

# **Tackling Climate Change through Science and Technology**

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**Kariuki Muigua**

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## **Tackling Climate Change through Science and Technology**

**Kariuki Muigua\***

### **Abstract**

*This paper critically explores the role of science and technology in tackling climate change. It argues that science and technology can enhance the global response to climate change. The paper examines ways through which countries have embraced science and technology to combat climate change. It further explores some of the problems hindering effective use of science and technology in the global response to climate change. Finally, the paper proposes reforms towards enhanced use of science and technology in tackling climate change.*

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## **1.0 Introduction**

Climate change has been described as the most defining challenge of our time<sup>1</sup>. It is a major global concern that is affecting both developed and developing countries in their efforts towards realization of the Sustainable Development agenda<sup>2</sup>. The United Nations 2030 Agenda for Sustainable Development acknowledges that climate change is one of the greatest challenges of our time and its adverse impacts undermine the ability of all countries to achieve Sustainable Development<sup>3</sup>. The impacts of climate change such as intense droughts, water scarcity, severe fires, rising sea levels, flooding, melting polar ice, catastrophic storms and declining biodiversity are being witnessed across the world threatening the achievement of Sustainable Development<sup>4</sup>. It has been argued that if left unchecked, climate change will undo a lot of the development progress made over the past years and will also provoke mass migrations that will lead to instability and wars<sup>5</sup>.

As a result of the foregoing concerns, tackling climate change has become a top policy agenda, at local, national, and global levels<sup>6</sup>. There have been global calls on governments and all other stakeholders to put in place measures towards responding to the threat of climate change and ensuring that economies are climate resilient<sup>7</sup>. Tackling climate change is one of the fundamental goals under the United Nation's 2030 Agenda for Sustainable Development with Sustainable Development Goal 13 calling upon countries to take urgent actions towards combating climate change and its impacts<sup>8</sup>.

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<sup>1</sup> United Nations., 'What is Climate Change?' Available at

<https://www.un.org/en/climatechange/what-is-climate-change> (Accessed on 25/10/2023)

<sup>2</sup> Muigua. K., 'Achieving Sustainable Development, Peace and Environmental Security.' Glenwood Publishers Limited, 2021

<sup>3</sup> United Nations General Assembly., 'Transforming Our World: the 2030 Agenda for Sustainable Development.' 21 October 2015, A/RES/70/1

<sup>4</sup> United Nations., 'What is Climate Change?' Op Cit

<sup>5</sup> United Nations., 'Goal 13: Take Urgent Action to Combat Climate Change and its Impacts.' Available at <https://www.un.org/sustainabledevelopment/climate-change/> (Accessed on 25/10/2023)

<sup>6</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Available at <https://www.un.org/en/desa/forum-climate-changeandscience-and-technology-innovation> (Accessed on 25/10/2023)

<sup>7</sup> Muigua. K., 'Achieving Sustainable Development, Peace and Environmental Security.' Glenwood Publishers Limited, 2021

<sup>8</sup> United Nations., 'Goal 13: Take Urgent Action to Combat Climate Change and its Impacts.' Op Cit

## *Tackling Climate Change through Science and Technology*

The world is tackling climate change through two fundamental approaches: mitigation and adaptation<sup>9</sup>. Mitigation involves reducing greenhouse gas emissions and stopping the problem of climate change from worsening<sup>10</sup>. Adaptation on the other hand involves learning how to live with the existing threat of climate change and protecting humanity from the future effects of climate change<sup>11</sup>. It has been observed that the reality of global climate change has heightened the critical importance of science and technological innovation to achieve the Sustainable Development Goals<sup>12</sup>. Science and technology can therefore enhance climate change mitigation and adaptation<sup>13</sup>.

This paper critically explores the role of science and technology in tackling climate change. It argues that science and technology can enhance the global response to climate change. The paper examines ways through which countries have embraced science and technology to combat climate change. It further explores some of the problems hindering effective use of science and technology in the global response to climate change. Finally, the paper proposes reforms towards enhanced use of science and technology in tackling climate change.

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<sup>9</sup> World Vision., 'How is the World Responding to Climate Change?' Available at [https://www.worldvision.com.au/docs/default-source/school-resources/how-is-the-worldrespondingto-climate-change.pdf?sfvrsn=32021b89\\_0](https://www.worldvision.com.au/docs/default-source/school-resources/how-is-the-worldrespondingto-climate-change.pdf?sfvrsn=32021b89_0) (Accessed on 25/10/2023)

<sup>10</sup> Ibid

<sup>11</sup> Ibid

<sup>12</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>13</sup> Ibid

## **2.0 Role of Science and Technology in Tackling Climate Change**

As the impacts of climate change continue to intensify, both developed and developing countries must embrace innovative strategies to strengthen their response to this threat<sup>14</sup>. The United Nations asserts that the reality of global climate change has heightened the critical importance of science and technological innovation to strengthen the global response to this problem and achieve the SDGs<sup>15</sup>. It further opines that an effective and sustainable response to climate change demands the best, most up-to-date scientific assessments of the issue, made in a holistic and multi-disciplinary way<sup>16</sup>. Science and technology can enhance the global response to climate change by strengthening adaptive capacity of countries<sup>17</sup>.

It has been pointed out that despite scientific and technological innovations being among the key drivers of climate change, they can play a positive role by being at the forefront in the global battle against climate change<sup>18</sup>. Scientific and technological innovations, especially the discovery and use of fossil fuels, have contributed to climate change but they have also allowed humanity to become aware of our impact on the planet and develop scientific and technological responses to address the climate crisis<sup>19</sup>. Science is therefore essential for understanding climate change and technology is critical in tackling the problem<sup>20</sup>.

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<sup>14</sup> Ospina. A., & Heeks. R., 'ICTs and Climate Change Adaptation: Enabling Innovative Strategies.' Available at <https://www.unapcict.org/sites/default/files/2019-01/ICTs%20and%20Climate%20Change%20Adaptation.pdf> (Accessed on 26/10/2023)

<sup>15</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>16</sup> Ibid

<sup>17</sup> Ospina. A., & Heeks. R., 'ICTs and Climate Change Adaptation: Enabling Innovative Strategies.' Op Cit

<sup>18</sup> Telecom Review., 'How ICTs Can Tackle the Climate Crisis.' Available at <https://www.telecomreview.com/articles/reports-and-coverage/3733-how-icts-can-tackle-the-climate-crisis#:~:text=The%20biggest%20impact%20ICT%20players,solutions%20that%20reduce%20energy%20use> (Accessed on 26/10/2023)

<sup>19</sup> Sky News., 'Climate Change: Seven Technology Solutions that Could Help Solve Crisis.' Available at <https://news.sky.com/story/climate-change-seven-technology-solutions-that-could-help-solve-crisis-12056397> (Accessed on 26/10/2023)

<sup>20</sup> Allison. S., & Miller. T., 'Why Science Needs the Humanities to Solve Climate Change.' Available at <https://uci.edu/brilliant/human-experience/humanities/science-needs-the-humanities-to-solve-climate-change.php> (Accessed on 26/10/2023)

The role of science and technology in tackling climate change is enshrined in various legal and policy instruments on climate change at the global, regional and national levels. The *United Nations Framework Convention on Climate Change (UNFCCC)* which is the principle global legal instrument on climate change requires all parties to promote and cooperate in the development, application and diffusion, including transfer, of technologies that control, reduce or prevent anthropogenic emissions of greenhouse gases<sup>21</sup>. The UNFCCC further obliges the developed country parties to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other parties, particularly developing country parties, to enable them to implement the provisions of the Convention<sup>22</sup>. The UNFCCC therefore sets the centre stage for the use of science and technology in tackling climate change by advocating for climate technology development and transfer.

The *Kyoto Protocol* was adopted in 1997 in order to operationalize the UNFCCC by committing industrialized countries and economies in transition to limit and reduce greenhouse gas emissions in accordance with agreed individual targets<sup>23</sup>. The Protocol requires all parties to cooperate in the promotion of effective modalities for the development, application and diffusion of, and take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies in particular to developing countries<sup>24</sup>. It further requires parties to cooperate in scientific and technical research towards tackling climate change<sup>25</sup>.

The *Paris Agreement*<sup>26</sup> further envisages the use of science and technology in confronting climate change. The Agreement recognizes the need for an effective and progressive

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<sup>21</sup> United Nations Framework Convention on Climate Change., United Nations, 1992., Article 4 (1) (c) Available at <https://unfccc.int/resource/docs/convkp/conveng.pdf> (Accessed on 26/10/2023)

<sup>22</sup> Ibid, Article 4 (5)

<sup>23</sup> United Nations Framework Convention on Climate Change., 'Kyoto Protocol to the United Nations Framework Convention on Climate Change.' Available at <https://unfccc.int/resource/docs/convkp/kpeng.pdf> (Accessed on 26/10/2023)

<sup>24</sup> Ibid, Article 10 (c)

<sup>25</sup> Ibid, Article 10 (d)

<sup>26</sup> United Nations Framework Convention on Climate Change., 'Paris Agreement.' Available at [https://unfccc.int/sites/default/files/english\\_paris\\_agreement.pdf](https://unfccc.int/sites/default/files/english_paris_agreement.pdf) (Accessed on 26/10/2023)

response to the urgent threat of climate change on the basis of the best available scientific knowledge<sup>27</sup>. It also requires countries to cooperate towards tackling climate change through measures such as strengthening scientific knowledge on climate, including research, systematic observation of the climate system and early warning systems, in a manner that informs climate services and supports decision-making<sup>28</sup>. In addition, the Paris Agreement acknowledges the importance of technology for the implementation of mitigation and adaptation actions and requires parties to fully realize technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions<sup>29</sup>.

The role of science and technology in tackling climate change is therefore upheld by global legal instruments on climate change including the UNFCCC, the Kyoto Protocol and the Paris Agreement. Implementing the provisions of these instruments is important in enhancing the use of science and technology in tackling climate change.

In Africa, the *Science, Technology and Innovation Strategy for Africa*<sup>30</sup> recognizes the role of science, technology and innovation in policy debate in areas including biosafety, climate change mitigation and adaptation, biodiversity and environment regulation. It requires Africa to embrace science, technology and innovation in tackling climate change in order to build its response capacities and capabilities and leverage existing relationships with relevant partners outside the Continent<sup>31</sup>.

Further, the African Union *Agenda 2063* envisages the use of science and technology to tackle climate change in Africa and requires African countries to transition to low carbon economies through approaches such as climate smart agriculture and energy

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<sup>27</sup> Ibid, Preamble

<sup>28</sup> Ibid, Article 7 (7) (c)

<sup>29</sup> Ibid, Article 10

<sup>30</sup> Africa Union., 'Science, Technology and Innovation Strategy for Africa, 2024.' Available at [https://au.int/sites/default/files/documents/38756-doc-stisa\\_science\\_tech\\_innovation\\_strategy.pdf](https://au.int/sites/default/files/documents/38756-doc-stisa_science_tech_innovation_strategy.pdf) (Accessed on 26/10/2023)

<sup>31</sup> Ibid

development<sup>32</sup>. Agenda 2063 captures the ideal of environmentally sustainable and climate resilient economies and communities in Africa which is to be achieved through measures such as clean technologies including renewable energy<sup>33</sup>. It also envisages the use of space based technologies to combat climate change in Africa through climate forecast among other measures<sup>34</sup>.

The role of science and technology in tackling climate change in Africa is also espoused under the *Nairobi Declaration on the African Process for Combating Climate Change*<sup>35</sup>. The Declaration requires African countries and the international community to increase support to Africa in the areas of technology development and transfer including support for South-South transfer of scientific knowledge, in particular indigenous knowledge in order to strengthen the response to climate change in Africa<sup>36</sup>. It also requires African countries to scale up capacity building in science and technology in order to enhance climate change mitigation and adaptation in the continent<sup>37</sup>. According to the Nairobi Declaration, extensive technology transfer, acquisition and diffusion and a much increased rate of innovation are needed in order to effectively tackle climate change in Africa<sup>38</sup>. The Nairobi Declaration envisages enhancing technology development and transfer, including hard technologies such as drip irrigation, water harvesting, drought-resistant crop varieties, renewable energy technologies, building technologies; and soft technologies such as knowledge, systems, procedures, best practices in order to tackle climate change in Africa<sup>39</sup>.

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<sup>32</sup> Africa Union., 'Agenda 2063: The Africa we Want.' Available at [https://au.int/sites/default/files/documents/33126-doc-framework\\_document\\_book.pdf](https://au.int/sites/default/files/documents/33126-doc-framework_document_book.pdf) (Accessed on 26/10/2023)

<sup>33</sup> Ibid

<sup>34</sup> Ibid

<sup>35</sup> United Nations Environment Programme., 'Nairobi Declaration on the African Process for Combating Climate Change.' Available at [https://wedocs.unep.org/bitstream/handle/20.500.11822/25791/Nairobi\\_Decl\\_climate.pdf?sequence=1&isAllowed=y](https://wedocs.unep.org/bitstream/handle/20.500.11822/25791/Nairobi_Decl_climate.pdf?sequence=1&isAllowed=y) (Accessed on 26/10/2023)

<sup>36</sup> Ibid

<sup>37</sup> Ibid

<sup>38</sup> Ibid

<sup>39</sup> Ibid

Actualizing the provisions of Agenda 2063; the Science, Technology and Innovation Strategy for Africa, 2024; and the Nairobi Declaration on the African Process for Combating Climate Change will foster the use of science and technology in responding to climate change in Africa.

In Kenya, the *Climate Change Act*<sup>40</sup> also upholds the role of science and technology in tackling climate change. One of the key objects of the Act is to promote low carbon technologies, improve efficiency and reduce emissions intensity by facilitating approaches and uptake of technologies that support low carbon, and climate resilient development in Kenya<sup>41</sup>. The Act requires the response to climate change in Kenya as enshrined under National Climate Change Action Plan to be informed by scientific knowledge on climate change and technology and innovations relevant to climate change<sup>42</sup>. The Act also requires Kenya to strengthen its approaches to climate change research and development training and technology transfer in order to enhance the response to climate change<sup>43</sup>. The Climate Change Act has since been amended by the *Climate Change (Amendment) Act 2023*<sup>44</sup> in order to enhance climate change mitigation and adaption measures in Kenya through the concept of carbon markets and trading. Carbon trading can accelerate technologies and projects geared towards reduction of greenhouse gas emissions in Kenya<sup>45</sup>.

Further, the *Science, Technology and Innovation Act*<sup>46</sup> is an Act of Parliament to facilitate the promotion, co-ordination and regulation of the progress of science, technology and innovation of the country; to assign priority to the development of science, technology and innovation; to entrench science, technology and innovation into the national

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<sup>40</sup> Climate Change Act, No. 11 of 2016, Laws of Kenya

<sup>41</sup> Ibid, S 3 (2) (g)

<sup>42</sup> Ibid, S 13 (5) (a)

<sup>43</sup> Ibid

<sup>44</sup> Climate Change (Amendment) Act, 2023, Government Printer, Nairobi

<sup>45</sup> Amboko. J., 'Kenya's Plan to Unlock Carbon Credit Market.' Available at <https://www.businessdailyafrica.com/bd/economy/kenya-s-plan-to-unlock-carbon-credit-market--4357006> (Accessed on 26/10/2023)

<sup>46</sup> Science, Technology and Innovation Act., No. 28 of 2013, Laws of Kenya

production system and for connected purposes<sup>47</sup>. The Act aims to achieve several objectives including fostering the development of scientific, technological and innovation activities in Kenya in relation to the economic and social policies of the Government, and the country's international commitments; and promoting the adoption and application of scientific and technological knowledge and information necessary in attaining national development goals<sup>48</sup>. Strengthening synergies between the Science, Technology and Innovation Act and the Climate Change Act and the institutions established under the two laws can enhance the role of science and technology in tackling climate change in Kenya through scientific research, technological development and innovation among other measures.

From the foregoing, it is evident that the role of science and technology in tackling climate change has been recognized and enshrined under the laws on climate change at the global, continental and national levels. Actualizing the provisions of these laws will enhance the global, continental and national responses to climate change through science and technology.

### **3.0 Tackling Climate Change through Science and Technology: Progress and Challenges**

It has been observed that science and technology have enhanced the response to the global threat of climate change through various ways including emissions reduction which involves tackling climate change by reducing greenhouse gas emissions; sequestration which entails removing carbon dioxide from the atmosphere into permanent geological, biological or oceanic reservoirs; adaptation through responding to and coping with climate change as it occurs, in either a planned or unplanned way; and solar geoengineering through large-scale engineered modifications to limit the amount

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<sup>47</sup> Ibid

<sup>48</sup> Ibid

of sunlight reaching the earth, in an attempt to offset the effects of ongoing greenhouse gas emissions<sup>49</sup>.

Further, science and technology are enhancing low carbon development in various sectors<sup>50</sup>. Low carbon development refers to forward-looking national economic development plans or strategies that encompass low-emission and/or climate-resilient economic growth<sup>51</sup>. Low carbon development has also been defined as long term climate-friendly growth strategies that can highlight a country's priority actions for climate mitigation and adaptation, and a country's role in the global effort against climate change<sup>52</sup>. Low-carbon development aims to achieve the goals of reducing greenhouse gas emissions, exploiting low-carbon energy, and fostering economic growth<sup>53</sup>. Scientific research and technological innovation have enhanced low carbon development through the development of clean and green technologies and climate smart practices in various sectors including energy, agriculture, transport, infrastructure, industry and biodiversity conservation<sup>54</sup>.

Science, technology and innovation have enhanced energy efficiency through the development of clean sources of energy such as renewable energy<sup>55</sup>. The energy sector is the central front in the battle to mitigate greenhouse gas emissions<sup>56</sup>. As a result, it has

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<sup>49</sup> Australian Academy of Science., 'What does Science Say About Options to Address Climate Change?' Available at <https://www.science.org.au/learning/general-audience/science-climate-change/9-what-does-science-say-about-climate-change-options> (Accessed on 26/10/2023)

<sup>50</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Available at <https://thesciencepolicyforum.org/articles/perspectives/role-of-science-technology-and-innovation-in-addressing-climate-change-a-perspective/> (Accessed on 26/10/2023)

<sup>51</sup> United Nations., 'Low Carbon Development.' Available at <https://sustainabledevelopment.un.org/index.php?menu=1448#:~:text=The%20concept%20of%20low%20carbon,low%2Dcarbon%20growth%20plans> (Accessed on 26/10/2023)

<sup>52</sup> United Nations Economic and Social Commission for Asia and the Pacific., 'Low-Carbon Development Plan.' Available at <https://www.unescap.org/sites/default/files/45.%20FS-Low-Carbon-DevelopmentPlan.pdf> (Accessed on 26/10/2023)

<sup>53</sup> Yuan. H, Zhou. P, & Zhou. D., 'What is Low-Carbon Development? A Conceptual Analysis.' *Energy Procedia*, 5 (2011) 1706–1712

<sup>54</sup> Ibid

<sup>55</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>56</sup> Ibid

been rightly pointed out that cleaner technologies, including cleaner energy technologies, have an important role to play in addressing climate change<sup>57</sup>. Clean energy technologies especially renewable sources of energy such as solar energy (solar thermal, solar photovoltaic, high efficiency solar cells), energy from urban and industrial wastes, wind, biomass (bio-fuels, bio-gas, waste to energy) and small hydro, ocean and geothermal energy and new technologies including fuel cells and hydrogen have enhanced global efforts towards tackling climate change<sup>58</sup>. It has been observed that clean energy technologies such as renewable sources of energy emit little to no greenhouse gases and have made massive strides in performance and cost, making it more feasible than ever to shift the world away from burning fossil fuels at a faster pace than previously thought<sup>59</sup>. Further, it has been asserted that these developments have increased the economic attractiveness of low-emission energy sector transitions towards combating climate change<sup>60</sup>. It is therefore important to effectively embrace clean energy technologies in order to strengthen the global response to climate change.

Science and technology is also enhancing low carbon development in the transport and infrastructure sector through low carbon infrastructure and green transport models<sup>61</sup>. It has been estimated that approximately 79% of global greenhouse gas emissions come from infrastructure construction and operations such as power plants, buildings, and transport<sup>62</sup>. In order to curb this situation while maintaining infrastructure as a priority sector for climate action, and national growth in general, climate experts have argued that

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<sup>57</sup> Ibid

<sup>58</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

<sup>59</sup> Irfan. U., 'This is What we Need to Invent to Fight Climate Change.' Available at <https://www.vox.com/23042818/climate-change-ipcc-wind-solar-battery-technology-breakthrough> (Accessed on 26/10/2023)

<sup>60</sup> Ibid

<sup>61</sup> Kennedy. C, Ibrahim. N, & Hoornweg. D., 'Low-Carbon Infrastructure Strategies for Cities.' Available at [https://www.researchgate.net/profile/Nadine-Ibrahim-2/publication/262954714\\_Lowcarbon\\_infrastructure\\_strategies\\_for\\_cities/links/5705559e08ae13eb88b9644e/Low-carboninfrastructure-strategies-for-cities.pdf](https://www.researchgate.net/profile/Nadine-Ibrahim-2/publication/262954714_Lowcarbon_infrastructure_strategies_for_cities/links/5705559e08ae13eb88b9644e/Low-carboninfrastructure-strategies-for-cities.pdf) (Accessed on 26/10/2023)

<sup>62</sup> Brickstone., 'Low-Carbon Infrastructure in Curbing Climate Change.' Available at <https://brickstone.africa/low-carbon-infrastructure-in-climatechange/#:~:text=Urban%20transport%20projects%2C%20such%20as,emissions%20compared%20to%20fo%20ossil%20fuels> (Accessed on 26/10/2023)

governments need to radically rethink how infrastructure is planned, delivered and managed in order to make it suitable for a low emission and resilient future<sup>63</sup>. Scientific research and technological innovation have tried to address this concern through the development of low carbon infrastructure projects such as railway infrastructure and urban transport projects including metros and light rail projects which reduce motor vehicle usage<sup>64</sup>.

Science and technology are revolutionizing the transport and infrastructure sector through the development of hybrid electric vehicles, battery electric vehicles, solar electric vehicles, fuel cell vehicles, improved diesel vehicles, alternative fuel technologies, material substitution technologies, smart traffic infrastructure/intelligent transport systems and the use of information technologies for traffic management<sup>65</sup>. Further, in the infrastructure sector, there is increased adoption of green construction materials including flyash based bricks, RCC blocks, cellular lightweight concrete, bamboo-based materials and bagasse boards; efficient lighting system; and adoption of nature-based infrastructure<sup>66</sup>. These measures have aided in the reduction of greenhouse gases and improved efforts towards tackling climate change.

Science and technology are also enhancing the response to climate change in the agriculture sector through climate smart agricultural practices which are geared towards enhancing the resilience of the agriculture sector and promoting food security while curbing greenhouse gas emissions<sup>67</sup>. Advanced farming machinery; innovative farming techniques including zero budget farming, organic farming; smart irrigation technologies including drip irrigation and sprinkler irrigation; energy efficient farming technologies; the use of nanotechnology; mechanisation of horticulture; and scientific research in agricultural extension are some of the scientific and technological approaches that are

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<sup>63</sup> Ibid

<sup>64</sup> Kennedy. C, Ibrahim. N, & Hoornweg. D., 'Low-Carbon Infrastructure Strategies for Cities.' Op Cit

<sup>65</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

<sup>66</sup> Ibid

<sup>67</sup> The World Bank., 'Climate-Smart Agriculture.' Available at <https://www.worldbank.org/en/topic/climate-smart-agriculture> (Accessed on 26/10/2023)

enhancing the resilience of the agricultural sector and promoting food security while reducing greenhouse gas emissions<sup>68</sup>. Technologies such as genetic engineering have been adopted to transfer the nitrogen fixing capabilities of legumes such as peas and beans into cereal crops so to attain higher yields, without the use of expensive fertilizers towards curbing carbon emissions and environmental pollution<sup>69</sup>. Scientific research and technological innovation have also increased the adoption of regenerative agricultural practices such as crop rotation, agroforestry, use of drought- and heat-resistant crops, integrated pest control systems, water harvesting and irrigation<sup>70</sup>. This approach has helped in fostering high-yielding, resilient, and adaptive practices in the agricultural sector<sup>71</sup>. Science and technology have therefore played a pivotal role in tackling climate change in the agriculture sector.

Science and technology have also enhanced the response towards climate change through carbon sequestration<sup>72</sup>. Carbon sequestration involves removing carbon dioxide from the atmosphere and storing it into permanent geological, biological or oceanic reservoirs<sup>73</sup>. Carbon sequestration can prevent further emissions from contributing to the heating of the planet<sup>74</sup>. This concept happens in two forms: biologically or geologically<sup>75</sup>. Biological carbon sequestration happens when carbon is stored in the natural environment in 'carbon sinks', such as forests, grasslands, soil, oceans and other bodies of water. Geological carbon sequestration is an artificial process

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<sup>68</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

<sup>69</sup> Conrow. J., 'Borlaug's Dream is Being Realized.' Available at <https://allianceforscience.org/blog/2017/04/borlaugs-dream-is-being-realized/> (Accessed on 26/10/2023)

<sup>70</sup> Climate Champions. 'How Regenerative Agriculture Can Increase Africa's Food Production.' Available at <https://climatechampions.unfccc.int/call-to-action-for-climate-resilient-sustainable-food-systems-inafrica/> (Accessed on 26/10/2023)

<sup>71</sup> Ibid

<sup>72</sup> Australian Academy of Science., 'What does Science Say About Options to Address Climate Change?'

Op Cit

<sup>73</sup> Ibid

<sup>74</sup> Lal. R., 'Carbon Sequestration.' Available at [https://www.researchgate.net/profile/Rattan-Lal-2/publication/6079761\\_Carbon\\_sequestration/links/55420e7b0cf224a89a3333ca/Carbon-sequestration.pdf](https://www.researchgate.net/profile/Rattan-Lal-2/publication/6079761_Carbon_sequestration/links/55420e7b0cf224a89a3333ca/Carbon-sequestration.pdf) (Accessed on 26/10/2023)

<sup>75</sup> Ibid

that involves removing carbon from the atmosphere and storing it in places such as underground geological formations or rocks<sup>76</sup>. It majorly relies on technology with recent innovations such as graphene production and carbon capture and storage showing carbon being sequestered more effectively on larger scales<sup>77</sup>. Carbon sequestration is therefore an important process in tackling climate change by removing carbon dioxide from atmosphere and storing it in order to mitigate its negative impacts on the planet. Science and technology are aiding in carbon sequestration.

In addition, science and technology are enhancing efforts to tackle climate change by fostering biodiversity conservation<sup>78</sup>. The *Convention on Biological Diversity*<sup>79</sup> recognizes the role of science and technology in the conservation of biodiversity and urges parties to foster and collaborate in areas such as scientific research, access to and transfer of technology and exchange of scientific information in order to enhance the conservation of biodiversity<sup>80</sup>. Science and technology can enhance conservation of biodiversity through remote sensing, ex-situ conservation, biotechnology, bioremediation in order to restore damaged biodiversity, and information technology among others<sup>81</sup>.

Finally, it has been pointed out that Artificial Intelligence (AI) is helping to reduce greenhouse gases at industrial facilities as part of the efforts towards tackling climate change<sup>82</sup>. AI is enhancing improvements in energy efficiency, generation and storage, redefining energy systems, unlocking the possibility of data driven power options and

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<sup>76</sup> Ibid

<sup>77</sup> Ibid

<sup>78</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

<sup>79</sup> United Nations., 'Convention on Biological Diversity.' Available at <https://www.cbd.int/doc/legal/cbd-en.pdf> (Accessed on 26/10/2023)

<sup>80</sup> Ibid

<sup>81</sup> Wellers. D et al., 'Technology for Preserving Biodiversity.' Available at <https://www.sap.com/africa/insights/viewpoints/technology-for-biology-preserving-biodiversity.html#:~:text=Sensors%20to%20detect%20and%20protect%20species%20at%20risk&text=New%20technologies%2C%20from%20robots%20and,risk%20to%20defending%20their%20homes.> (Accessed on 26/10/2023)

<sup>82</sup> Stantec., '9 Breakthrough Technologies for Tackling Climate Change.' Available at <https://www.stantec.com/en/services/sustainability/climate-change-design-technology> (Accessed on 26/10/2023)

enabling smart city development. It has been pointed out that climate data sets are enormous and take significant time to collect, analyze, and use to make informed decisions and enact actual policy change<sup>83</sup>. Using AI to factor in elements of climate change that are constantly evolving can aid in making informed predictions about changes in the environment, in order to adopt mitigation efforts earlier<sup>84</sup>. AI is therefore one of the technological revolutions that can aid efforts towards tackling climate change.

It is therefore evident that science and technology are viable tools in tackling climate change. However, it has been observed that developing countries continue to face barriers in accessing clean and climate friendly technology<sup>85</sup>. Further, most countries especially in the developing world are yet to fully invest in climate science research and development hence hindering effective mitigation and adaptation efforts<sup>86</sup>. It is imperative to effectively embrace science and technology in order to enhance the global response on climate change.

#### **4.0 Way Forward**

There is need to embrace science and technological interventions in order to foster low carbon development towards achieving the goals of reducing greenhouse gas emissions and fostering economic growth<sup>87</sup>. Science and technology have enhanced low carbon technology in various sectors such as energy through the development of renewable sources of energy; transport and infrastructure through initiatives such the development of electric cars, metros and light rail projects and use of green construction materials; and the agriculture sector through the adoption of climate smart agricultural practices<sup>88</sup>.

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<sup>83</sup> Mastrola. M., 'How AI Can Help Combat Climate Change.' Available at <https://hub.jhu.edu/2023/03/07/artificial-intelligence-combat-climate-change/> (Accessed on 26/10/2023)

<sup>84</sup> Ibid

<sup>85</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>86</sup> Ibid

<sup>87</sup> Yuan. H, Zhou. P, & Zhou. D., 'What is Low-Carbon Development? A Conceptual Analysis.' Op Cit

<sup>88</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

Countries should therefore continue embracing science and technology in order to tackle climate change by fostering low carbon development.

It is also imperative for countries to continue advancing scientific and technological research and development on climate change<sup>89</sup>. This calls for enhanced financing and investments by both the public and private sectors in climate change research and development<sup>90</sup>. Research and development enhances the response to climate change by closing the knowledge gap through the availability of scientific data and information on climate change which can inform policy decisions and measures on climate change<sup>91</sup>. It has been observed that in Africa, limited understanding of the African climate system impedes the collective ability to deliver adequate early warnings and climate predictions<sup>92</sup>. This restricts the use of climate information by African decision makers and communities most vulnerable to current and future impacts of a changing climate<sup>93</sup>. As a result, tackling these significant climate knowledge gaps across Africa and the developing world requires targeted and sustained capacity development interventions in climate science research, development, applications and policy<sup>94</sup>. Climate research and development provides accurate, timely, reliable and spatially relevant information to guide appropriate climate change actions in Africa and the developing world<sup>95</sup>. Both developed and developing countries should accelerate research and development on climate change in order to effectively tackle the problem. Mobilizing public and private sources of finance can accelerate research and development on climate change<sup>96</sup>.

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<sup>89</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>90</sup> Ibid

<sup>91</sup> Ibid

<sup>92</sup> United Nations Economic Commission for Africa., 'Climate Research for Development in Africa: Using Climate Science to Drive Africa's Development.' Available at <https://repository.uneca.org/bitstream/handle/10855/43288/b11974965.pdf?sequence=1&isAllowed=y> (Accessed on 27/10/2023)

<sup>93</sup> Ibid

<sup>94</sup> Ibid

<sup>95</sup> Ibid

<sup>96</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

Further, there is need for developed countries to support developing countries in their climate mitigation and adaptation efforts through technology development and transfer<sup>97</sup>. It has been pointed out that developing countries continue to face problems in developing, accessing and deploying technologies as part of their response on climate change<sup>98</sup>. Various legal instruments on climate change including the UNFCCC and the Paris Agreement calls upon developed member states to support the developing member states through climate technology development and transfer<sup>99</sup>. It is therefore essential for developed countries to enhance technology development and transfer to developing countries in order to boost their ability to tackle climate change. According to the UNFCCC, support needs in terms of technology development and transfer ranges from financial resources for a given technology, the strengthening of institutions and human resources for technology research and development to capacity-building and the establishment of information and awareness-raising programmes<sup>100</sup>. Technology development and transfer is therefore essential in enhancing the capacity of countries especially those in the developing world to tackle climate change through science and technology. The United Nations urges develop countries to redouble their efforts to diffuse and transfer proven technologies, for instance, in the area of energy efficiency in order to enhance climate change responses in developing countries<sup>101</sup>. Equally critical in technology development and transfer is international technology cooperation and focused partnerships, both to broaden the scope and to accelerate the pace of innovation<sup>102</sup>. It has been observed that there remains untapped potential for cooperation

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<sup>97</sup> United Nations Climate Change., 'What is Technology Development and Transfer?.' Available at <https://unfccc.int/topics/what-is-technology-development-and-transfer#:~:text=In%201992%2C%20when%20countries%20established,that%20reduce%20emissions%20of%20GHGs>. (Accessed on 27/10/2023)

<sup>98</sup> Ibid

<sup>99</sup> United Nations Framework Convention on Climate Change, Article 4 (1) (c); Paris Agreement, Article 10

<sup>100</sup> United Nations Climate Change., 'Technology Development and Transfer.' Available at <https://unfccc.int/topics/adaptation-and-resilience/groups-committees/adaptation-committee/joint-ac-and-leg-mandates/nap-support/technology-development-and-transfer> (Accessed on 27/10/2023)

<sup>101</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

<sup>102</sup> Ibid

between developed and developing countries, as well as for South-South cooperation in the areas of technology development and transfer which needs to be realized in order to strengthen global efforts towards tackling climate change.<sup>103</sup>

Finally, there is need for countries to create conducive environments that will enhance the development, access and deployment of climate science and technology<sup>104</sup>. It has been asserted that the production and dissemination of scientific and technological knowledge thrives in the right environment. Science, technology and innovation need supportive ecosystems, right from funding opportunities, ownership, product certification, market access, to public procurement<sup>105</sup>. It is thus pertinent to enhance government support and create enabling legal, institutions, policy and social frameworks in order to accelerate the role of science and technology in tackling climate change<sup>106</sup>.

These among other measures are important in strengthening the role of science and technology in tackling climate change.

## **5.0 Conclusion**

Science and technology can enhance the global response to climate change by strengthening adaptive capacity of countries<sup>107</sup>. Science and technological innovations have accelerated efforts towards tackling climate change by enhancing low carbon development in various sectors including energy, transport and infrastructure and agriculture; carbon sequestration; fostering biodiversity conservation; and enhancing availability of climate data through AI<sup>108</sup>. However, the viability of science and technology in tackling climate change is hindered by factors such as barriers in accessing

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<sup>103</sup> Ibid

<sup>104</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

<sup>105</sup> Ibid

<sup>106</sup> Ibid

<sup>107</sup> Ospina. A., & Heeks. R., 'ICTs and Climate Change Adaptation: Enabling Innovative Strategies.' Op Cit

<sup>108</sup> United Nations Department of Economic and Social Affairs., 'Forum on Climate Change and Science and Technology Innovation.' Op Cit

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clean and climate friendly technology and inadequate investment in research and development<sup>109</sup>. It is imperative for countries to embrace science and technology in combating climate change by fostering low carbon development, advancing scientific and technological research and development on climate change, accelerating technology development and transfer, and creating conducive environments that will enhance the development, access and deployment of climate science and technology<sup>110</sup>. Tackling climate change through science and technology is a worthy and achievable objective.

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<sup>109</sup> Ibid

<sup>110</sup> Verma. R., 'Role of Science, Technology and Innovation in addressing Climate Change.' Op Cit

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