POLICY URGENCY ON EDUCATION SYSTEM IN INDONESIA BASED ON CLIMATE CHANGE IN EFFORTS TO MONITOR SUSTAINABLE DEVELOPMENT

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Abstract

Climate change is one of the key points of the Sustainable Development Goals. The urgency of climate change has become the world's primary concern because it affects every aspect of human life's viability. The effects of climate change can extend to the entire sector and the equilibrium of global existence. Here, the purpose of education is to prepare and humanize individuals so they can comprehend their responsibilities and develop the skills necessary for a sustainable existence. Education on climate change and sustainable development should be expanded in all subject areas, including the curriculum. This study investigates the necessity and ramifications of climate change-based education policies in Indonesia for monitoring sustainable development. Based on the findings of a literature review, the research method employed in this study is qualitative research with a descriptive approach. The urgency of education based on sustainable development, including awareness and comprehension, mitigation and adaptation, and strengthening sustainable development in Indonesia is discussed in this study. Incorporating climate change-based education into the curriculum and learning methods, resources and capacity, and participation and sustainability are some of the challenges that must be considered when implementing climate change-based education.

Keywords: Policy, Climate Change Based Education, Sustainable Development, Adaptation, Mitigation.

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1. Introduction

Climate change is a global issue that affects individuals everywhere. This phenomenon refers to long-term changes in the Earth's weather patterns and climatic conditions caused primarily by the emission of greenhouse gases and the consumption of fossil fuels (Nema et al., 2012). The environment, economy, and society are all adversely affected by climate change. Rising global temperatures, increased intensity and frequency of natural disasters such as floods and droughts, threats to biodiversity, disruption of agricultural patterns, rising sea levels, and alterations to marine and terrestrial ecosystems are among the effects (Haines et al., 2006).

Change has a different impact on each country. Countries that have sea areas will have a different impact than countries that do not have sea areas. Countries with marine areas face more direct impacts related to climate change on their marine ecosystems (McGranahan et al., 2007). Increasing sea surface temperatures can result in coral bleaching, which damages marine biodiversity and threatens fish resources. In addition, rising sea levels due to global warming can threaten small islands and coastal areas vulnerable to flooding, coastal erosion, and seawater intrusion into groundwater (Dasgupta et al., 20090). Countries dependent on fisheries and marine tourism may also experience significant economic impacts from climate change. On the other hand, countries that do not have sea areas may experience climate change impacts that are more related to land conditions. This can include changes in rain patterns, droughts, and temperature increases, affecting the agricultural sector, water availability, and human health (Huq et al., 2004). In both cases, countries need to develop appropriate adaptation policies and strategies according to the impacts of climate change, be it sea or land related, to protect their people, ecosystems, and economies (Swaminathan & Kesavan, 2012). Climate change is influenced by two main factors, namely biological activities and human activities. Biological activity includes natural changes in the climate system, such as volcanic activity, variations in the solar cycle, and natural changes in atmospheric and oceanic circulation (Beniston & Beniston, 2004). These biological activities can cause short-term climate fluctuations or long-term climate changes on a geological scale (Hasselmann et al., 2003). Examples are periods of ice ages and periods of natural global warming in Earth's history. In recent centuries, however, human activities have become the primary cause of climate change. Increased greenhouse gas emissions due to the combustion of fossil fuels, deforestation, and patterns of intensive consumption have led to an increase in the concentration of greenhouse gases in the atmosphere (Guo et al., 2022). Greenhouse gases, such as carbon dioxide (CO2) and methane (CH4), intensify the natural greenhouse effect and increase global temperatures. This phenomenon is referred to as global warming or climate change caused by humans (Zhou et al., 2012). Human activities such as using fossil energy, industry, transportation, and agriculture also contribute to air pollution and other environmental pollution, affecting air quality, human health, and ecosystems (Ukaogo et al., 2020). In addition, unsustainable land use, such as deforestation and land use change, also hurts climate change. These activities have a very complex effect on every aspect of life, such as the agricultural sector, the economy, and even human psychology (Smith et al., 2016).

The magnitude of the effects of climate change on various aspects of human existence necessitates education and a strengthening of adaptation and mitigation strategies. Adaptation to climate change is an effort to reduce vulnerability and increase resilience (Leichenko, 2011). Adaptations to infrastructure, such as the construction of dikes or improved drainage systems, can reduce the danger of flooding caused by extreme rainfall. The development and application of plant varieties that are more resistant to high temperatures, drought, or insect attacks is also a form of adaptation. In addition, sustainable spatial planning contributes to climate change adaptation by addressing the risks of inundation, rising temperatures, and natural disasters in urban planning and development (Dow et al., 2006). Climate change mitigation, on the other hand, refers to actions taken to reduce greenhouse gas emissions and the human contribution to global warming (Preston & Jones, 2006). Increasing the use of renewable energy sources, such as solar or wind, is an example of energy sector mitigation. Reducing energy consumption in the transportation, industrial, and building sectors through energy efficiency efforts is also a form of mitigation. Climate change mitigation also includes reforestation and forest restoration because plants can absorb carbon dioxide and reduce greenhouse gas emissions. Moreover, fostering sustainable transportation, such as public transportation or electric vehicles, is a mitigation strategy for reducing greenhouse gas emissions from the transportation sector (Fawzy et al., 2020). As a solid foundation, education is required for humans to take strategic measures to combat climate change. (Mochizuki & Bryan, 2015) Education plays a crucial role in equipping current and future generations to comprehend and confront the challenges of climate change. Education must become a resource for teaching about climate change, adaptation, and mitigation in this context. Through education, individuals can acquire an in-depth comprehension of climate change, including its causes, effects, and implications for various

facets of life (Wolf & Moser, 2011). Education must also provide an understanding of climate change adaptation. This involves teaching about concrete steps that can be taken to reduce vulnerability to the effects of climate change. By acquiring knowledge about adaptation strategies, individuals can take necessary actions within their personal, community, and economic sectors (Anderson, 2012). Furthermore, education must teach about climate change mitigation. This includes understanding what can be done to reduce greenhouse gas emissions and limit human contribution to global warming. Education should promote awareness of the importance of using renewable energy, energy efficiency, waste reduction, and other sustainable practices (Msengi et al., 2019).

In the reality that exists in the Indonesian education system to date, the issue of climate change is still limited to certain topics in several subjects, such as science, geography, or subjects related to the environment. Unfortunately, the issue of climate change has not yet become a separate subject comprehensively taught in the education curriculum. This limitation can result in students' need for understanding and awareness of climate change and the importance of adaptation and mitigation actions. Students only get limited exposure to climate change through topics related to the subject without a thorough understanding of its impact on human life and the environment.

Literature Review

1. Climate change

It's no secret that climate change is one of the most pressing global challenges at the moment. According to Boateng (2015), it's also the biggest public policy problem. According to the United States Global Climate Change Program (Okoli & Ifeakor, 2014), climate change is an extreme response to weather phenomena that has negative effects on food production, water supply, human health, ozone depletion, plant life, and soil quality, and thus doubles the concentration of carbon dioxide in ecosystems. Forests, grasslands, peat swamps, and other terrestrial ecosystems store more carbon than the atmosphere combined (Lal, 2004), and this is only one example of how ecosystems manage Earth's temperature by adding and removing greenhouse gases like CO2 from the atmosphere. Ecosystems contribute to climate change by sequestering carbon dioxide from the atmosphere in the form of wood, other biomass, and soil (Watson et al., 2000).

According to Urry (2015), weather changes on Earth, such as shifts in temperature and wind speed, constitute climate change because of a shift in the statistical nature of the climate system. All parties are focused on combating climate change because of the immediate harm it causes to humanity and the environment. According to the UN Convention on Environment and Development (1992), global environmental damage is increasing, ozone depletion causes an increase in ultraviolet rays penetrating Earth, which is harmful to humans, and more and more species of flora and fauna are going extinct as a result of global warming and climate change (Sand, 1992). Emissions of greenhouse gases, in particular, have a negative effect on the natural world. When atmospheric greenhouse gas concentrations rise, the result is an increase in Earth's average surface temperature (global warming). Climate change is a result of this process (Ehhalt et al., 2001). An worldwide environmental pact was created to address the issue of climate change. The Kyoto Protocol Agreement is a global pact.

The global community's desire to slow the rise of warming gases in the atmosphere is reflected in the Kyoto Protocol. By establishing regulations for their greenhouse gas emissions, signatories to the Kyoto Protocol hope to achieve a 5 percent reduction in those emissions between 2008 and 2012 (Bohringer, 2003). Increasing temperatures, unpredictable seasonal variations, crop failures, the emergence of new illnesses, a decline in biodiversity, rising sea levels, and so on are all repercussions of the huge and global greenhouse effect. There is a clear and present risk to human existence and the continued viability of Earth due to the greenhouse effect, which is caused by an increase in greenhouse gases ((Sharma et al., 2021). Conflicts between government action to mitigate climate change and action to adapt to it are among the most important that can occur (Laukkonen et al., 2009).

2. Climate Change-based Education

The 1972 meeting of the UNCHE (United Nations Conference on the Human Environment) in Stockholm, Sweden, was crucial in determining the relationship between education levels and unsustainable development. It was discovered at this meeting that education is critical in educating people to comprehend that climate change is more than just a problem of global warming and disasters, but also has complicated ramifications for human vulnerability and survival (Ledley et al., 2017; Ben-Peretz, 2009).

So far, climate change education has frequently been limited to environmental education and natural scientific literacy. Despite its importance, education that focuses solely on natural science cannot properly communicate the complexities of climate change, which includes social, economic, political, and cultural components (Stevenson et al., 2017). Climate change education must cross these borders and include subjects such as social sciences, economics, and humanities. This enables students to comprehend the intricate relationship that exists

between climate change, sustainable development, and human life (Colluci-Gray et al., 2013).

Climate change education must also include broader literacy, such as comprehending environmental ethics, social justice, and individual and communal responsibility for the future of the earth. Students can comprehend how climate change affects their daily lives through inclusive and holistic education, such as food, water, health, and security (Howard-Jones et al., 2021). We can equip future generations with a broader understanding of the complexities of climate change issues and inspire them to take real action in maintaining the sustainability of this planet by developing climate change-based education that goes beyond the limitations of a natural science approach. This multidisciplinary education will serve as a solid foundation for addressing the challenges of climate change and developing a sustainable society in the future (Mauser et al., 2013).

3. Sustainable Development

The World Commission on Environment and Development (WCED, 1987) defines sustainable development as a type of development that serves present requirements while also ensuring fair opportunity for future generations (Knoke & Hahn, 2012). Its inception must be linked to the Rio de Janeiro Earth Summit in 1992. The summit participants decided at the time to define it as development focused toward addressing human needs through the intelligent and efficient use of natural resources, while also taking into account the sustainability of their usage for both current and future generations (Koohafkan et al., 2012).

Connelly (2007) argues that since 20 years ago, sustainable development has become the main principle in policymaking at the international and national levels. In fact, according to Krysiak (2009), this issue is of concern and becomes a guide in the business or corporate world (Knoke & Hahn, 2013). The main idea of sustainable development is basic human needs and limitations. Human needs must be met, but nature provides little human needs so that they make the best use of what humans have to do (Robinson, 1993).

Bockisch (2012) suggests three pillars that support sustainable nature, namely economic, environmental, and social, which interact. It was further explained that each pillar is interconnected in a system triggered by strength and purpose. The three pillars are: (1) economics to see the development of human resources, especially through increased consumption of goods and services; (2) the environment is focused on the integrity of the ecological system; and (3) social aims to improve human relations, achieve individual and group aspirations and strengthen values and institutions.

2. Methods

This investigation employs a qualitative, descriptive approach. According to Creswell et al. (2007), the qualitative method is founded on postpositivism and is used to investigate natural object conditions (as opposed to experiments) in which the researcher is the primary instrument. Qualitative research employs triangulation (combined) data collection techniques, inductive/qualitative data analysis, and emphasizes meaning over generalization in its findings. The objective of qualitative descriptive research is to describe, describe, explain, explain, and provide more specific answers to the research questions by investigating an individual, a group, or an event in as much detail as possible. Humans are the research instruments in qualitative research, and the written results are in the form of words or statements that reflect the actual situation. Because this research investigates the Urgency of Education System Policy in Indonesia Based on Climate Change in Efforts to Monitor Sustainable Development, the researcher employs a qualitative descriptive research method. Explanation of information obtained through literature study, i.e. research that uses various literature, books, research articles, reports, notes, or other references to address or discuss questions or topics related to the topic at hand. Therefore, in this study, books, research articles, and media report articles were used as literature sources.

3. Results and Discussion

1. The Urgency of Climate Change-based Education Policy in Efforts to Monitor Sustainable Development

Awareness of the importance of climate change education in Indonesia needs to be increased in climate change. For this reason, stakeholders are asked to involve the education system to solve major challenges the world has never faced before. The following are the reasons for the urgency of climate change-based education policies in Indonesia to monitor sustainable development.

a) Awareness and understanding

Education plays an important role in shaping people's perceptions and attitudes toward this problem in the increasingly worrying global climate change context. By including climate change issues in the education curriculum, students can be introduced to the concepts, facts, and impacts of climate change more comprehensively. They can learn how climate change occurs, what the causes are, as well as its long-term implications for the environment, economy, and society. This awareness will help them recognize the importance of reducing greenhouse gas emissions, protecting biodiversity,

and implementing sustainable practices in their daily lives (Dawson et al., 2022).

In addition, a better understanding of climate change will help society recognize its impact on sustainable development. They will realize that unsustainable development, such as over-exploitation of resources or consumption patterns that are not environmentally friendly, can exacerbate climate change and threaten human life and ecosystems. With this understanding, people can care more about aspects of sustainable development, such as the use of renewable energy, good waste management, and environmental preservation.

In addition to awareness and understanding, climate change-based educational policies will also help build the skills and knowledge necessary for monitoring sustainable development. In the educational curriculum, students can be trained to understand sustainable development indicators and use relevant monitoring tools, such as environmental impact assessments or sustainability indexes. They can learn how to analyze and interpret data and identify corrective steps that can be taken to achieve sustainable development goals.

Furthermore, climate change-based education can also provide space for community collaboration and participation in efforts to monitor sustainable development. By involving various stakeholders, such as students, teachers, parents, government, and non-governmental organizations, education can become a forum for discussion, joint planning, and implementation of action programs related to climate change. This creates opportunities to generate innovative solutions, strengthen interagency collaboration, and expand the positive impact of climate change-based education in monitoring sustainable development.

Thus, the urgency of climate change-based education system policies in Indonesia in efforts to monitor sustainable development lies in the importance of increasing awareness, understanding, skills, and community participation. By preparing a generation that is aware of climate change issues and is able to take sustainable actions, Indonesia can move towards development that is more sustainable and resilient to climate change.

b) Mitigation and Adaptation

Climate change-based education policies will encourage strengthening adaptation and mitigation of climate change in various development sectors (Muttarak & Lutz, 2014). Adaptation in climate change-based education has dimensions that include building resilience and reducing vulnerability to the impacts of climate change that are occurring or that will occur in the future. One form of adaptation is the development of environmentally friendly infrastructure in the scope of education, such as the construction of a university building with a green building design. By using more energy-efficient materials, better waste management systems, and integration of renewable energy sources, university buildings can reduce greenhouse gas emissions and optimize resource use.

In addition, climate change adaptation in education also involves the development of climate-resistant plant varieties. In the face of higher temperatures, droughts, or more frequent pest attacks due to climate change, developing and applying crop varieties that are more resistant to these conditions is important. Plant varieties with better resistance to temperature or drought stress can be found or developed through research and development. Applying these climate-resistant crop varieties in agricultural and agroecology education can help farmers and farming communities reduce their vulnerability to climate change and maintain sustainable agricultural productivity. In addition to infrastructure adaptation and the development of plant varieties, climate change adaptation in education also involves sustainable spatial planning. In dealing with the risks of flooding, rising temperatures, and risks of other natural disasters exacerbated by climate change, it is important to consider adaptation aspects in urban planning and development. This includes identifying areas prone to flooding, adopting better water management techniques, and building infrastructure that can reduce the impact of climate change. Education on sustainable spatial planning will equip professionals with the necessary knowledge and skills to consider adaptation aspects in urban planning. Whereas the mitigation of climate change-based education is about identifying the causes of climate change and developing knowledge and skills about the disposition needed for individual and societal change to improve the causes of the impacts of climate change. One aspect of mitigation is developing knowledge about the use of renewable energy. Through education, students can learn about various renewable energy sources, such as solar, wind, and hydro. They can also learn about the technologies used to utilize this renewable energy source efficiently. With this understanding, students can become agents of change, promoting the use of renewable energy and reducing dependence on fossil fuels that contribute to climate change.

In addition, climate change-based education mitigation also involves developing reforestation and forest restoration skills. Students can learn about the importance of forests as carbon sinks and habitats for biodiversity. They can learn about tree planting techniques, sustainable forest management, and effective forest restoration efforts. Through this education, students can be involved in reforestation and forest restoration activities to reduce greenhouse gas emissions and strengthen the carrying capacity of ecosystems. Furthermore, mitigation in climate change-based education also involves understanding

and promoting sustainable transportation. Students can study the negative impacts of conventional transportation, such as greenhouse gas emissions and air pollution, and alternative transportation that is more environmentally friendly, such as using public transportation, bicycles, or walking. In this education, students can also understand the importance of sustainable transportation planning, including developing infrastructure that supports sustainable transportation and public policies that reduce the use of motorized vehicles. Through this knowledge and understanding, students can promote sustainable transportation in their daily lives and contribute to reducing greenhouse gas emissions.

c) Strengthening Sustainable Development in Indonesia

Sustainable development is an approach that integrates economic, social, and environmental aspects to achieve a balance between current human needs and the needs of future generations. Climate change and sustainable development have become increasingly important because climate change can threaten economic stability, social welfare, and environmental sustainability. Climate change-based education is important in strengthening sustainable development in Indonesia (Alfarizi, 2022). Through education, young people can understand the importance of integrating social, economic, and environmental dimensions in their decision-making. They can learn about the principles of sustainable development, including social justice, economic efficiency, and environmental sustainability, and how to apply them in their daily lives.

In addition, climate change-based education can also provide the knowledge and skills needed to develop innovative and sustainable solutions in various sectors. For example, students can learn about green technology, energy efficiency, sustainable management of natural resources, and environmentally friendly consumption patterns. By acquiring this knowledge, they can create sustainable development in energy, agriculture, transportation, industry, etc. Furthermore, climate change-based education can encourage active community participation in sustainable development. Through education, communities can be empowered to act as agents of change that contribute to addressing climate change and building a more sustainable society. Communities can be involved in decision-making, planning, and implementation of sustainable development programs and in monitoring and evaluating their impacts. By actively involving communities, sustainable development can become more inclusive, participatory, and resilient.

By strengthening sustainable development through climate change-based education, Indonesia can better face the challenges of climate change. Climate change-based education can empower young people, develop innovative solutions, and encourage community participation in efforts to achieve sustainable development. Thus, an education system policy that focuses on sustainable development will provide a strong basis for Indonesia in dealing with climate change and monitoring future sustainable development progress.

By implementing climate change-based education system policies in Indonesia, the country can prepare generations who are aware of climate change issues, able to adapt to existing challenges and contribute to efforts to monitor sustainable development. Education is an important foundation in building the awareness, knowledge, and skills needed to achieve sustainable development goals that are inclusive and resilient to climate change.

2. The Challenges of Implementing Climate Change-Based Education Policies in Monitoring Sustainable Development.

Applying climate change-based educational policies in monitoring sustainable development can give students the importance of protecting the environment and sustainable development, but the implementation is challenging. The challenges are:

a) Integrating climate change-based education into the curriculum and learning methods

The importance of integrating climate change-based education into the curriculum is to ensure that issues of climate change and sustainable development become an integral part of the educational process. This means identifying opportunities within existing curricula to include topics related to climate change, be it in natural sciences, geography, economics, or even in other subjects such as Indonesian or the arts. For example, in natural science courses, students can learn about climate change, its environmental and societal impact, and adaptation and mitigation solutions.

Innovative and participatory learning methods must also be developed to strengthen climate change-based education. This method can involve students actively learning and applying climate change concepts through research projects, simulations, group discussions, or field activities. This approach will encourage students to think critically, collaborate, develop problem-solving skills related to climate change, and increase their understanding of the importance of sustainable development.

The challenge in integrating climate change-based education into the curriculum and learning methods is the limited time and available resources. A dense curriculum and limited learning time can hinder teaching climate change issues. Therefore, developing a flexible curriculum and adjusting learning priorities is necessary to provide sufficient space for climate change-based education.

By addressing this challenge, integrating climate change-based education into curricula and learning methods can provide a solid foundation for holistic and sustainable education, which generates knowledge and shapes attitudes, skills, and values that support sustainable development in facing the challenge of climate change.

b) Resources and capacities

To implement climate change-based education effectively, adequate resources are needed: trained teaching staff, adequate educational infrastructure, and relevant learning materials. First of all, it is necessary to have teachers with adequate knowledge and skills in teaching about climate change and sustainable development. This requires investing in educators' training and professional development, both through specialized training programs and in formal and non-formal education contexts. With skilled and trained teachers, students will get quality and in-depth learning experiences related to climate change.

In addition, supporting educational infrastructure is also important. The construction of school buildings that are environmentally friendly and sustainable (green building) can be one of the efforts to reduce the environmental impact of the education sector. Adequate educational infrastructure also includes laboratories, libraries, and information technology facilities supporting climate change learning. In this case, there needs to be adequate financial support from the government and related institutions to ensure the availability of the necessary infrastructure. Relevant learning materials are also a major concern. Developing teaching materials appropriate to the local context, covering climate change, adaptation, and mitigation, is important in building a holistic and in-depth understanding of climate change. These learning materials must be adaptable to different levels of education and accessible to students and teachers. Therefore, support is needed in developing and disseminating quality learning materials that are climate change-oriented.

Limited resources and capacity regarding teaching staff, infrastructure, and learning materials can significantly challenge the implementation of climate change-based education policies. Therefore, allocating adequate resources and prioritizing investment in continuing education is important. Cooperation between the government, educational institutions, and the private sector is also needed to create synergies and ensure the availability of resources and capacity building needed in climate change-based education efforts.

c) Participation and continuity

Effective and inclusive participation is important for creating a deep understanding of the urgency of climate change issues and ensuring that the resulting policies truly reflect the needs and aspirations of the people. Involving various stakeholders can also expand access to the resources, knowledge, and skills needed in climate change-based education. In this regard, it is important to ensure the active participation of various groups, including students, teachers, parents, local communities, non-governmental organizations, and the private sector.

In addition, the challenge associated with participation is ensuring continuity in implementing climate change-based education policies. Climate change education must be an integral part of the long-term education system, not just a temporary initiative or limited to certain funding projects. To achieve this sustainability, a long-term commitment from the government and related institutions is needed to prioritize climate change issues in curricula, training programs, and educator capacity building.

In addition, sustainability also involves maintaining and increasing accessibility to learning resources, including textbooks, digital teaching materials, and educational facilities that support learning about climate change. In this case, sustainable financial support from the government and donor agencies is very important to ensure the continuity and development of climate change-based education programs. Participation and sustainability are complex challenges in implementing climate change-based education policies. However, by dealing with it effectively, an education system that is inclusive, sustainable, and responsive to climate change will be created.

4. Conclusion

This research highlights the urgency of Indonesia's climate change-based education system policies in efforts to monitor sustainable development. In this context, several important points have been discussed. First, awareness and understanding of climate change need to be instilled through education, so people can understand that climate change is not only related to warming and disasters but also affects the sustainability of human life. Furthermore, climate change-based education must involve aspects of adaptation and mitigation. Adaptation includes measures to build resilience and reduce vulnerability to the impacts of climate change, such as building environmentally friendly infrastructure, developing climate-resistant crop varieties, and sustainable spatial planning. Mitigation involves identifying the causes of climate change and developing knowledge, skills, and attitudes that support changes in individual and community behavior, such as using renewable energy, greenery, and sustainable transportation. In addition, this research also highlights the challenges in implementing climate change-based education policies. These challenges include the integration of

climate change-based education into the curriculum and learning methods, the availability of adequate resources and capacity building, and active and sustainable participation in policy implementation. To address this challenge, considerable investment is needed in educators' training and professional development, supporting educational infrastructure, and developing relevant learning materials. In conclusion, Indonesia's climate change-based education system policies are very important to monitor and encourage sustainable development. By increasing awareness, understanding, adaptation, and mitigation of climate change through education, a generation that is skilled, environmentally aware, and ready to face the challenges of climate change can be created. However, challenges in curriculum integration, resources, participation, and sustainability must be overcome to achieve successful implementation. Support from the government, educational institutions, and various stakeholders is key to achieving this goal.

5. References

Alfarizi, M. (2022). Literature Review of Climate Change and Indonesia's SDGs Strategic Issues in a Multidisciplinary Perspective. In *IOP Conference Series: Earth and Environmental Science* (Vol. 1105, No. 1, p. 012040). IOP Publishing.

Anderson, A. (2012). Climate Change Education for Mitigation and Adaptation. *Journal of Education for Sustainable Development*, *6* (2), 191–206.

Beniston, M., & Beniston, M. (2004). Natural Forcing of the Climate System. *Climatic Change and Its Impacts: An Overview Focusing on Switzerland*, 53-71.

Ben-Peretz, M. (2009). *Policy-Making in Education: A Holistic Approach in Response to Global Changes*. R&L Education.

Boateng, CA (2015). Tertiary Institutions in Ghana Curriculum Coverage on Climate Change: Implications for Climate Change Awareness. *Journal of Education and Practice*, *6* (12), 99–106.

Bockisch, JS (2012). Sustainability in Transportation Case Studies-Roswell, GA. In *ITE 2012 Annual Meeting & Exhibit Institute of Transportation Engineers (ITE)*.

Böhringer, C. (2003). The Kyoto Protocol: A Review and Perspectives. *Oxford Review of Economic Policy*, *19* (3), 451-466.

Colucci-Gray, L., Perazzone, A., Dodman, M., & Camino, E. (2013). Science Education for Sustainability, Epistemological Reflections, and Educational Practices: From Natural Sciences to Trans-Disciplinarity. *Cultural Studies of Science Education*, 8, 127-183.

Connelly, S. (2007). Mapping Sustainable Development as a Contested Concept. *Local Environment*, *12* (3), 259–278.

Creswell, JW, Hanson, WE, Clark Plano, VL, & Morales, A. (2007). Qualitative research designs: Selection and Implementation. *The Counseling Psychologist*, *35* (2), 236-264.

Dasgupta, S., Laplante, B., Meisner, C., Wheeler, D., & Yan, J. (2009). The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis. *Climatic change*, *93* (3-4), pp. 379–388.

Dawson, V., Eilam, E., Tolppanen, S., Assaraf, O., Gokpinar, T., Goldman, D., ... & Widdop Quinton, H. (2022). A Cross-Country Comparison of Climate Change in Middle School Science and Geography Curricula. *International Journal of Science Education*, *44* (9), 1379–1398.

Dow, K., Kasperson, RE, & Bohn, M. (2006). Exploring the Social Justice Implications of Adaptation and Vulnerability. *Fairness in Adaptation to Climate Change*, *79*, 79-96.

Ehhalt, D., Prather, M., Dentener, F., Derwent, R., Dlugokencky, E., Holland, E., ... & McFarland, M. (2001). Atmospheric Chemistry and Greenhouse Gases.

Fawzy, S., Osman, A., Doran, J., & Rooney, DW (2020). Strategies for Mitigating Climate Change: A Review. *Environmental Chemistry Letters*, p. *18*, 2069-2094.

Guo, B., Wei, C., Yu, Y., Liu, Y., Li, J., Meng, C., & Cai, Y. (2022). The Dominant Influencing Factors of Desertification Changes in the Source Region of the Yellow River: Climate change or human activity? *Science of the Total Environment*, *813*, 152512.

Haines, A., Kovats, RS, Campbell-Lendrum, D., & Corvalán, C. (2006). Climate Change and Human Health: Impacts, Vulnerabilities, and Public Health. *Public Health*, *120* (7), 585-596.

Hasselmann, K., Latif, M., Hooss, G., Azar, C., Edenhofer, O., Jaeger, CC, ... & Wokaun, A. (2003). The Challenge of Long-Term Climate Change. *Science*, *302* (5652), 1923-1925.

Howard-Jones, P., Sands, D., Dillon, J., & Fenton-Jones, F. (2021). The views of teachers in England on an action-oriented climate change curriculum. *Environmental Education Research*, *27* (11), 1660–1680.

Huq, S., Reid, H., Konate, M., Rahman, A., Sokona, Y., & Crick, F. (2004). Mainstreaming Adaptation to Climate Change in Least Developed Countries (LDCs). *Climate Policy*, *4* (1), 25–43.

Knoke, T., & Hahn, A. (2013). Global Change and the Role of Forests in Future Land-Use Systems. *Developments in Environmental Science*, *13*, 569-588.

Koohafkan, P., Altieri, MA, & Gimenez, EH (2012). Green Agriculture: Foundations for Biodiverse, Resilient, and Productive Agricultural Systems. *International Journal of Agricultural Sustainability*, *10* (1), 61-75.

Krysiak, F. (2009). Risk Management as a Tool for Sustainability. *Journal of Business Ethics*, pp. *85*, 483–492.

Lal, R. (2004). Carbon Sequestration in Dryland Ecosystems. *Environmental Management*, pp. *33*, 528–544.

Laukkonen, J., Blanco, PK, Lenhart, J., Keiner, M., Cavric, B., & Kinuthia-Njenga, C. (2009). Combining Climate Change Adaptation and Mitigation Measures at the Local Level. *Habitat International*, *33* (3), 287-292.

Leichenko, R. (2011). Climate Change and Urban Resilience. *Current Opinion in Environmental Sustainability*, *3* (3), 164-168.

Mauser, W., Klepper, G., Rice, M., Schmalzbauer, BS, Hackmann, H., Leemans, R., & Moore, H. (2013). Transdisciplinary Global Change Research: The Co-Creation of Knowledge for Sustainability. *Current Opinion in Environmental Sustainability*, *5* (3-4), 420-431.

McGranahan, G., Balk, D., & Anderson, B. (2007). The Rising Tide: Assessing the Risks of Climate Change and Human Settlements in Low Elevation Coastal Zones. *Environment and Urbanization*, *19* (1), 17–37.

Mochizuki, Y., & Bryan, A. (2015). Climate Change Education in the Context of Education for Sustainable Development: Rationale and Principles. *Journal of Education for Sustainable Development*, *9* (1), 4-26.

Msengi, I., Doe, R., Wilson, T., Fowler, D., Wigginton, C., Olorunyomi, S., ... & Morel, R. (2019). Assessment of Knowledge and Awareness of "Sustainability" Initiatives among college students. *Renewable Energy and Environmental Sustainability*, 4, 6.

Muttarak, R., & Lutz, W. (2014). Is Education a Key to Reducing Vulnerability to Natural Disasters and Unavoidable Climate Change? *Ecology and Society*, *19* (1).

Nema, P., Nema, S., & Roy, P. (2012). An Overview of Global Climate Change in the Current Scenario and Mitigation Action. *Renewable and Sustainable Energy Reviews*, *16* (4), 2329-2336.

Okoli, JN, & Ifeakor, AC (2014). An Overview of Climate Change and Food Security: Nigeria's Adaptation Strategies and Mitigation Measures. *Journal of Education and Practice*, *5* (32), 13-19.

Preston, BL, & Jones, RN (2006). *Climate Change Impacts Australia and the Benefits of Early Action to Reduce Global Greenhouse Gas Emissions* (p. 41). Canberra: CSIRO.

Robinson, J. (1993). The Limits to Caring: Sustainable Living and the Loss of Biodiversity. *Conservation Biology*, *7* (1), 20–28.

Sand, PH (1992). UNCED and the Development of International Environmental Law. *J.Nat. Resources & Envtl. L.*, 8, 209.

Sharma, GD, Shah, MI, Shahzad, U., Jain, M., & Chopra, R. (2021). Exploring the Nexus Between Agriculture and Greenhouse Gas Emissions in the BIMSTEC Region: The Role of Renewable Energy and Human Capital as Moderators. *Journal of Environmental Management*, p. *297*, 113316.

Smith, P., House, JI, Bustamante, M., Sobocká, J., Harper, R., Pan, G., ... & Pugh, TA (2016). Global Change Pressures on Soils from Land Use and Management. *Global Change Biology*, *22* (3), 1008-1028.

Stevenson, R., Nicolls, J., & Whitehouse, H. (2017). What is Climate Change Education? *Curriculum Perspectives*, pp. *37*, 67–71.

Swaminathan, MS, & Kesavan, PC (2012). Agricultural Research in an Era of Climate Change. *Agricultural Research*, pp. 1, 3–11.

Ukaogo, PO, Ewuzie, U., & Onwuka, CV (2020). Environmental Pollution: Causes, Effects, and the Remedies. In *Microorganisms for sustainable environment and health* (pp. 419-429). Elsevier.

Urry, J. (2015). *Climate change and society* (pp. 45–59). Palgrave Macmillan UK.

Watson, RT, Noble, IR, Bolin, B., Ravindranath, NH, Verardo, DJ, & Dokken, DJ (2000). *Land use, land-use change, and forestry: a special Intergovernmental Panel on Climate Change* report. Cambridge university press.

Wolf, J., & Moser, SC (2011). Individual Understandings, Perceptions, and Engagement with Climate Change: Insights from In-Depth Studies across the World. *Wiley Interdisciplinary Reviews: Climate Change*, *2* (4), 547-569.

Zhou, H., Zhang, X., Xu, H., Ling, H., & Yu, P. (2012). Climate Change and Human Activities Have Influenced the Tarim River Runoff in China over the Past Half-Century. *Environmental Earth Sciences*, pp. *67*, 231–241.