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Looking through the Lens of Complexity Theory: An Evaluation of Climate Change and Coronavirus 2019 Outbreak

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Abstract: When world leaders and delegates convened in Madrid, Spain in December 2019 for the 25th Congress of Parties (COP-25) to re-evaluate their obligations to the Paris Agreement on climate change, they could not prefigure coronavirus was about to overrun humanity. Virtually everyone describes climate change as the most complex ecological and social crisis confronting society in this century. When coronavirus outbreak struck humanity in December 2019, virtually everyone also describes it as the most complex crisis that had struck mankind since the end of Second World War. Both crises have also attracted significant response from policymakers; yet no research has weighed these two common challenges of our time side-by-side in a single study to establish whether they have equivalent level of complexity. This is crucial because confronting a problem without first understanding its complexity would culminate in a waste of resources and or failure to find a permanent solution to it. To address this concern, this paper evaluates global climate change and corona-virus 2019 outbreak using complexity theory as a conceptual framework, and makes recommendations for policy and research based on the outcomes.

Keywords: Looking through, lens, complexity theory, evaluation, climate change, coronavirus 2019 outbreak.

Introduction

When world leaders and delegates assembled in Spain, Madrid in early December 2019 for the 25th Congress of Parties (COP-25) under the United Nations Framework Convention on Climate Change (UNFCCC) to evaluate and reinforce their obligations to the Paris Agreement, they could not prefigure a coronavirus outbreak was imminent. A majority of climate scientists agree that the Earth's climate had changed both gradually and abruptly in the past and will persist for many decades, but the change occuring in this century is unprecedented. Already it is ravaging a range of natural and human systems globally. Although everyone anywhere in the world is affected, the most affected are people in the developing countries owing to their geographical locations, their limited coping capacities, and their vulnerable social, institutional and physical infrastructures. Virtually everyone describes climate change as the most complex ecological crisis confronting humanity in this century, and a quick and efficient response is needed to combat it; otherwise future generation may not have the resources they will need to sustain themselves. Consequently climate change has become a critical social and economic issue for policymakers (American Geosciences Institute, 2019; IPCC, 2014; United Nations Climate Change Secretariate, 2019).

On the other hand, corona-virus disease, also referred to as COVID-19, emerged in Hubei, Wuhan Province, China in late December 2019. It is a highly infectious pathogenic viral disease caused by severe acute respiratory syndrome coronavirus 2 (SARS-Cov-2). Between January and May 2020 the virus has spread across more than one hundred and ninety countries, infected millions of people, left hundreds of thousands dead, and hundreds of thousands recovered from the infection. It took three months to reach the first 1000 confirmed cases and only twelve days to reach the next 100,000 cases. The majority of confirmed cases occurred outside China even though the virus emerged from there. As at 7th of May 2020, global number of confirmed cases was 3,588,773 and 247,503 deaths. Europe had the highest number of confirmed cases and deaths, followed by the Americas. Africa had the least number of confirmed cases and deaths (WHO, 2020a; WHO, 2020b). Like climate change, virtually everyone describes COVID-19 as the most complex crisis that has befallen humanity in over a century. Alarmed by the swift spread of the virus, the World Health Organisation (WHO) on 11 March 2020 declared coronavirus outbreak a global health emergency. A disease outbreak becomes a global emergency when it causes large numbers of morbidity and fatality together with an overwhelming social and economic impact on society. Previous global health emergencies include Swine Flu in 2009, Polio in 2014, Ebola in 2014, Zika in 2016 and Ebola again in 2019 (WHO, 2020c).

Whenever society is confronted with an ecological, health, economic or social emergency, it turns to policymakers for a solution. One of the challenges policymakers face when presented with a societal problem is that a problems appear simple at a glance but exhibit significant complexity when examined carefully. In some other instances a problem may seem complex at a glance but simple in reality. Sometimes, a problem straddles multiple levels of complexity warranting the application of entirely novel strategies or adaptation of existing ones. There are also situations where a problem metamorphoses from one level of complexity to another over a short duration of time. Complexity theory, also referred to as complex science theory, resolves these issues (Anderson et al., 2014; Poli, 2013; Cilliers, 1998).

Complexity theory has been employed as a framework to evaluate a range of societal systems and problems; for example, healthcare (Rycroft-Malone, 2018; Glouberman and Zimmerman, 2002), educational reforms (Synder, 2013), complex problem solving (Fischer et al., 2012), leading complex situations (Hansen, 2013), decision-making (Tamasaitiene and Zavadskas, 2012) and research and program evaluation (Wolf-Brangin, 2013). None evaluated global climate change and COVID-19 outbreak, thereby leaving a conceptual gap. To close the conceptual gap, this paper evaluates climate change and COVID-19 outbreak using complexity theory as a framework. According to (Fitzgibbon and Mensah, 2012), complexity of a problem can be judged by the source of the problem and by the nature of the problem. The main objective of this paper is to determine whether climate change and COVID-19 outbreak are equivalent by level of complexity with particular focus on the sources, impacts and responses. The outcomes offers some thoughts policymakers and researchers may reflect on when formulating response strategies for combating current and future problems.

Complexity Theory

Until 1930s, the most widely used approach for studying the nature of problems was reductionism. Supporters of reductionism believed that a problem can be understood by first breaking it down into smaller components, analyze each component separately, and then assemble them back again to understand the whole. They believed that the whole is the sum of the parts. But as society advances, problems with multiple components interacting in a nonlinear manner emerged. These problems are such that internal processes unfold spontaneously without much overall control and monitoring, thereby making prediction of outcomes inherently tricky. Consequently, reductionism has become less tenable for analyzing the nature of problems (Poli, 2013; Fischer et al., 2012; Giudice, 2016). Complexity theory is an interdisciplinary theory used by scientists for analyzing the nature of complex problems in various domains. Proponents believe that the complexity of a problem is a function of the number of its components and the degree of interactions occurring among them. In complex systems science, a problem is a state of affairs for which improvement or solution is needed. Complexity theory categorizes problems into four types, namely the simple, the complicated, the complex and the chaotic (Anderson et al., 2014; Fischer et al., 2012; Tamasaitiene and Zavadskas, 2012; Wolf-Brangin, 2013; Giudice, 2016).

Simple problems have few but well-ordered components that interact with each other in a linear fashion. Relationship between cause and effect is straightforward and can easily be modeled. Solution to simple problems does not require professional knowledge but rather the application of clear-cut guideline. Once the guideline has been mastered in one context it can readily be transferred to similar contexts. Unlike simple problems, complicated problems have numerous components that are well-ordered and interact with each other in a cyclical fashion. The components can be individually distinguished and analysed piece-by-piece. Relationship between cause and effect can be modeled, thereby making it easy to predict consequences. Solution to these problems requires a set of guidelines or formulas sometimes from a range of disciplines. Once result is achieved, the guidelines can be replicated. Basically, complicated problems manifest as simple multi-stage problems. Responding to them with a single strategy often yields in incorrect solution (Poli, 2013; Glouberman and Zimmerman, 2002; Hansen, 2013; Giudice, 2016).

In contrast, complex problems have a network of components and numerous subcomponents without a central control. Problems in this category evolve through time. They are such that their past behaviour is co-responsible for their present behavior thereby making it difficult to determine their actual causes. Relationship between cause and effect can only be perceived in retrospect after probing the problem. They affect society in multiple ways and their consequences are crushing. They manifest a fusion of volatility, uncertainty, complexity and ambiguity, and evade attempts to solve them permanently. Ignoring them (not taking action at all) could result in the situation becoming more difficult to tackle in future. Solution often involves interdisciplinary approach. While this approach may yield some creative ideas, it may also produce some crazy and spontaneous ideas. It is worthwhile to acknowledge and, if possible, build on those crazy and spontaneous ideas (Poli, 2013; Synder, 2013; Hansen, 2013; Giudice, 2016; Dörner and Funke, 2017).

Chaotic problems are novel, turbulent and wicked. Unlike complex problems that evolve through time, most chaotic problems occur swiftly and within a short time cause unbearable devastation on people and their livelihoods. They are such that no relationship exists between cause and effects at system level, thereby making it difficult to understand their nature, unless a solution has been attempted. There is also the risk of discovering or creating new problems in the course of solving these problems. Because the parameters for solution are often incomplete, changing and contradictory, it may take long before a solution is provided. The best way to respond to problems of this nature is to act fast to slow down the situation while waiting for a pattern to emerge or some form of order is achieved, even if the order exists for a short time (Hansen, 2013; Sun and Yang, 2016; Williams and Hof, 2014).

Following the analysis of complexity theory, there are four categories of problems encountered in society, namely the simple, the complicated, the complex and the chaotic; hence four levels of complexity. The next section analyzes climate change along and COVID-19 outbreak, focusing on their sources, impacts and responses.

Analysis of Climate Change and COVID-19 Outbreak

Sources

One of the main beliefs of complex system theory is that the various crises (ecological, social, economic and health) confronting humanity are the outcomes from complex processes occurring within natural and anthropogenic systems. In some cases the actual origin and causes of the problems are hard to trace. The Earth's climate system is composed of multiple interconnected components including the physical (for example: the atmosphere, biosphere, hydrosphere and geosphere) and the anthropogenic (for example: society, culture and economy, and their subsystems).With incoming solar radiation being the main source of energy, these components interact among themselves to create and permit movements of mass and energy within the system. At the same time outputs from the system re-enter the system and become additional inputs. This cyclic movement of energy and mass occurs slowly and small inputs may result in disproportionate effects. Indicators of this movement include rising temperatures, extreme heat waves, drought and dryness, extreme sea level rise and rapid melting of sea ice. Yet, the quantity of mass and energy within the various components of the Earth's climate system, the contributions of each components towards climate change, and the actual cause of climate change remain inconclusive (American Geosciences Institute, 2019; National Academy of Science, 2012; The Royal Society, 2019). The definitions of climate change offered by two most important international bodies with different obligations on tackling climate change, United Nations Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change (IPCC), communicate opposing views on the meaning and actual cause of climate change. While UNFCCC attributes climate change directly or indirectly to anthropogenic activities that alter the composition of the Earth's climate system in addition to natural causes resulting to climate variability, IPCC attributes it to mainly human activities (IPCC, 2014; United Nations Statistics Division, 2016).

Coronaviruses belong to a family of viruses known for causing a range of infection such as common cold, acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). SARS appeared for the first in southern China in 2002 and is believed to have been transmitted to humans from civet cats. MERS emerged in Saudi Arabia and is believed to have been transmitted to humans from one of the species of camel. Coronavirus are known to spread during close contact through tiny droplets produced when someone who is infected coughs, sneezes and breathes; though the virus is not typically airborne. Apart from close contact with someone who is infected, a person may be infected by touching a contaminated surface and later touch the face. The virus could survive on a surface up to seventy-two hours and is most transmittable during the first three days after onset of symptoms. People who are infected show similar symptoms including fever, cough, fatigue and shortness of breath, and are sometimes asymptomatic. Most of the past pandemics originated from animal influenza viruses and were transmitted to humans. Although COVID-19 is known to have originated from China in December 2019 and spread to other countries, there are many unanswered questions including possible routes of transmission and impact of infection prevention and control measures on health care settings**.** Policymakers in China maintain the virus originated from a seafood market in Wuhan notable for illegal trading of animals. In contrast, Chinese scientists believe the virus may have spread from infected animals to humans through illegal trafficking of pangolins prized for food and medicines in some Asian countries. Some world leaders also argued that the virus originated from a laboratory in China, accused Chinese leadership for concealing facts about the origin of the virus and blamed the WHO for leaning too much on China. Amid this tension the WHO executive cautioned against politicising the pandemic and urged world leaders to concentrate on combating the disease and saving lives (Clarivate Analytics, 2020; European Centre for Disease Control and Prevention, 2020; Lin et al., 2020; WHO, 2020d; United States Centre for Disease Control, 2020; Pang et al., 2020; The Week, 2020).

Impacts

Complex system theory maintains that some problems occur swiftly and have overwhelming impacts on society. Some individual researchers (Frost, 2019; Goodland and Counsell, 2008; Jakob and Stecke, 2016; Thapa, 2015) and international organisations (National Academy of Sciences, 2012; IPCC, 2014; International Institute for Sustainable Development, 2013) have examined the impact of climate change and found it is already affecting systems, sectors and regions in many different ways. A key feature of climate change impact is that it starts slowly and becomes creepy over time. Among the natural systems, the most vulnerable are the ecosystems owing to threats from sea-level rise, decrease in rainfall, and higher rates of evaporation and transpiration. Pertaining to human systems the most vulnerable include agriculture, particularly in low latitudes due to reduced water availability, and human health, especially in areas with low adaptive capacity. Many biological species on which humans rely on for food, medicine and cultural preservation are at risk of extinction and some have already vanished completely. Rising coral bleaching and widespread coral mortality have resulted in a decline of fish stock. Wild fires are now more rampant and intense in many regions. Many coasts, coastal wetlands, and coastal infrastructure are lost daily due to frequent storms and floods. Extreme heat waves and severe droughts have increased the burden of diseases, malnutrition and poverty. Some disease vectors previously unknown to mankind are now frequent. By devastating the systems on which people rely for livelihood climate change aggravates poverty and morbidity. Often the most at risk in the world by climate change are communities in the Arctic, Africa, the Small Islands States, some parts of Asia and Latin America owing to inadequate infrastructure and know-how to initiate efficient responses against climate change. Consequently, millions of people in these regions are overwhelmed by climate-related armed conflicts that are now destabilising political systems, increasing international security and intensifying tensions within and between countries. For populations in these regions, climate change is a life or death concern.

COVID-19 outbreak came as a bombshell. When it struck Hubei in early December 2019 many misunderstood it to be an ordinary flu while others referred to it as Chinese disease, but in a matter of weeks it had spread worldwide. The infection affects humans, although few cases have been found in animals. The disease has been described as an unprecedented public health challenge because of the high rate of infection and fatality. Most people who were infected developed complications including pneumonia and some severe and fatal respiratory diseases such as acute respiratory distress syndrome and kidney failure. As of mid May 2020, over three million people have been affected and more than two hundred thousand fatality occurring in over 190 countries. Fatality rate is highest among males and people aged above sixty, and lowest among those aged below fifty. However, people of any age with pre-existing conditions such as cardiovascular diseases, diabetes, hypertension, cancer and chronic respiratory diseases are at highest risk of dying from the disease. The period from onset of symptoms to death ranges from two to eight weeks. This implies that some people who are currently infected will die before long and others will recover after hospitalization. Rising number of infected persons has put public health services under enormous pressure to mobilize more equipment and manpower to treat the hospitalized. Some health workers and volunteers on the frontlines have lost their lives due to infection by the virus (Evans, 2020; Ayittley et al., 2020). Since the outbreak many economic activities, including air transport, manufacturing, agriculture, tourism/hospitality and education have closed down and millions of people have lost their jobs. Prices of commodities and services have gone higher in many countries. Uncertainty over what comes next has resulted in high rates of panic, anxiety and depression. The most affected are people in developing countries, owing to poor access to health care and lack of capacity to procure the equipment and medicines to combat the virus. World leaders, scientists, health workers and even ordinary people have expressed the view that nothing of this magnitude had befallen humanity since the end of World War II (European Centre for Disease Control and Prevention, 2020; Lin et al., 2020; United States Centre for Disease Control, 2020; IPCC, 2014; International Institute for Sustainable Development, 2013; Evans, 2020; Ayittley, 2020).

Responses

Complex systems theory also maintains that some problems confronting society do not have permanent solution, and some cases an attempt to solve them create new problems. Climate change affects everyone and combating it is everybody's business. The UNFCCC has proposed a two-pronged approach encompassing mitigation (reducing emission of CO_2 into the atmosphere) and adaptation (adjustments in human and natural systems in response to climate change and its impacts). This is amid caution from climate scientists that even if the amount of CO_2 (the gas suspected to be the main driver of climate change) is reduced today, the processes leading to climate change will not cease. Mitigation has been intensely politicized as many countries are less willing to commit to reduction in CO_2 emission. Policymakers in developing countries urge their counterparts in developed countries to show greater commitment to combating climate change since they are the ones producing large amounts of CO_2 from their heavy industries. Besides, some economic sectors are less willing to commit to adaptation for the reason that commitment in that direction will deny them access to resources needed to sustain their business. Some developing countries have also criticized adaptation policies for undercutting livelihood and exacerbating poverty. While scientists and policymakers are working tediously to come up better option for combating climate change, skeptics are busy publicizing a different reality and giving people false hope (National Academy of Science, 2012; IPCC, 2014; Union of Concerned Scientists, 2018; Carter, 2010). The education sector is playing an important role in developing capacity to combat climate change but its effort is challenged by uncertainty surrounding climate change science, the vast scope of climate change topics and content, inadequate knowledge of teachers regarding climate change science, as well as lack of a pedagogical approach for teaching climate change topics and content (Anyanwu and Grange, 2018; Chang and Pascua, 2017).

Since the outbreak of corona-virus 2019 many world leaders have described it as a common threat to humanity that requires a common approach. Since the outbreak was swift, the initial response was to mitigate the outbreak using a set of guidelines prescribed by the WHO. The guidelines include washing hands regularly with soap and water or alcohol-based hand rub, covering nose and mouth with elbow or disposable tissue when coughing or sneezing, avoiding close contact with individuals suspected to be unwell (social distancing), and staying at home and self-isolating from other people. As the virus spread and fatality increased, other sweeping mitigation measures such as quarantine of suspected persons, nationwide lockdowns, bans on large gatherings, closure of schools and mandatory work-from-home were introduced. Major airlines cancelled flights to and fro international destinations. Some countries banned non-citizens from entering their territories and several more evacuated their citizens overseas, and returnees were quarantined for days and weeks in some cases in an effort to avoid imported infections. In addition, some countries introduced emergency relief funds ranging from millions to trillions of dollars to alleviate the burden of the pandemic on their people and the economy. A number of countries received donation of machines, money and medicines from philanthropic individuals, countries and businesses. International financial donors pledged fiscal support to weaker economies to help them to weather the impacts of the pandemic on their populations (European Centre for Disease Control and Prevention, 2020; Lin et al., 2020; Thapa, 2015; National Academy of Sciences, 2012; Evans, 2020; Ayittley et al., 2020).

Until now, there is no clinically certified antiviral drug or vaccine ready for use against the virus. However, some broad-spectrum antiviral drugs are being tested in clinical trials and clinical recoveries have been observed in few cases (United Nations Statistics Division, 2016; Lin et al., 2020). Owing to the burden of the pandemic on society, some policymakers unwilling to adhere to public health directives and keen to ease restrictions and resume economic activities, but scientists have cautioned against lifting restriction prematurely as that could risk new spikes in infections. The question here is whether focus should be on saving people or saving the economy? Even among vaccine scientists, some maintain that vaccine development takes a long time and caution against hurriedly producing ineffective vaccines. Others are optimistic that with the support of world leaders a vaccine for COVID-19 will be available for mass distribution before the end of 2020. Currently, over one hundred different vaccines for coronavirus are under laboratory trials globally. Until a vaccine is available for mass distribution, restrictions on movement and social interaction will remain a way of life (Crisis Group, 2020; Akpan, 2020; Amanat and Krammer, 2020).

Conclusion

Looking through a complexity theory lens, climate change and COVID-19 outbreak portray some distinctiveness. Climate change is a physical process occurring slowly within the Earth's climate system. It devastates ecological systems everywhere on our planet. Until now, its actual cause is still uncertain. In contrast, COVID-19 outbreak is a biological process occurring in humans and animals, spreads swiftly across continents, has killed millions of people of them, and paralyzed global economy. The virus has been identified, but its source and mode of transmission to humans are uncertain for now. Vulnerabilities created by one could be exacerbated by the other. Their responses are characterized by conflict between science and politics. While climate change is a global environmental concern, COVID-19 outbreak is a public health concern. Both have affected the way we live. While scientific evidence indicates climate change will continue for many decades, vaccine scientists give us the hope that a vaccine ofr COVID-19 will be available before long. Based on these characteristics, climate change and COVID-19 straddle multiple levels of complexity, namely complicated, complex and chaotic; hence they belong to a unique class of problems. Anyone offering solution to problems of this nature should not assume that the strategy for combating one will be suitable for the other; instead effort should be invested on understanding their sources and behaviours first in order to formulate appropriate response strategy. However, when the battle against COVID-19 is finally won, policymakers with vested interest in climate change should reflect whether there are lessons from COVID-19 response strategy that can be incorporated into climate change response strategy. Since this paper is the first scholarly attempt to evaluate two global problems confronting humanity in our time, future research should employ other theoretical frameworks for evaluating societal problems to verify the perspective of this paper.

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