



E-ISSN: 2707-8272
P-ISSN: 2707-8264
IJRCET 2023; 4(1): 01-05
Received: 01-10-2020
Accepted: 05-11-2020

Benjamin Anabaraonye
Institute of Climate Change,
Energy and Environment
Studies, University of Nigeria,
Nsukka, Nigeria

Charles C Anukwonke
Chukwuemeka Odumegwu
Ojukwu University, Uli,
Nigeria

Somkenechi S Unachukwu
Department of Environmental
Management, Nnamdi Azikiwe
University, Awka, Nigeria

Corresponding Author:
Benjamin Anabaraonye
Institute of Climate Change,
Energy and Environment
Studies, University of Nigeria,
Nsukka, Nigeria

Renewable energy infrastructure projects as a veritable tool for enhancing climate resilience in Nigeria

Benjamin Anabaraonye, Charles C Anukwonke and Somkenechi S Unachukwu

Abstract

The use of renewable energy and a lesser reliance on fossil fuels in Nigeria which is in line with the United Nations Paris Agreement will help to reduce the excessive emission of green house gases which is a major cause of global warming and climate change. Excessive emission of greenhouse gases has been discovered to affect the health of individuals, communities and institutions in Nigeria adversely. This study identified that the use of renewable energy which is one of the climate change mitigation strategies will help to enhance good health and well being, increase environmental sustainability and also boost sustainable economic growth in Nigeria. It further identified solar energy as the most promising of the renewable energy sources in view of its apparent limitless potential. This study further highlighted case studies of some renewable energy infrastructure projects in Nigeria. It concluded with the call for more intensive research on the use of renewable energy infrastructure projects as a veritable tool for enhancing climate resilience in Nigeria.

Keywords: Climate resilience, infrastructure projects, renewable energy, sustainable development

Introduction

Renewable energy is defined by the National Renewable Energy and Energy Efficiency Policy (NREEEP) as energy derived from energy sources whose use does not lead to the depletion of the earth's resources (NREEEP, 2015). Renewable energy sources have drawn more attention in recent years, and the Federal Government of Nigeria's (FGN) electrical strategy is beginning to emphasize them. As a result, the NERC and the REA both played crucial roles in the establishment of policy and regulatory mechanisms meant to encourage investment in renewable energy industry in Nigeria (Esan *et al.*, 2021) ^[19]. The renewable energy infrastructure projects which will help to decrease the nation's reliance on fossil fuels is also a mitigation strategy for which will enhance climate resilience in Nigeria. The Intergovernmental Panel on Climate Change (IPCC) defines climate change as statistical variations that persist for an extended period, typically decades or longer. Similarly, they define adaptation as the "adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to natural or human systems adjusting to actual stimuli or their effects that reduce harm or exploit beneficial opportunities. Various types of adaptation can be famed, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation (IPCC, 2001) ^[24]. Climate mitigation is any action adopted to reduce the long-term risk and hazards of climate variations to human life, property and society. The Intergovernmental Panel on Climate Change (IPCC) described mitigation as: "An anthropogenic intervention to suppress the causes or enhance the sinks of greenhouse gases "(IPCC 2001; GGW, 2018) ^[24]. Climate resilience is the capacity of a socio-ecological system to absorb pressures and maintain function in the face of external stresses resulting from climate change (Folke *et al.*, 2010; Moench, 2014; Shamsuddin, 2020) ^[21, 26, 30]. It also includes the ability and capacity of an ecosystem to adapt, reorganize, and evolve into more desirable configurations that improve the system's sustainability, leaving it better prepared for future climate impacts (Carpenter *et al.*, 2001; Folke, 2006) ^[15, 20]. In order to provide sustainable energy in Nigeria at competitive pricing, the Climate Investor One (CIO) program receives additional funding from the Nigeria Renewable Energy Programme (NREP) (EC, 2020). CIO is a blending finance facility with an overall budget of €115.1 million and an EU commitment of €10.1

million in 2020. It is intended to offer whole-of-life financing for renewable energy infrastructure in developing nations like Nigeria. The Nigeria Renewable Energy Programme (NREP), which focuses on centralized energy solutions, including off-grid programs, is anticipated to: Provide Nigerians with access to inexpensive, sustainable energy; develop, fund, and build an additional 150+ MW of capacity; Identify and address market weaknesses related to finance for investments in renewable energy technology in developing markets; help cut down on greenhouse gas (GHG) emissions while leveraging significant direct private sector investment into emerging markets like Nigeria. The development of technology able to use various sources of energy is primarily responsible for the explosive expansion of the renewable energy sector in Nigeria (Obasoyo, 2022) [27]. The shift to renewable energy is now seen as a support, rather than a replacement, for the more conventional source of income (oil) in Nigeria. The emphasis on renewable energy sources has increased in the Nigerian government's electrical strategy. To encourage investment in renewable energy, policy and regulatory tools have been established. The primary law establishing the sector's legal and regulatory framework is the Electric Power Sector Reform Act of 2005 (EPSRA). The Nigerian Electricity Regulatory Commission (NERC) was founded by the EPSRA as the industry's regulator and is given authority to issue rules, regulations, and policies (Obasoyo, 2022) [27]. The Nigerian government launched the Solar Power Naija Project in 2020 with the intention of supplying 5 million off-grid villages with solar-powered connections. According to estimates, the initiative will affect 25 million homes and generate 250,000 jobs. The Nigerian government started work on the project in Jigawa State in April 2021, with an estimated cost of US\$620 million. The Central Bank of Nigeria has also established a solar intervention fund that offers loan providers of renewable energy projects low-interest loans (5% interest) of up to 500 million naira. The US-EXIM Bank granted Nigeria a \$1.5 billion loan to expand the country's solar power infrastructure in ten distinct areas, according to Adam Cortese, CEO of SUN Africa LLC in the United States. (Elumoye, 2022) [18]. Additionally, it creates the Rural Electrification Agency (REA), which is in charge of establishing isolated mini-grid systems, extending the main grid, and encouraging the production of electricity from renewable sources. To ensure more equal regional access to electricity, the REA, which manages the Rural Electrification Fund (REF), is in charge of promoting, supporting, and putting rural electrification plans into action. The United States Agency for International Development (USAID) and Power Africa's Renewable Energy and Energy Efficiency Project (REEEP) in Nigeria, which provided renewable energy to 261,938 Nigerians through 16,600 connections and decreased carbon emissions, are two projects that have been aimed at developing the renewable energy industry in Nigeria (Obasoyo, 2022) [27]. The Nigerian Federal Ministry of Power also invited qualified bidders to submit a tender in 2020 for the construction of different off-grid solar infrastructure projects and other energy infrastructure around the nation. One of the solar sectors with the fastest growth rates worldwide is the Nigerian solar energy subsector (Adegbite, 2021) [1]. With a mean generating capacity factor of 27%, the daily solar energy density is approximately 12.6 MJ/m²/day in the southern region and

25.2 MJ/m²/day in the far north, near to the Sahara (Ohunakin *et al.*, 2014; Anon, 2015) [28, 7]. Ilorin and Maiduguri's capacity factors estimates of the production effectiveness of energy systems are calculated to be 25.85% and 28.67%, respectively, for these selected sites within the nation (Adewuyi *et al.*, 2020) [3]. In order to distribute electricity utilizing solar-powered plants, the Nigerian Electrification Programme (NEP) was introduced in 2019. For the project's implementation, the federal government, working through the Rural Electrification Agency (REA), obtained funds from the World Bank, African Development Bank, Africa Growing Together Fund, and European Union. With this investment, at least 90 million Nigerians and business owners will have access to affordable renewable energy (Obasoyo, 2022) [27]. Michaelmas Chambers (2021) [25] claims that there are several types of renewable energy infrastructure. In terms of hydropower energy production, Nigeria has some noteworthy hydropower infrastructure in Niger State at Kainji, Jebba, and Shiroro. According to data for the northern and central parts of Nigeria, which are rich in solar energy, the estimated generation potential for solar PV is roughly 43,000 MW (Africa-EU Energy Partnership, 2015), of which only a very small portion has yet to be used. Compared to other VREs, solar energy research and development (R&D) activities have received more attention in Nigeria because to its comparatively simple technology and adequate capacity factor (Giwa *et al.*, 2017) [22]. In 2017, the federal government spent over \$20 billion on new solar projects, and Kaduna state has been chosen as the location for a private company's 30 MW solar farm project (Ayemba, 2017; Bulbulia, 2018) [11, 12]. A pilot wind farm is being built at Katsina, and there is some potential for producing wind energy in the country's north and along its coast (Oyedepo *et al.*, 2012; Brimmo *et al.*, 2017) [29, 14].

A total of \$150 million worth of solar equipment was imported in 2019. An estimated \$2 billion of Nigeria's \$9 billion yearly market for solar home systems and mini-grids goes toward solar home systems. Significant financial resources have been devoted to the development and expansion of solar energy solutions in Nigeria through the Rural Electrification Agency (REA) and private non-profit organizations including Shell-backed AllOn, IFC, and The Rockefeller Foundation. In remote regions, REA will have installed over 6,000 solar residential systems and seven mini-grids by 2020 (Adegbite, 2021) [1].

In 2019, AllOn Hub offered off-grid energy entrepreneurs a \$3.5 million grant as part of a partnership with The Rockefeller Foundation to help them scale their firms at the ideation, growth, and market entry stages. The same year, through the Nigeria Off-Grid Energy Challenge, both organizations gave \$50,000 in angel stage funding to Nigerian off-grid energy companies so they could reach communities without access to current power grids. This was done in collaboration with the U.S. African Development Foundation (USADF) (Adegbite, 2021) [1]. Despite these noteworthy advancements, the solar energy industry is still in its infancy, with a total installed capacity of just 28MW. One key obstacle facing renewable energy technology is the hefty upfront cost.

An enormous increase in renewable energy (particularly solar and wind) projects has been seen in many nations as a result of this worldwide paradigm shift and different legislative actions by governments to encourage their development and finance. Even for a nation like Nigeria,

where renewable energy has always been a part of the energy mix (approximately 12.5% of its on-grid energy comes from hydropower), the present trend offers a chance to promote and draw in sustainable investment to its energy industry. (Esan *et al.*, 2021) ^[19] to boost its perpetual abundance. Generally, this paper aimed to examine the “the use of renewable energy infrastructure projects as a veritable tool for enhancing climate resilience in Nigeria”. This paper examined current progress with the use of renewable energy infrastructure projects which is a climate change mitigation strategy in Nigeria through existing literature review.

Methodology

Data used for this study is derived from published works, including academic journal articles, conference papers, textbooks and internet materials. The researchers gathered a lot of materials for the research but summarized the characteristics of the papers that centered more on “the use of renewable energy infrastructure projects as a veritable tool for enhancing climate resilience in Nigeria”. This enabled the researchers to generate the synthesis of various researchers’ views on the subject matter.

Results and Discussion

Just about 59.3% of Nigerians have access to electricity which is not stable and most are forced to resort to rely on alternate sources of energy which are unclean and have deleterious climatic effects. Similarly, only about 28.2% of the population primarily rely on clean energy and technologies for cooking. This however is not surprising as 62.6% of Nigerians were recorded as living below the poverty line and for this subset of the population, the primary concern would be survival and food security rather than the choice of technology for cooking due to cost (Ajator, Anabaraonye & Ewa, 2020) ^[5]. Nigeria wants to cut its greenhouse gas (GHG) emissions by at least 47% by 2030, subject to certain conditions. The nation's nationally determined contributions (NDCs) under the Paris Agreement include the following goals: achieving zero gas flaring by 2030; reducing fugitive emissions from oil and gas production by 60% by 2031; and ensuring that 30% of on-grid electricity and 13 gigawatts of off-grid energy are derived from renewable sources. It is estimated that the NDCs will cost USD 177 billion to implement. In order to meet the anticipated rise in global demand, Nigeria is now attempting to introduce a carbon price and plans to develop its essential mineral reserves. (EITI, 2021). Recognizing the consequences and adverse impact of climate change on Nigeria, the country joined the global community to adopt treaties developed to tackle climate change. Nigeria became a Party to the UNFCCC in 1992 and ratified the Convention in 1994, it also became a Party to the Kyoto Protocol in 2004. Nigeria ratified the Paris Agreement (PA) in March 2017, which was approved by the UNFCCC on the 16th May 2017 and entered into force on 15th June 2017 (Manso & Behmiri, 2013) In June 2017, the Federal Government of Nigeria and the United Nations Development Program (UNDP) flagged off a \$218 million renewable energy project. This project was aimed at reducing greenhouse gas emissions by meeting the energy targets set in the NDC (Ajator, Anabaraonye & Ewa, 2020) ^[5].

How renewable energy infrastructure projects can achieve sustainable development in Nigeria

In Nigeria, the limitless potentials of the renewable energy sources are yet to be fully utilized and maximized (Adewuyi *et al.*, 2019) ^[2]. There is no question that Nigeria has a lot of untapped renewable energy potential that has appeared to be constrained throughout time by a number of factors. To stimulate the continuous growth of renewables into the economy's energy mix, the public sector, industry players, investors, and other stakeholders are, however, quickly developing frameworks and programs, as was previously indicated (Esan, *et al.*, 2021) ^[19]. The establishment of the necessary energy framework required to power Nigeria's renewable energy infrastructure projects depends on the availability of investment funding. However, even though the necessary financial assistance may not always be accessible or may be subject to prohibitive conditions when it is available, specific steps can be taken at the non-governmental and governmental levels to promote energy sustainability in Nigeria and other sub-Saharan African countries (Anabaraonye *et al.*, 2021) ^[6]. Setting up a profit/benefit-oriented investment environment with beneficial regulations and legal paperwork that will support environmental sustainability while pursuing energy sustainability, such as alternatives in green entrepreneurship, is one way to attain this renewable energy efficiency (Anabaraonye *et al.*, 2021) ^[6]. With minimal negative financial and socio-political repercussions, these circumstances will entice investors in both domestic and international alternative energy sources. Domestic consumers will be encouraged to participate in any way they can because current laws and policies will safeguard their rights and interests on a national and personal level (Adewuyi *et al.*, 2019) ^[2]. Increased investment in hydropower technology is planned in terms of returns on investment, operation and maintenance, scale economies, and other factors, hydropower continues to be among the most dependable energy sources. Therefore, increasing investment in hydroelectric power plants can greatly aid in achieving environmental and energy sustainability. Utilizing the available energy resources to their fullest potential is known as energy resource management. These energy carriers are frequently ignored, allowed to waste, and become a nuisance to the environment. Renewable energy sources in Nigeria have potential wastes that should be utilized. The ability to produce effective renewable energy will be lacking until this is accomplished in Nigeria.

Diverse energy resource management strategies, such as the implementation of effective waste-to-energy models for the disposal of agricultural wastes and some non-toxic/organic biological wastes from household and industrial wastes, are honorable initiatives with promise for renewable energy. Through the installation of a 100 kVA refuse-derived fuel (RDF) gasification power plant on their main campus, the University of Nigeria, Nsukka has led this initiative (Anon, 2019) ^[8]. Therefore, energy conservation focuses on maximizing the benefits from the energy output that is now accessible by reducing waste and making smart use of energy that has been sent (Askari *et al.*, 2015) ^[10]. Ajator, Anabaraonye & Ewa (2020) ^[5] identified the solar energy as the most promising of the renewable energy sources in view of its apparent limitless potential. They further identified the health and economic benefits of the use of solar energy across various communities and institutions for sustainable

development in Nigeria (Ajator, Anabaraonye & Ewa, 2020) [5]. As a deliberate strategy to hasten the adoption of renewable energy, there is a need. to increase investor incentives for promoting renewable energy. Although Nigeria's current regulatory framework for renewable energy is commendable, additional leadership enablers need to be fixed in order to improve process flow and policy execution across the many operators in the renewable energy infrastructure (Ajator, Anabaraonye & Ewa, 2020) [5]. To build Nigeria's renewable energy sector, the country's policy framework, which consists of legal, fiscal, and regulatory instruments, must be perfectly aligned with both domestic and foreign investment requirements. Meeting the goals of the Paris Agreement will need a fundamental shift toward renewable energy sources like solar and wind (UNFCCC, 2019) [31]. The Paris Agreement is a global climate change agreement that was ratified by 196 Parties at COP 21 in Paris six years ago. Its objectives are to keep climate change and the accompanying global warming below 1.5°C compared to pre-industrial levels. As a result, the Paris Agreement is a turning point in the complex process of addressing climate change because it was the first to provide a legally enforceable commitment for all signatory countries to mainstream efforts to fight climate change and prepare for its hazards.

Recommendations

The Nigerian government should

- A) Undertake risk assessment and risk reduction measures to increase resilience of the renewable energy infrastructure projects in Nigeria.
- B) Develop and diversify secure energy backup systems to ensure both civil society and security forces have access to emergency energy supply through the renewable energy technology.
- C) Encourage and fund further research projects to enable researchers and scientists to fully explore the use of the renewable energy infrastructure projects as a veritable tool to enhance climate resilience in Nigeria.
- D) Individuals, Communities and Institutions in Nigeria should be well educated using innovative tools such as poetry, music, educational blog, social media, etc. on the use of renewable energy infrastructure projects to enhance climate resilience in Nigeria.

Conclusion

The Paris Agreement is a significant milestone for Nigeria's efforts to mitigate the effects of climate change and a step toward achieving its de-carbonization targets, which look at ways to reduce GHG emissions and advance the goal of achieving net-zero GHG emissions through various strategies like carbon crediting (Anukwonke and Abazu, 2020) [9] including the renewable energy infrastructure projects. Furthermore, The Nigerian Government should provide financial frameworks aimed at stimulating the expansion of the renewable energy electricity market. Considering the risk element involved in financing renewable energy infrastructure projects, Nigerian government investments should enhance rates of return and develop new policies in order to attract more investors into the renewable energy industry to enhance climate resilience in Nigeria.

References

1. Adegbite T. Where's Nigeria Headed with Renewable Energy?; c2021. <https://www.thisdaylive.com/index.php/2021/11/14/wheres-nigeria-headed-with-renewable-energy/>
2. Adewuyi OB, Lotfy ME, Akinloye BO, Howlader HOR, Senjyu T, Narayanan K. Security-constrained optimal utility-scale solar PV investment planning for weak grids: Short reviews and techno-economic analysis. *Appl. Energy.* 2019;245:16-30. <http://dx.doi.org/10.1016/j.apenergy.2019.04.008>, <http://www.sciencedirect.com/science/article/pii/S0306261919306336>.
3. Adewuyi OB, Kiptoo MK, Afolayan AF, Amara T, Alawode OI, Senyu T. Challenges and prospects of Nigeria's sustainable energy transition with lessons from other countries experiences *Energy Reports.* 2020;6:993-1009
4. Africa-EU Energy Partnership. Nigeria Renewable Energy Potential. European Union and the African Union; c2015.
5. Ajator C, Anabaraonye B, Ewa B. The Health Benefits in the Use of Solar Energy for Sustainable Development in Nigeria. *EC Emergency Medicine and Critical Care.* 2020;4(2):01-06.
6. Anabaraonye B, Ewa BO, Anukwonke CC, Eni M, Anthony PC. The Role of Green Entrepreneurship and Opportunities in Agripreneurship for Sustainable Economic Growth in Nigeria. *Covenant Journal of Entrepreneurship,* 2021, 5(1). ISSN: p.2682-5295
7. Anon. Today in Energy: Electric Generator Capacity Factors Vary Widely Across the World. U.S. Energy Information Administration (EIA); c2015. <https://www.eia.gov/todayinenergy/detail.php?id=22832>.
8. Anon. UNN Becomes the first Nigerian university to generate its own electricity using organic waste, 2019. <https://witnesta.com/2019/03/20/unnbecomes-the-first-nigerian-university-to-generate-its-own-electricityusing-organic-waste.html>.
9. Anukwonke CC, Abazu CI. Green Business through Carbon Credit. In *Climate Change Alleviation for Sustainable Progression: Floristic Prospective and Arboreal Avenues as a Viable Sequestration Tool.* Science Publishers CRC Press Taylor and Francis Boca Raton, USA; c2020. ISBN: 9780367618872
10. Askari IB, Sadegh MO, Ameri M. Energy management and economics of a trigeneration system considering the effect of solar PV, solar collector and fuel price. *Energy Sustain. Dev.* 2015;26:43–55., <http://www.sciencedirect.com/science/article/pii/S0973082615000265>
11. Ayemba D. Natural Nigeria Invests US \$ 20 bn in 20 New Solar Power Projects. *Construction Review Online;* c2017. <https://constructionreviewonline.com/2017/12/nigeria-invests-us-20bn-20-new-solar-projects/>
12. Bulbulia T. DLO Energy resources invests in 30 MW solar plant in Nigeria; c2018.
13. http://www.engineeringnews.co.za/article/dlo-energy-resources-investsin-30-mw-solar-plant-in-nigeria-2018-12-10/rep_id:4136.
14. Brimmo AT, Sodiq A, Sofela S, Kolo I. Sustainable energy development in Nigeria: Wind, hydropower,

- geothermal and nuclear (vol. 1). *Renew. Sustain. Energy Rev.* 2017;74:474–490.
<http://dx.doi.org/10.1016/j.rser.2016.11.162>,
<http://www.sciencedirect.com/science/article/pii/S1364032116309169>.
15. Carpenter S, Walker B, Anderies JM, Abel N. From Metaphor to Measurement: Resilience of What to What? *Ecosystems.* 2001;4(8):765-781.
<https://doi.org/10.1007/s10021-001-0045-9>
 16. EC. European Commission, Europa external investment plans and projects including renewable energy programme. Facts Sheet in Gazette; c2020.
https://ec.europa.eu/eu-external-investment-plan/projects/nigeria-renewable-energy-programme-nrep_enit
 17. EITI. Nigeria, Pathways to energy transition Using EITI data and dialogue. Overview of how the EITI can support Nigeria in addressing the economic implications of the energy transition; c2021.
<https://eiti.org/documents/nigeria-pathways-energy-transition>
 18. Elumoye D. Nigeria Secures 1.5 Billion from US to Boost Solar Power Infrastructure; c2022.
<https://www.thisdaylive.com/index.php/2022/08/05/nigeria-secures-1-5bn-loan-from-us-to-boost-solar-power-infrastructure/>
 19. Esan W, Akinola J, Onakoya D, Monnou G. Renewable Energy in Nigeria: law, regulation, trends and opportunities, International Bar Association; Reference Update; c2021.
 20. Folke C. Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change.* 2006;16(3):253–267.
<https://doi.org/10.1016/j.gloenvcha.2006.04.002>
 21. Folke C, Carpenter SR, Walker B, Scheffer M, Chapin T, Rockström J. Resilience Thinking: Integrating Resilience, Adaptability and Transformability. *Ecology and Society,* 2010, 15(4).
<https://doi.org/10.24926/ijps.v7i2.338612>
 22. Giwa A, Alabi A, Yusuf A, Olukan T. A comprehensive review on biomass and solar energy for sustainable energy generation in Nigeria. *Renew. Sustain. Energy Rev.* 2017;69:620–641.
<http://dx.doi.org/10.1016/j.rser.2016.11.160>,
<http://www.sciencedirect.com/science/article/pii/S1364032116309108>.
 23. Global Greenhouse Warming. Climate mitigation and adaptation, 2018. <http://www.global-greenhouse-warming.com/climate-mitigation-and-adaptation.html>
 24. IPCC. Climate change 2001: the scientific basis. Contribution of working group 1 to the third assessment report of the intergovernmental panel on climate change. Published by the press syndicate of the University of Cambridge, The Pitt Building, Trumping Street, Cambridge, United Kingdom. First published, 2001.
https://ipcc.ch/ipccreports/tar/wg1/pdf/WGI_TAR_full_report.pdf
 25. Michaelmas Chambers. Renewable Energy Deployment in Nigeria, 2021.
<https://www.michaelmaschambers.com/insight-page.php?i=20&a=renewable-energy-deployment-in-nigeria>
 26. Moench M. Experiences applying the climate resilience framework: linking theory with practice. *Development in Practice.* 2014;24(4):447-464.
 27. Obasoyo O. Nigeria: Regulating Renewable Energy in Nigeria; c2022.
<https://www.mondaq.com/nigeria/renewables/1175982/regulating-renewable-energy-in-nigeria>.
 28. Ohunakin OS, Adaramola MS, Oyewola OM, Fagbenle RO. Solar energy applications and development in Nigeria: Drivers and barriers. *Renew. Sustain. Energy Rev.* 2014;32:294-301.
<http://dx.doi.org/10.1016/j.rser.2014.01>.
 29. Oyedepo SO. On energy for sustainable development in Nigeria. *Renew. Sustain. Energy Rev.* 2012;16(5):2583-2598,
<http://www.sciencedirect.com/science/article/pii/S1364032112001037>.
 30. Shamsuddin S. Resilience resistance: The challenges and implications of urban resilience implementation. *Cities.* 2020;103:102763.
<https://doi.org/10.1016/j.cities.2020.102763>
 31. UNFCCC. For every dollar invested in climate-resilient infrastructure six dollars are saved, Secretary-General says in message for disaster risk reduction day. United Nations; c2019.
<https://www.un.org/press/en/2019/sgsm19807.doc.htm#>