2020; C40, 2020).

Likewise, it is fundamental to **enhance their capacity to identify and prepare a portfolio of sustainable and bankable projects** related to mobility, housing, energy, waste, and nature-based solutions. Even when many measures may not vary from a pre-crisis scenario, some impacts and responses highlight their benefits to alleviate social and economic pressures, as it is shown below. In the case of countries in the Global South, greater priority should be given to low-cost investments with high benefits, such as the promotion of active mobility, zones free of pollution and emission, and residential infrastructure in marginalized areas (C40, 2020).

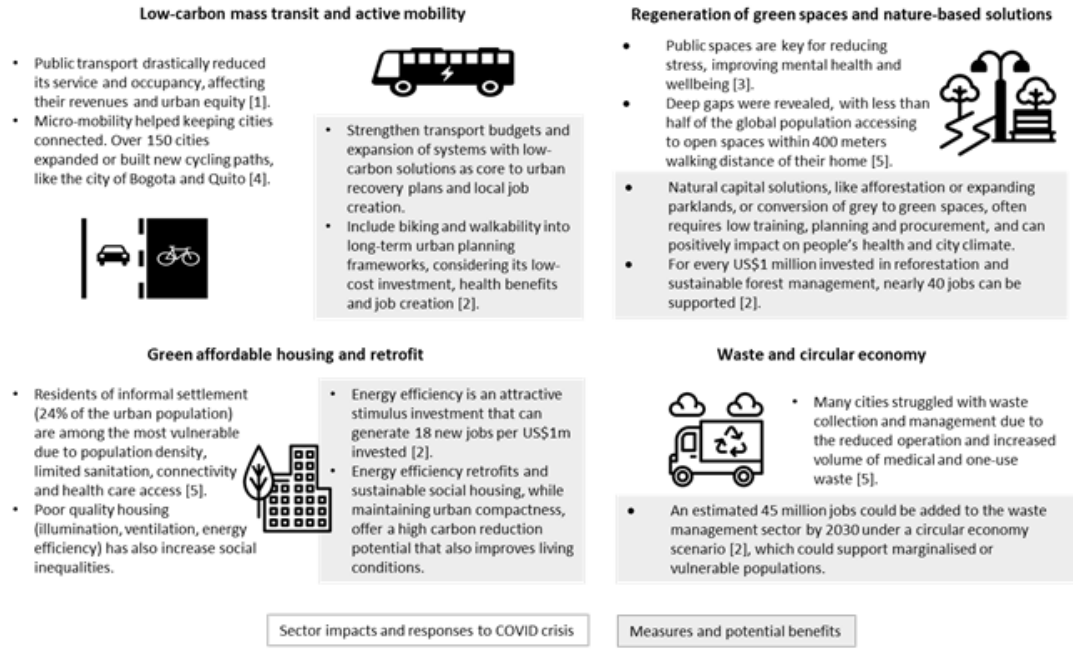


Figure 2. Covid-19 impacts and responses on key urban sectors and potential benefits of low-carbon measures.

Source: Author[8]

Collaborative climate action at all levels of government is crucial to mobilizing and leveraging the funds, coherence and knowledge sharing needed to activate these measures. The following diagram intends to visualise the above-mentioned elements and the ideal components of the top-down and bottom-up relations between tiers of government for achieving a green recovery in urban environments.

As noted, the **leadership and commitment of national authorities is essential** to the success of efforts to integrate green urban strategies in economic stimulus plans and raise NDC ambitions. Depending on the degree of decentralisation in governance, the national level could also play an important role in unlocking budgetary capacities at the local level and funding access to complement green

[8] Based on: [1] (OECDa, 2020); [2] (Coalition for Urban transitions, 2020); [3] (OECD, 2020); [4] (BMU, WRI, 2020a); [5] (UN, 2020); Icons by:). [a] Electric bus by Rutmer Zijlstra, licensed under CC BY-ND 3.0; [b] Park by priyanka (ibid); [c] green building by Bakena Studio (ibid); [d] Garbage Truck by tezar tantular (ibid)

investments (OECDa, 2020). Countries with weak national support or climate retrograde strategies should deepen the **collaboration of cities with the private and social sectors along with their participation in regional and international partnerships**.

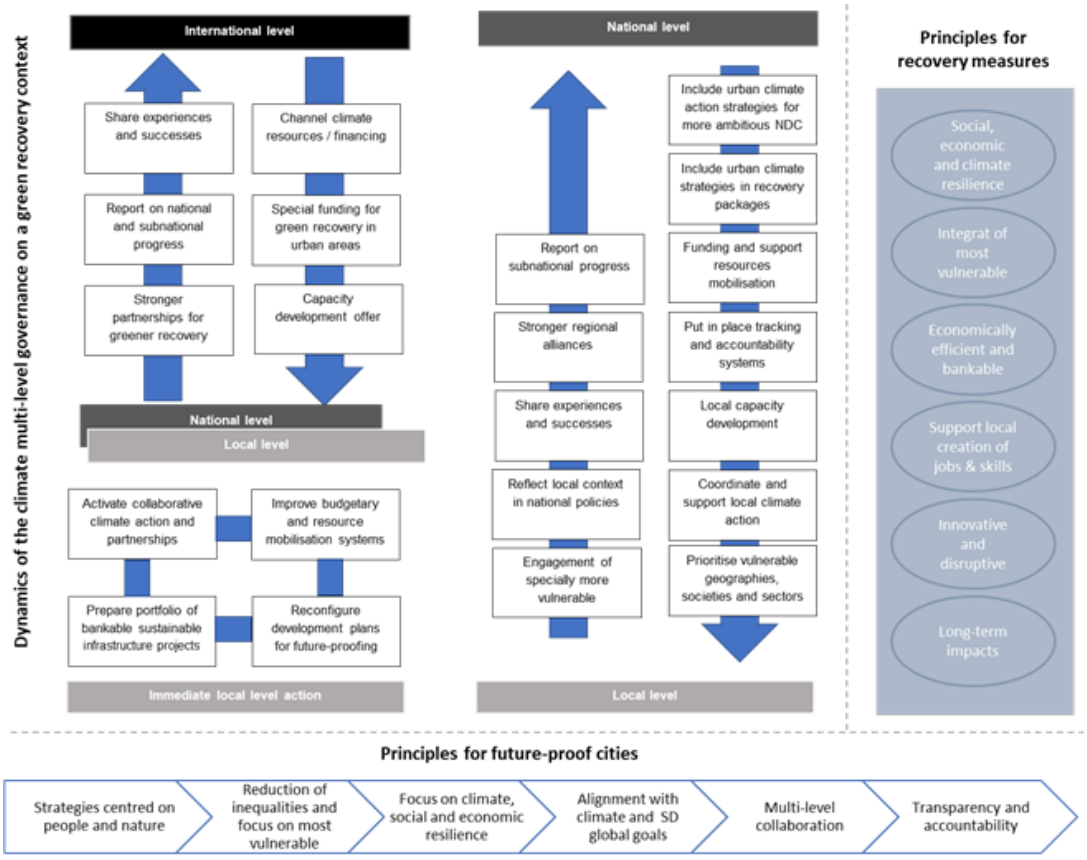


Figure 3. Main components of effective multi-level governance for climate action for a green recovery.

Source: Author[9]

In this regard, cities can **benefit from the growing engagement with local climate action at regional and international levels**. Funding initiatives for sustainable urban infrastructure such as the Urban Climate Gap Fund, with a potential to leverage more than 4 billion euros (City funding gap fund, 2020), the issue of green bonds by the Developing Bank of Latin America (CAF, 2020) and the announcement of a subnational fund by the Coalition of Capital Cities of the Americas on Climate Change (CC35, 2020), are tangible examples of funding opportunities to move bankable and impactful climate projects to an implementation phase.

In the face of the crisis, cities have an unavoidable opportunity to redirect their development towards a more sustainable and fairer future. Mainstreaming future-proofing principles, focusing on priority measures and exploiting a collaborative environment could be a real boost to meeting climate and development goals at the local level.

[9] Based on UN-Habitat, 2020 p.18, Coalition for urban transitions, 2019 and OECD, 2020

3.3 Covid-19: Lessons for a more resilient future

Melissa Cuevas Flores

Although climate change and the Covid-19 crises have unique characteristics, they also share similarities and challenges. Thus, the latter could offer some insight into what could happen with our current economic system under a climate change scenario. In addition, it could shed light on what needs to be done to foster structural changes and reduce current vulnerabilities.

Here, I compare both crises, and reflect upon some aspects that could be key to emerging from the current crisis more resilient and better prepared to confront climate challenges today and in the future.

Similarities and differences between Covid-19 and climate change

1) Shock versus slow onset

One of the main differences between both events is the timing with which they unfold. The coronavirus pandemic was a sudden outbreak and can be considered a shock. It was the abruptness of its occurrence that made it possible for governments to implement drastic measures that otherwise would not have been adopted (Nay,2020).

Unfortunately, climate change has not received the same attention. Since it has evolved over a longer period, it has been normalized. The belief that climate change is not a significant threat, regardless of the accuracy of this perception, prevents society from making the needed decisions. Yet, it is worth noting that, although climate change is slower in onset, its effects will ultimately be more severe (Bapna,Gorissen and Wascow, 2020).

2) Existing vulnerabilities

In both cases there is a high correlation between countries' current state of development and their capacity to respond to the challenges presented by these crises. The less resources and capacities countries have to adapt to new circumstances, the more vulnerable their population is to the impacts of these crises. (IPCC, 2018a).

Although the factors that determine adaptive capacities can be hazard-specific, other aspects apply to a variety of hazards (Brooks, 2003). Factors such as limited economic resources, access to health services or poor infrastructure all influence the capacities of countries to adapt to various challenges (IPCC, 2018b). Those factors that heighten the vulnerability of populations to the worsening impacts of Covid-19 apply to a large extent to other crises, including the climate crisis.

3) Lack of resources for recovery efforts

Although many countries from the Global North have developed packages to help their economies recover from the impacts of the pandemic, developing countries face a very different situation due to the fragility of their finances, which prevents them from making the necessary investments. Climate change presents similar challenges and developing countries will face an uphill struggle in their efforts to prevent or recover from climatic hazards.

Although international aid could transform this situation, the available funding represents only a small

fraction of what is needed (Micale,Tonkonogy and Mazza, 2018). In this way, the capacity of the GLobal South to recover from these contingencies remains constrained.

4) Impact on development

Experts anticipate that the Covid-19 pandemic will push as many as 150 million people into (extreme) poverty (World Bank, 2020). This marks a significant reversal in the progress made in the development sector over the last decades (Sumner, Hoy and Ortiz-Juarez, 2020).

Similarly, climate change could also put development progress at risk. The negative nexus between climate change and development is widely acknowledged in relevant literature (Adger and Kelly, 1999; Blaikie, Cannon, Davis and Wisner, 2003; Cannon and Mueller-Mahn, 2010). It highlights the potential risks that climate change could have on development gains.

Additionally, as will be discussed below, the interaction of these crises can conspire to undo decades of development progress (IIED. 2020). As a result, developing countries will become even more vulnerable to new shocks and stresses.

5) System fragility

One key issue that the current pandemic has revealed is that risk is multidimensional. Hence, every additional layer of risk interacts with existing problems and magnifies them when a shock in the system takes place.

This is exemplified by the recent flooding in South Asia, where the impacts of the pandemic had already affected the economic and social conditions of the region's most vulnerable populations. This reduced their capacities to respond to climatic events, which in turn aggravated existing challenges.

In this situation, we can clearly observe the nexus between the coronavirus pandemic, climate change, and development. These circumstances put in evidence how fragile the system can be to these events and how much they affect the most vulnerable.

What Covid-19 could teach us

1) Need for systemic changes

Something that became clear during this crisis is the need for structural changes that will make societies more resilient in the face of future challenges. To transform the way the current system operates, changes need to take place over the short and the long term.

In the long term, it is important to target the root causes of the current problems and work towards systemic changes in the economic, environmental and social spheres. The aim is to have a resilient system "ready to face up changes and shocks that are yet to come, leaving the logic of adapting on contingent emergency towards the attitude to constantly reduce vulnerabilities" (Tricarico and Venturi, 2020,2).

However, it is worth noting that when dealing with a constant scarcity of resources, we tend to become more risk averse and adopt a more conservative position towards change. Yet, it is exactly under these conditions when change is needed and when we need to start rethinking potential transformational paths.

2) Climate finance as a central pillar for the corona crisis recovery

In the short term, financial support should be provided to developing countries to aid their effective and prompt recovery. While the coronavirus crisis is an immediate priority, a reduction in climate finance could result in catastrophic outcomes for vulnerable populations. Climate finance should target efforts to promote a sustainable and resilient recovery.

As mentioned previously, what these events have shown is not only how they interact among each other, but also with other risks. For this reason, it is key that interventions address the problem in an holistic way, by recognizing and considering other types of risk. For instance, funding decisions in climate finance could consider both climate and non-climate risks. And the same rationale could be applied to the allocation of Covid-19 and development aid.

It is also important to identify and invest in potential synergies where interventions could achieve complementary effects. Climate resilient development initiatives, for example, could help the most vulnerable populations to adapt and respond to multiple social and economic risks such as unemployment, disease, and climate change (IIED, 2020).

What the current situation is showing us is the importance of an holistic approach that seeks to address the multiple dimensions of risk and helps communities and countries to become more resilient.

Photo by Shane Rounce on Unsplash

3.4 A world in crisis: On inequality, democracy, climate change and what realistic solutions mean

Nadeem Abdelgawad

In September 2014, the Egyptian government passed a law (in the absence of an elected parliament) that allowed for the use of coal in the production of energy for the first time in Egypt's history. Corporations engaged in energy-intensive industries (spearheaded by the cement industry) that had benefitted from electricity subsidies prior to the Egyptian energy crises of 2012-13 had lobbied for this decision for several years. Egyptian activists, environmentalist groups and many coalitions that grew in the wake of the 2011 uprising, organized and for a time succeeded in highlighting the drawbacks of using this dirty and obsolete technology in energy generation. They also argued that Egypt had no significant coal reserves and would import practically all its coal while it has huge unharnessed solar and wind resources. The law was passed in 2014, in correlation with a rise in authoritarianism and a crackdown on civil society that included new restrictions to the right to freedom of assembly (Human Rights Watch, 2013). Hindered from exercising their right to freedom of speech and assembly, the anti-coal coalition lost leverage and the battle against the dirty technology and its corporate advocates (see Gomez and Regaignon (2015) and Zayed and Sowers (2014)). This was a stark lesson for many on the interlinkages between democracy, human rights, neoliberal capitalism, and the struggle to mitigate climate change impacts.

It is from this starting point that this article tackles two issues. In the first section, it argues that the battle to halt global warming is at the heart of the struggle against economic inequality, the consolidation of wealth and power by the world's richest 1%, racism, and patriarchy. Covid-19 has merely forced us to confront this inconvenient reality more directly than ever. The second section then briefly explores two emerging alternatives: the Green New Deal (GND) and degrowth. It doesn't take a strong stance towards one of them at the cost of the other. Rather, it highlights the importance of putting these two at the core of the climate movement and the need for radical holistic policies rather than a slow, fragmented, and inadequate tweaking of the status quo.

Socio-economic inequalities and climate change are intertwined

According to Oxfam International (2018), the world's richest 1% have more than twice as much wealth as 6.9 billion people combined. Millions of people still lack access to healthcare and education. 100 million people are pushed into extreme poverty each year due to healthcare costs, a statistic that was already alarming before the pandemic, let alone today. 20 % of all children are denied access to education, with girls being affected disproportionately, minimizing their social mobility. Women worldwide are not only underpaid in comparison to men, they also make up the larger proportion of the poor. Gender is just one dynamic of the complexity of economic inequality. In many parts of the world minorities and marginalized groups (whether divided by race or other categories) tend to disproportionately own less wealth. Black and Hispanic communities in the United States are a case in point (Akee et al., 2019).

Meanwhile, the World Bank (2020) notes that there are still 689 million people living in extreme poverty, with numbers increasingly concentrated in Sub-Saharan Africa. Covid-19 will worsen this situation and the World Bank estimates that the pandemic will push a further 150 million people into extreme poverty by the end of 2021. On the other hand, while many people lost their jobs and lacked adequate social welfare nets, the net worth of the world's billionaires increased by more than US$ 2 trillion since the outbreak of the pandemic. Their net worth has now reached an all-time high of US$10.2 trillion (PWC, 2020). The pandemic is clearly exacerbating the global inequality crisis.

This crisis is closely linked to the existential battle against climate change. Firstly, the growth of inequality and the austerity policies that were adopted after the 2008 economic crisis (See Ostry et al. (2016)) have hampered efforts to pursue socio-economic and environmental justice. Carbon dioxide emissions continued to increase as economic growth resumed, and the world returned to business as usual with no fundamental change in public investment policies or shift towards a more equitable and environmentally sustainable economy. Moreover, austerity economics posed another barrier for communities to invest in climate change adaptation (for example see (Bigger and Millington, 2020)).

Carbon inequality has also tracked the growing economic inequality gap. Data from G20 countries show carbon inequality both within countries and across countries (see Gore, 2015). According to (Oxfam, 2020) the richest 1 % of Earth's population are responsible for 15 % of cumulative CO2 emissions. And the richest 10 % are responsible for over half of all cumulative CO2 emissions. Meanwhile, the poorest half of humanity are responsible for only 7 % of cumulative emissions. Without urgent action, the global carbon budget will be exhausted by 2030 and we will exceed the 1.5 C target set in the Paris Agreement. The richest 10 % will be responsible for the bulk of these emissions.

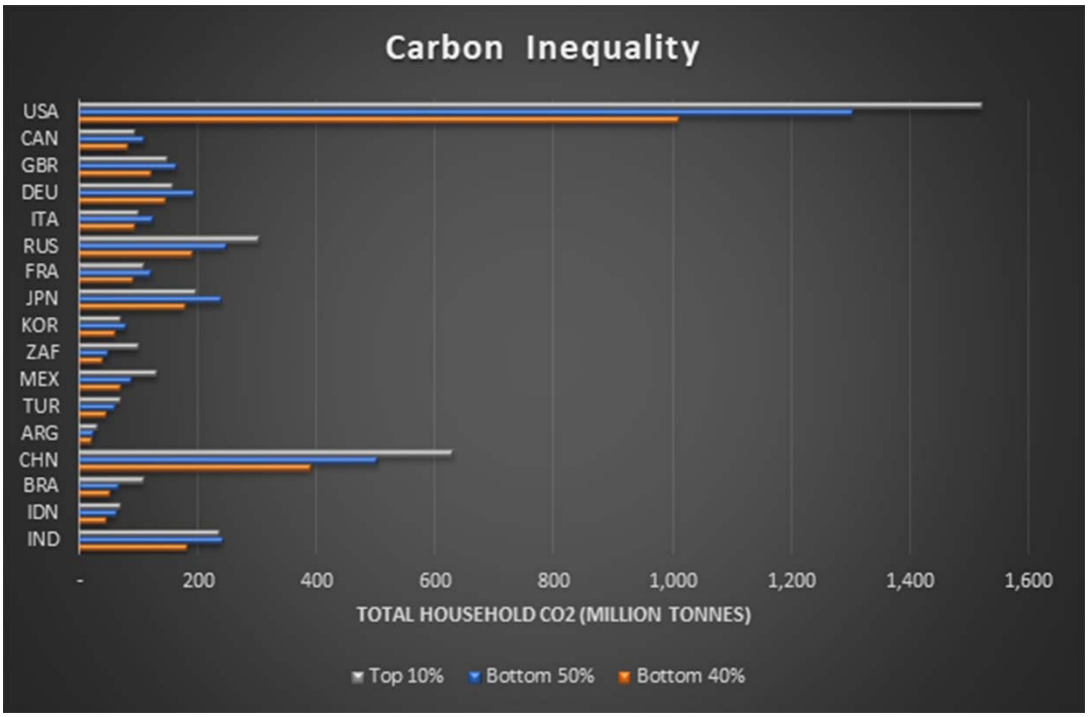


Figure 1: Carbon inequality

Source: Author

The poorest countries and communities are most vulnerable and least able to adapt to the impacts of climate change. They will be the first to foot the bill despite being the lowest emitters of greenhouse gases. Urgent action is not a privilege and must bring change to a system that creates economic and environmental crises through socio-economic inequality and unsustainable growth. These issues are interrelated, and it seems that, within the current status quo, even political concessions that would achieve the bare minimum to protect the world and its working-class majority from the adverse effects of climate change are unattainable.

In a climate emergency, radical solutions are the realistic solutions

It is impossible to delve deep into the ways forward in this short article. Nonetheless the coming lines aim to shed light on two different (not completely reconciled) radical solutions to the climate crisis. The purpose here is to highlight the importance of a paradigm shift as opposed to a slow incremental move away from fossil fuels if we are to meet the 1.5 C target and to argue that since today's world socio-economic and environmental issues are intertwined then the solution has to be holistic and address economic, gender and racial inequalities as well as climate change.

The Green New Deal has come a long way and has evolved into a complex, intersectional and holistic project that addresses energy transitions employment and labour relations, public/communal ownership of energy infrastructure and other factors relevant to improving socio-economic inequality. "In this new GND framing, the climate emergency is not a market externality to be fixed through pricing, but rather it is part of a social crisis. Such a crisis can be addressed only "by redistributing economic and political power" (The Economist, 2019). This marks a radical departure from the first incarnation of the GND(Mastini et al., 2020).

More recently, the concept of 'degrowth' has been gaining ground in the public debate and is likely to figure more prominently as the pandemic continues. Degrowth marks a radical move from an economy centred around continuous growth and instead focuses on creating a more sustainable and equitable economy that works for all (Mastini et al., 2020). The difference between degrowth and the GND is that "the degrowth argument holds instead that the slower the rate of economic growth, the easier it is to achieve emissions reductions. This is because the rate of change of carbon emissions is equal to the rate of change of output multiplied by the rate of change of carbon intensity. Relying on GDP growth to finance the deployment of renewable energy means increasing total energy demand, which makes emissions reductions more difficult to achieve" (Mastini et al., 2020).

The fight for radical, urgent, and fundamental policies to mitigate climate change is at the core of the fight for equality and democracy. Global business elites (ones that have power concentrated due to the concentration of capital) have failed to do enough. Meanwhile, the poorest and most marginalized are the ones projected to pay the higher price. Decades of rising inequality and concentration of wealth in the few under austerity capitalism mean that the many voices and interests of the marginalized majority have been overlooked. From the unbinding Paris Agreement to corporations continuing to get away with pollution and heating up the planet for the accumulation of profits that in turn are used for more breaks from governments to exploit more resources in a vicious cycle, Billionaires and political elites have not done enough. Covid-19 is a magnifying class to an already troubled reality. To discuss and offer 'radical' potential solutions, such as a GND or degrowth (as a point of departure in this debate), is the most realistic thing we can do if we are to survive and prosper.

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4 Additional Contributions

In the previous sections the authors considered issues relating to different countries across three thematic strands. This final section includes contributions from Fellows who did not take part in the group discussions. It is a space for personal statements and research on the impact of Covid-19. In the first contribution, Magaly Ines Beltran-Siñani considers how the pandemic is affecting waste management systems in the Global South and Bolivia in particular. Amir Mosavi and Sina Ardabili then offer a broader evaluation of pandemic management and show how model analyses could help predict outbreaks. These contributions offer readers a broader perspective from the Global South and highlight concerns related to the pandemic.

4.1 Post Covid-19 sustainable solutions in waste management for Bolivia and southern countries

Magaly Ines Beltran Siñani

Introduction

The Covid-19 pandemic came unannounced. Since early 2020, countries around the world have been scrambling to adapt to this "new normality" and to strengthen their resilience to pandemics and other emergencies.

With one of the largest economies in the world, Germany was in some ways well prepared for the Covid-19 pandemic, with ample hospital capacities and a strong enabling environment, including a good public healthcare system and expert scientific institutions. Thanks to its strategy to prevent, detect, contain, and treat infected persons, Germany has a lower case fatality rate than many comparable countries (Robert Koch Institute, 2020);

In response to the ongoing crisis, the Federal Association of the German Disposal, Water and Raw Materials Management (BDE) has appealed for measures such as greater worktime flexibility for drivers affected by illness, the increased use of digital technologies to protect the health of employees, and financial support for companies to purchase protective and hygiene materials for their employees. Additionally, some formalities in the waste collection process have been relaxed, such as the obligation to sign documents (Parul Kumar, 2020).

Some German municipalities have stopped the collection of certain waste streams due to staff shortages, nevertheless, the general obligation to store and collect different waste streams separately still holds. The coronavirus is also affecting the recycling industry, with shortages in the supply of waste material as paper, glass, and plastic.

Bolivia initiated a national quarantine on 21 March 2020 with the aim of reducing the high rate of Covid-19 infections; as is the case in most developing countries; hospital capacities are limited in Bolivia, which increases its vulnerability and the fatality rate.

In Bolivia, of the total waste generated at the national level, approximately 45 % is disposed in sanitary landfills, 18 % in controlled dumps and 37 % in open dumps, of which about 30 % are close to bodies of water that are used for human consumption and irrigation (Quispe et al., 2012). Differentiated waste collection is being trialed in some of the country's 340 municipalities. In addition, there are informal collectors that reduce the waste flows to the sanitary landfill, but these activities are done without operational precautions, risking the health of the collectors (Página siete, 2019). During the pandemic, waste collection trials have been relaxed in some municipalities.

Sustainable solutions in waste management

History has shown us that pandemics are recurrent; thus, the search for sustainable solutions must be a priority. Some solutions relevant to waste management are mentioned below:

a. International collaboration on waste management. This can help countries to learn from other experiences in order to understand and assess the impact of Covid-19. As waste pollution is not restrained by political boundaries and has a global impact, international cooperation is essential, especially in the sharing of knowledge, technology, and funding.

b. Fee modulation for non-household municipal waste. In view of the increase in the consumption of raw materials resulting from shortages in the supply of waste materials; waste disposal fees charged to industrial and commercial users should be modulated in line with the 'polluter pays' principle in order to encourage the reduction of waste generated in these sectors (Association of Cities and Regions for sustainable Resource management, 2020);

c. Design and analysis of sustainable waste management chains. Involving all stakeholders in cooperation with each other, these chains must consider waste generation, collection, transport, recycling and treatment, recovered resource use, and disposal of remains. (Siming et al., 2020);

d. Incorporate a standardized labeling system for packaging and disposable wastes that communicates recycling instructions to consumers, in cooperation with a coalition of brands that want their packaging to be recycled (How2Recycle, 2020)

e. Improve treating facilities for medical wastes. This measure was implemented in some countries as South Korea, with comprise closed systems with maintain temperature of 4°C up to seven days, and after is treated by incineration. However, incineration procedure must be analyzed and replaced by other technology since it has negative impacts on the environment (Whee, 2020);

f. Promote biodegradable packaging production and its use. The adoption of express delivery systems dramatically shortens the lifespan of packaging materials and disposable goods. A joint effort with the academy, industry and government stakeholders will be necessary in order to develop new packaging options (UNDP, 2020);

g. Implement efficient municipal solid waste management systems with organic waste fraction treatment. As the main contributor to greenhouse gas emissions by the waste sector is the decomposition of organic wastes, converting generated organic waste into energy using chemical, biological, and physical treatment will help to reduce its emissions through biogas, biofuels, and pellets production (Oluwalana et al., 2020)

h. Develop Life Cycle Assessments (LCAs) for municipal solid waste management in order to determine the environment impacts of different waste treatment alternatives and facilitate decision-making around the implementation of new treatment and disposal facilities and the reduction of raw materials consumption by industries.;

i. Increase the monitoring (aquatic, terrestrial and aerial surveys) of waste. Pollution from waste poses a severe risk to both environmental and human health. Citizen science (i.e., NGOs) must be involved as it would greatly contribute to this cause (Silva et al., 2020);

j. Develop an inclusive and equitable MSW management policy. Waste workers such as street collectors, scrap dealers, and cart pushers are part of the waste management system; they should be recognized and involved in the development of solid waste governance and sustainability policy (Chidi, 2020).

Conclusions

This article considers various challenges around solid waste management in the context of the Covid-19 pandemic. Developing countries such as Bolivia are more vulnerable to this and future pandemics given the lack of MSW management policies, the dominance of landfill solutions, and the widespread lack of treatment technologies. Medical waste from quarantine centers and hospitals needs to be handled separately from the regular waste stream. During the quarantine, demand for packaging material

has exacerbated shortages in the supply of waste materials such as paper, glass and plastic resulting from interruptions to collection services. However, international collaboration, fee modulation, analysis of sustainable waste management chains, secure treatment for medical wastes, biodegradable packaging production, efficient MSW systems implementation, LCA models developing, monitoring of waste, and inclusive and equitable MSW management policy developing; are some interestingly post Covid-19 sustainable solutions for MSW management. Their implementation could help to mitigate adverse pandemic impacts and achieve the goal of creating sustainable cities and communities (SDG 11 of the UN Sustainable Development Goals).

Photo by Hobi industri on Unsplash

4.2 Global Covid-19 outbreak prediction with artificial intelligence methods

Amir Mosavi & Sina Ardabili

Introduction

SARS-CoV-2 broke out in December 2019 in Wuhan, China (Fanelli et al. 2020). Treatments or vaccinations to address the virus, which causes Covid-19, were unavailable at the time. Proper prediction strategy for Covid-19 outbreak can attract attentions to the strategies of quarantine and other governmental measures, like lockdown, media coverage on social isolation, as well as improving the public hygiene to control it (Shen et al. 2020). Recently, several strategies including mathematical models, have been successfully employed for pandemic prediction of disease. Singhal et al. (2020) employed Fourier decomposition method (FDM) and susceptible-infected-recovered (SIR) model for the prediction of Covid-19 pandemic. According to the results, the total number of cases and death were predicted to be 12.7 × 106 and 5.27 × 105, respectively (Singhal et al. 2020). Sarkar et al. (2020) employed a mathematical model for the pandemic prediction of the Covid-19 in India. The proposed model was a combination of susceptible (S), recovered (R), asymptomatic (A), infected (I), quarantined susceptible (Sq), and isolated infected (Iq) models (Sarkar, et al. 2020). Anirudh (2020) employed SIR, SEIRU, SEIR, SLIAR, SIRD, ARIMA and SIDARTHE for the Covid-19 pandemic prediction (Anirudh et al., 2020). But mathematical models have disadvantages such as complexity, time consuming and lower reliability (Pinter et al., 2020; Sedaghat, et al., 2020).

Machine Learning (ML) based models have been successfully employed in different fields of science (Mosavi 2020). Pandemic prediction can be considered as one of the fields that ML based models provided promising accuracy and reliability. Recently, researchers have developed studies for the prediction of Covid-19 cases and mortality rates using ML-based methods. Tabrizchi et al. (2020) employed a Deep Learning-based estimation model integrated by image-based diagnosis method to detect coronavirus infection. Dutta et al. (2020) employed a DL-based prediction model for the estimation of the Covid-19 outbreak. Ardabili et al. (2020) employed different single and hybrid ML-based methods for the prediction of the Covid-19 outbreak in USA, Germany, China, Iran and Italy. According to the results, ML-based prediction models could successfully cope with the prediction task. Pinter et al. (2020) employed hybrid ML based models (ANFIS and ANN-ICA) to predict the total cases of Covid-19 in Hungary using time-series data. Accordingly, the present study aimed to predict the trajectory of the global Covid-19 outbreak using a robust hybrid Artificial Neural Network integrated by Grey Wolf Optimizer (ANN-GWO) in the presence of the time-series total and daily Covid-19 cases.

Material and method

The required data for the developing the prediction model was generated from https://www.worldometers.info/. The nature of the dataset is time-series based. Accordingly, the total and daily number of cases are presented in Figure 1 from January 22 to November 15, 2020. Figure 1 has two vertical axes. One is for total cases and the other is related to the daily cases.

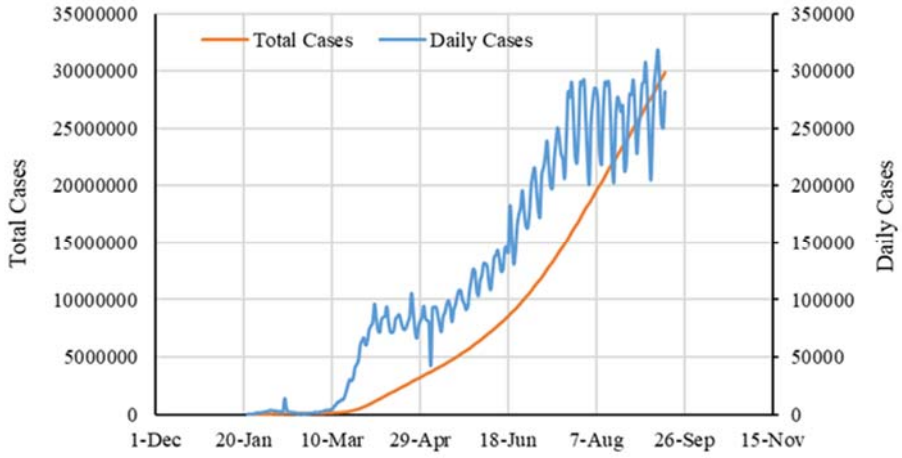


Figure 1. The employed time-series dataset for developing the ML-based prediction model

Due to the use of time-series data, it has been decided to choose the input dataset according to the Table 1 for the prediction of the global Covid-19 outbreak as the output parameter.

Inputs	Output
$X_{(t-1)}$, $X_{(t-2)}$, $X_{(t-3)}$, $X_{(t-4)}$, $X_{(t-5)}$, $X_{(t-6)}$ and $X_{(t-7)}$	Global Covid-19 Outbreak

Table 1. description of the inputs and output of modeling process

Modeling was performed by ANN-GWO in the presence of input and output dataset. ANN-GWO can be considered as one of the robust hybrid ML based methods (Mosavi et al., 2020). Modeling phase was started by employing the different architectures of ANN and different population sizes for GWO. Finally, according to the accuracy of the model, ANN with architecture of 7-10-4-1 in the presence of population size 150 for GWO was selected as the best prediction model for the global Covid-19 prediction with a high accuracy. 70 % of total data were selected for training phase, 30 % of total data were employed for testing phase and the predicted Covid-19 outbreak for September 16 to October 20, 2020 were selected for validation phase. The description of ANN-GWO has been comprehensively presented in our previous study in (Ardabili, et al. 2020). Figure 2 presents the main schematic of the developed model.

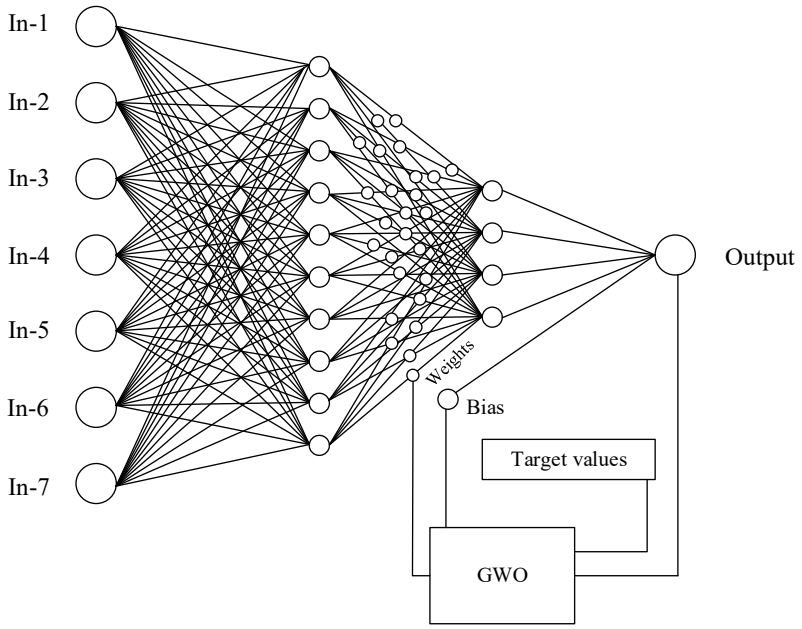


Figure 2. The main schematic of ANN-GWO

According to Figure 2, the main mechanism of the GWO is to update the bias and weights of the desired ANN architecture to reach the highest accuracy.
The performance and accuracy of the developed method was evaluated using the Mean Absolute Percentage Error (MAPE) and correlation coefficient (r) according to Eq. 1 and 2:

$$MAPE = \frac{\sum_{k=1}^{N} \left| \frac{y_k^{pred.} - y_k^{exp.}}{y_k^{exp.}} \right|}{N} \times 100 \qquad (1)$$

$$R = \sqrt{1 - \frac{\sum_{k=1}^{N} \left(y_k^{exp.} - y_k^{pred.}\right)^2}{\sum_{k=1}^{N} \left(y_k^{exp.} - y_{ave.}\right)^2}} \qquad (2)$$

Where $y_k^{exp.}$ Refers to the target values, $y_k^{pred.}$ Refers to the predicted values and N refers to the number of data.

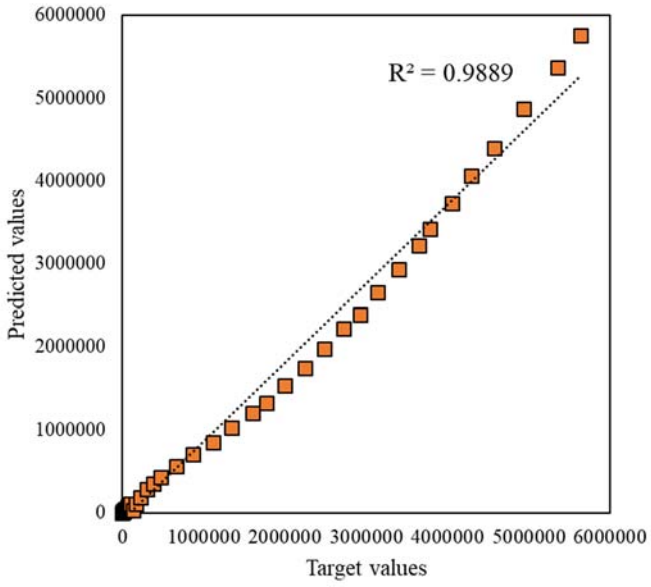
Results

Table 2 presents the results for training, testing, and validating phases into two terms of MAPE and r values. According to the results, the selected ANN architecture with population size 150 at the maximum iteration of 500, provided a promising accuracy for training, testing, and validating phases.

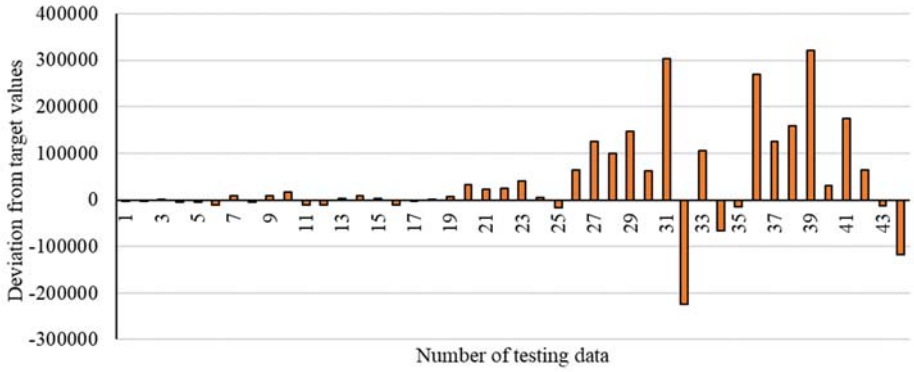
ANN architecture	Pop. size	Maximum iteration	Phase	MAPE	Correlation coefficient
7-10-4-1	150	500	Training Testing Validating	6.23 % 13.15 % 11.4 %	0.999 0.994 0.994

Table 2. results of the training, testing and validating phases

Figure 3a and b presents the plot diagram of the predicted and target values and the deviation from the target values for the testing phase, respectively. As is clear from Figure 3a and according to the determination coefficient of testing phase the performance of the testing phase is acceptable.



(a)



(b)

Figure 3. a) the plot diagram, b) deviation from target values.

Figure 4 presents the outbreak prediction by ANN-GWO from October 16 to June 4, 2021 (for 232 days. As is clear according to the predictions, the outbreak of Covid-19 continues is still increasing, and this trend is building. This can be a serious warning to the World Health Organization.

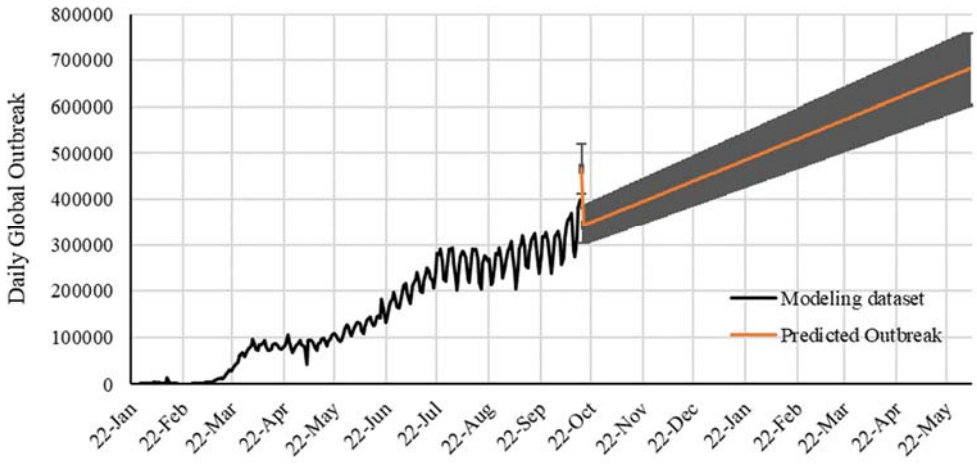


Figure 4. The prediction of the Global Covid-19 outbreak from October 16 to June 4, 2021

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