Strengthening Climate Information and Early Warning Systems for Effective Environmental Governance

Kariuki Muigua

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Kariuki Muigua*

Abstract

Responding to climate change has become both a both national priority and a global responsibility as a result of the adverse impacts associated with climate change. The world is responding to climate change through mitigation and adaptation strategies. One key climate change adaptation strategy involves enhancing climate information and early warning systems. Strengthening the resilience and capacity of all countries especially developing states to adapt to climate change cannot be achieved without scientific knowledge and data on climate change and its impacts. Climate information and early warning systems aim to achieve this goal. This paper critically examines the role of climate information and early warning systems in climate change mitigation. It argues that strengthening climate information and early warning systems can bolster environmental governance. The paper conceptualizes climate information and early warning systems and discusses how these ideas can enhance the global response towards climate change. It also discusses the progress and challenges towards embracing these two vital concepts and offers proposals towards strengthening climate information and early warning systems for effective environmental governance.

1.0 Introduction

The impacts of climate change including intense droughts, water scarcity, severe fires, rising sea levels, flooding, melting polar ice, catastrophic storms and declining biodiversity are being witnessed all over the world[1]. Due to these impacts, climate change has been described as the main global challenge that is affecting both developed and developing countries in their efforts towards realization of the Sustainable Development

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[1] United Nations., 'What is Climate Change?' Available at https://www.un.org/en/climatechange/what-is-climate-change (Accessed on 08/04/2024)

agenda[2]. Climate change has therefore risen to the top of the policy agenda, at local, national, and international levels[3]. Responding to climate change has become both a both national priority and a global responsibility[4]. The United Nations *2030 Agenda for Sustainable Development*[5] acknowledges that climate change is one of the greatest challenges facing humanity and its adverse impacts undermine the ability of all countries to achieve Sustainable Development. Sustainable Development Goal 13 urges all countries to take urgent action to combat climate change and its impacts[6].

The world is responding to climate change through mitigation and adaptation strategies[7]. Mitigation involves reducing greenhouse gas emissions and stopping the problem of climate change from growing[8]. Adaptation on the other hand involves learning how to live with the existing threat of climate change and protecting humanity from its future effects[9]. Climate change mitigation involves actions aimed at reducing or preventing greenhouse gas emissions such as reducing energy consumption, prioritizing renewable energy or absorbing carbon from the atmosphere[10]. Climate change adaptation meanwhile entails ecological, social or economic adjustments that can be taken to enable

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[2] Muigua. K., 'Achieving Sustainable Development, Peace and Environmental Security.' Glenwood Publishers Limited, 2021

[3] 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 08/04/2024)

[4] United Nations Development Programme., 'Islamic Finance's Answer to SDGs and Climate Change.' Available at https://www.undp.org/blog/islamic-finances-answer-sdgs-and-climate-change (Accessed on 08/04/2024)

[5] United Nations General Assembly., 'Transforming Our World: the 2030 Agenda for Sustainable Development.' 21 October 2015, A/RES/70/1., Available at https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf (Accessed on 08/04/2024)

[6] Ibid

[7] World Vision., 'How is the World Responding to Climate Change?' Available at https://www.worldvision.com.au/docs/default-source/school-resources/how-is-theworldrespondingto-climate-change.pdf?sfvrsn=32021b89_0 (Accessed on 08/04/2024)

[8] Ibid

[9] Ibid

[10] Ramsey County., 'On climate justice: Climate Change and Environmental Justice.' Available at https://www.ramseycounty.us/content/climate-justice-climate-change-and-environmentaljustice#:~:text=Climate%20Justice%20is%20a%20subset,the%20impacts%20of%20climate%20change (Accessed on 08/04/2024)

humanity to thrive in the face of changing climate such as planning for emergencies, ensuring that vulnerable individuals have reliable access to cooling and heating systems and planting drought tolerant crops[11].

One of the key climate change adaptation strategy involves enhancing climate information and early warning systems[12]. It has been noted that strengthening the resilience and capacity of all countries especially developing states to adapt to climate change cannot be achieved without scientific knowledge and data on climate change and its impacts[13]. Climate information and early warning systems aim to achieve this goal[14].

This paper critically examines the role of climate information and early warning systems in climate change mitigation. It argues that strengthening climate information and early warning systems can bolster environmental governance. The paper conceptualizes climate information and early warning systems and discusses how these ideas can enhance the global response towards climate change. It also discusses the progress and challenges towards embracing these two vital concepts and offers proposals towards strengthening climate information and early warning systems for effective environmental governance.

[11] Ibid
[12] United Nations Environment Programme., 'New UNEP Programme to Support Climate Resilience in Pacific Islands through Early Warning Systems' Available at https://www.unep.org/news-and-stories/press-release/new-unep-programme-support-climate-resilience-pacific-islands (Accessed on 08/04/2024)
[13] Ibid
[14] Ibid

2.0 The Need for Climate Information and Early Warning Systems

Early warning systems are processes aimed at reducing the impact of natural hazards by providing timely and relevant information in a systematic way[15]. Climate information and early warnings systems are necessary in strengthening the global response towards climate change. With the ongoing threat of climate change, the frequency and intensity of climate-related hazards is expected to increase[16]. Climate information and early warning systems have a great potential to avert disaster risk and minimize loss and damage associated with climate-related hazards through supporting well-informed science-based decision-making[17]. The use of climate information and early warning systems is an adaptive measure towards climate change that utilizes integrated communication systems to help communities prepare for hazardous climate-related events[18].

It has been noted that climate information and early warning systems are key elements of climate change adaptation and disaster risk reduction which aim to avoid or reduce the damages caused from hazards[19]. This approach embraces the use of sound scientific and technical data and focuses on people, communities or sectors mostly exposed to the adverse impacts of climate change[20]. It involves the adoption of a system approach incorporating all relevant risk factors, whether arising from the climate-hazards or social

[15] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Available at https://www.adaptation-undp.org/sites/default/files/resources/undp_brochure_early_warning_systems.pdf (Accessed on 08/04/2024)

[16] United Nations Environment Programme., 'Climate Information and Early Warning Systems' Available at https://www.unep.org/topics/climate-action/climate-transparency/climate-information-and-early-warning-systems (Accessed on 08/04/2024)

[17] Ibid

[18] United Nations., 'Early Warning Systems' Available at https://www.un.org/en/climatechange/climate-solutions/early-warning-systems (Accessed on 08/04/2024)

[19] Climate Adapt., 'Establishment of Early Warning Systems' Available at https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/establishment-of-early-warning-systems (Accessed on 08/04/2024)

[20] Ibid

vulnerabilities, and from short-term or long-term processes[21]. Some of the key early warning systems include detection, analysis, prediction, and then warning dissemination followed by response decision-making and implementation[22]. It has been noted that climate information and early warning systems are being utilized in many parts of the world to monitor, forecast, and warn people and communities about adverse consequences of climate change such as tropical cyclones, floods, storms, tsunami, avalanches, tornadoes, severe thunderstorms, volcanic eruptions, extreme heat and cold, forest fires, and drought among others[23].

Strengthening climate information and early warning systems is vital in saving lives and jobs, land and infrastructures and supporting long-term sustainability[24]. It has been noted that climate information and early warning systems are directly relevant for diverse sectors that are primary affected by climate-related events[25]. These sectors include health, disaster risk reduction, agriculture, forestry, buildings, coastal and urban areas[26]. In addition, it has been asserted that other sectors that can indirectly benefit from early warning systems include the transport sector, if roads or rails are closed in advance before humans are negatively impacted, or tourism, when ensuring that tourist groups are warned to access or refrain from accessing certain areas during extreme weather periods[27]. If effectively implemented, climate information and early warning systems can contribute to increasing the resilience of developing countries to natural disasters and climate-related events while offering simultaneous support for the achievement of the Sustainable Development Goals (SDGs) especially in reducing the loss of life and livelihood[28].

[21] Ibid
[22] Ibid
[23] Ibid
[24] United Nations., 'Early Warning Systems' Op Cit
[25] Climate Adapt., 'Establishment of Early Warning Systems' Op Cit
[26] Ibid
[27] Ibid
[28] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit

Climate information and early warning systems are therefore proven cost-effective disaster risk reduction and climate change adaptation measures which have been demonstrated to save lives, livelihoods and ecosystems in the face of climate-related events[29]. This approach addresses an urgent need to provide an evidence base for planning, decision-making and responses towards climate change that have the potential to save lives and livelihoods[30]. Strengthening climate information and early warning systems can improve the capacity to observe and predict the impacts of climate change and contribute to more effective environmental management, disaster risk reduction and food security[31]. It can also facilitate effective disaster risk reduction and climate change adaptation, empowering populations and communities at risk to initiate timely and appropriate actions to reduce the impact of climate-related hazards and extreme weather events[32]. Strengthening climate information and early warning systems ensures the provision of timely and effective information, through identified institutions, that allows individuals exposed to climate hazards to take action to avoid or reduce their risk and prepare for effective response[33].

The need to strengthen climate information and early warning systems is recognized at the global, regional, and national levels. In order to effectively confront climate change, SDG 13 urges all countries to improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and *early warning*[34]. Further, the *Early Warnings for All Initiative (EW4All)* was launched at COP

[29] United Nations Environment Programme., 'Climate Information and Early Warning Systems' Op Cit
[30] United Nations Environment Programme., 'New UNEP Programme to Support Climate Resilience in Pacific Islands through Early Warning Systems' Op Cit
[31] Ibid
[32] Ibid
[33] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[34] United Nations General Assembly., 'Transforming Our World: the 2030 Agenda for Sustainable Development.' 21 October 2015, A/RES/70/1., Op Cit

27[35]. The Initiative calls for the whole world to be covered by an early warning system by the end of 2027[36]. The Initiative articulates four pillars for implementation of effective early warning systems which are: risk knowledge and management; observations and forecasting; dissemination and communication; and preparedness to respond[37]. Holistic strengthening of all these elements can accelerate evidence-based policy, planning and early action towards climate change.

At the continental level, the *African Union Climate Change and Resilient Development Strategy and Action Plan*[38] recognizes the role of climate information and early warning systems in confronting climate change in Africa. The Strategy and Action Plan urges African countries to enhance climate information services and improve climate literacy and awareness[39]. It acknowledges that climate data, information and related products are useful in multiple climate-sensitive socio-economic sectors such as: agriculture; disasters risk management; water resources; health; and energy for societal benefits[40]. In addition, the Strategy and Action Plan recognizes that early warning systems can help to build resilience by responding to climate crises before they occur[41]. It states that if early warning systems are properly linked with national social protection systems, they have the potential to not only help smooth climate-related shocks, avoiding set-backs in development, but also to enable poor and vulnerable people to manage climate risks more effectively and in a proactive manner[42]. The Strategy and Action Plan requires

[35] United Nations Office for Disaster Risk Reduction., 'Early Warnings for All Initiative Scaled Up into Action on the Ground' Available at https://www.undrr.org/news/early-warnings-all-initiative-scaled-action-ground#:~:text=Background%20to%20the%20initiative,by%20the%20end%20of%202027. (Accessed on 08/04/2024)
[36] Ibid
[37] Ibid
[38] African Union., 'African Union Climate Change and Resilient Development Strategy and Action Plan' Available at https://au.int/sites/default/files/documents/42276-doc-CC_Strategy_and_Action_Plan_2022-2032_23_06_22_ENGLISH-compressed.pdf (Accessed on 09/04/2024)
[39] Ibid
[40] Ibid
[41] Ibid
[42] Ibid

African countries to strengthen their prediction, early warning and preparation activities in order to effectively respond to climate change[43]. It is necessary to implement the *African Union Climate Change and Resilient Development Strategy and Action Plan* in order to strengthen climate information and early warning systems for effective environmental governance.

In addition, the *African Leaders Nairobi Declaration on Climate Change and Call to Action*[44] recognizes the need to strengthen climate information and early warning systems for effective environmental governance in Africa. It urges African countries to strengthen early warning systems and climate information services, as well as take early action to protect lives, livelihoods and assets and inform long-term decision-making related to climate change risks[45]. The Nairobi Declaration also emphasizes the importance of embracing indigenous knowledge and citizen science in both adaptation strategies and early warning systems for effective response towards climate change in Africa[46].

At a regional level, *the East African Community (EAC) Climate Change Policy*[47] requires EAC member states to strengthen climate information and early warning systems. It identifies climate information services as a key tool in the response towards climate change in the EAC region[48]. It urges EAC member states to strengthen research and promote data and information exchange[49]. The Policy further notes that early warning system is a functional approach for generation and provision of timely and effective information, through identified institutions, that allows individuals exposed to a hazard to take action to avoid

[43] Ibid
[44] African Leaders Nairobi Declaration on Climate Change and Call to Action., Available at https://au.int/sites/default/files/decisions/43124-Nairobi_Declaration_06092023.pdf (Accessed on 09/04/2024)
[45] Ibid
[46] Ibid
[47] East African Community Climate Change Policy., Available at https://www.eac.int/environment/climate-change/eac-climate-change-policy-framework (Accessed on 09/04/2024)
[48] Ibid
[49] Ibid

or reduce their risk and prepare for effective response[50]. The Policy requires EAC member states to develop timely, reliable and adequate early warning information systems for extreme weather and climatic disasters[51]. It also requires EAC member states to enhance disaster risk preparedness through, inter alia, production, acquisition and dissemination of weather and climate information services for improved early warning systems[52]. It is imperative for EAC member states to embrace and implement this Policy in order to enhance climate information and early warning systems for effective environmental governance in the region.

At a national level, Kenya's *National Framework for Climate Services*[53] sets out the importance of strengthening climate information and early warning systems. The Framework notes that climate information includes climate data, climate products and climate knowledge[54]. It seeks to enhance the capacity to generate and use climate information and products for effective climate action in Kenya[55]. It also requires Kenya to enhance investments in disaster risk reduction and early warning systems to mitigate the impact of extreme weather events[56]. According to the Framework, Kenya being one of the countries severely impacted by climate change and increased frequency and magnitude of extreme climate events should be at the forefront of ensuring protection of its citizens by early warning systems and information[57]. It is therefore vital to strengthen climate information and early warning systems for effective environmental governance in Kenya.

[50] Ibid
[51] Ibid
[52] Ibid
[53] Republic of Kenya., 'National Framework for Climate Services' Available at https://meteo.go.ke/sites/default/files/downloads/NFCS_Kenya_11_Oct_2023_0.pdf (Accessed on 09/04/2024)
[54] Ibid
[55] Ibid
[56] Ibid
[57] Ibid

Despite the key role played by climate information and early warning systems in environmental governance, several factors hinder their effective uptake. For example, gaps in legal, institutional and policy frameworks can prevent the operationalisation of early warning systems and the integration of climate information into decision-making across all sectors[58]. It has correctly been noted that laws and regulations are of paramount importance for clearly defining roles, responsibilities, and actions to undertake for the operation and management of climate information and early warning systems[59]. Therefore an inefficient legal and institutional framework can result in confusion and delayed reaction especially in an emergency situation where the time factor is crucial[60]. It has also been noted that in many developing countries, the public sector lacks human resources with the necessary experience, skills, and expertise to maintain and operate early warning systems[61]. In addition, many developing countries lack the necessary technology, infrastructure, and forecasting capability[62]. For example, it has been observed that despite the progress made towards the development of observational networks in Africa, the continent's observational infrastructure has not yet met the optimum standards for effective forecasts and early warning systems[63]. It is necessary to solve these challenges in order to strengthen climate information and early warning systems for effective environmental governance.

3.0 Way Forward

In order to strengthen climate information and early warning systems, there is need to enhance dissemination of climate information[64]. Climate information is a very vital

[58] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[59] Ibid
[60] Ibid
[61] Ibid
[62] Ibid
[63] African Union., 'African Union Climate Change and Resilient Development Strategy and Action Plan' Op Cit
[64] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit

component of the global response towards climate change[65]. It enables citizens and communities to better understand and manage their exposure to climate change[66]. It can also support well-informed science-based decision-making on climate action[67]. Climate information can also enable populations to initiate timely and appropriate actions to reduce the impact of hazards and extreme events[68]. Climate information is therefore a key tool for climate change adaptation that makes it possible to observe and predict the impacts of climate change therefore contributing to more effective environmental management, disaster risk reduction and food security[69]. It is therefore necessary for all countries to enhance access to climate information for improved environmental governance.

It is also vital to build effective early warning systems[70]. It has been noted that effective early warning systems ensure that precursors to events are monitored on a continuous basis, data is analysed to generate a forecast, and that if there is a forecast of a large event, a warning is issued[71]. According to the United Nations Development Programme, effective early warning systems comprise of risk knowledge which is the interplay between establishing organisational arrangements, identifying natural hazards, community vulnerability assessment, risk assessment, and information storing and sharing[72]; monitoring and warning services which comprises of the infrastructure that delivers forecasts and warnings[73]; dissemination and communication services which involves distribution of understandable warnings and preparedness information to those

[65] African Union., 'African Union Climate Change and Resilient Development Strategy and Action Plan' Op Cit
[66] Ibid
[67] United Nations., 'Early Warning Systems' Op Cit
[68] United Nations Environment Programme., 'New UNEP Programme to Support Climate Resilience in Pacific Islands through Early Warning Systems' Op Cit
[69] Ibid
[70] Ibid
[71] Republic of Kenya., 'National Framework for Climate Services' Op Cit
[72] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[73] Ibid

at risk of a hazard[74]; and response capability which entails centralised knowledge, plans, and inputs needed for timely and appropriate action by authorities and those at risk[75]. It is necessary for all countries to build effective early warning systems. If correctly implemented, early warning systems can help to reduce losses of lives and property, and to minimise environmental damage associated with the adverse impacts of climate change[76].

In addition, it is imperative to embrace public participation and the role of indigenous knowledge in order to strengthen climate information and early warning systems[77]. It has been correctly noted that to be effective, early warning systems need to actively involve the people and communities at risk from a range of hazards, facilitate public education and awareness of risks, disseminate messages and warnings efficiently and ensure that there is a constant state of preparedness and that early action is enabled[78]. Therefore, the significance of an effective early warning system lies in the recognition of its benefits by people at local levels who are mostly exposed to climate hazards[79]. Participatory or people-centered early warning systems have great potential to improve decisions taken by both emergency institutions and communities exposed or affected by climate hazards[80]. In addition, indigenous knowledge can help in disaster risk reduction and increase the resilience of vulnerable communities[81]. Indigenous communities in places such as Africa have over the years developed an array of early warning indicators and well-developed structures through which the wisdom of the community is applied to

[74] Ibid
[75] Ibid
[76] Ibid
[77] African Leaders Nairobi Declaration on Climate Change and Call to Action., Op Cit
[78] Climate Adapt., 'Establishment of Early Warning Systems' Op Cit
[79] Ibid
[80] Marchezini. V et al., 'A Review of Studies on Participatory Early Warning Systems (P-EWS): Pathways to Support Citizen Science Initiatives' Available at https://www.frontiersin.org/articles/10.3389/feart.2018.00184/full (Accessed on 09/04/2024)
[81] Haokip. T., 'Indigenous Knowledge as Early Warning Guide in Disaster Management' Available at https://link.springer.com/referenceworkentry/10.1007/978-981-19-8388-7_8#:~:text=However%2C%20indigenous%20knowledge%20is%20often,the%20resilience%20of%20vulnerable%20communities. (Accessed on 09/04/2024)

deal quickly and efficiently with disasters[82]. These include the ability to predict extreme weather events such as heavy rainfall, droughts, and famine which enabled communities to prepare adequately for the impacts of such events[83]. Therefore, integrating indigenous knowledge with modern scientific approaches can strengthen climate information and early warning systems[84].

Finally, it is necessary to enhance the legal, institutional, policy, technical and human capacity for effective climate information and early warning systems[85]. Countries should therefore enact laws and policies with precise indications of roles, responsibilities, and actions in climate information and early warning systems[86]. It is also necessary for all countries to strengthen institutional capacities which refers to the ability of governments and institutions to effectively perform functions in a sustainable and long-term manner[87]. In addition, it is imperative to enhance human capacity through training and capacity building in prediction, early warning and preparation activities[88]. International, continental, and regional cooperation is also key in strengthening climate information and early warning systems in developing countries through financial, technological and capacity development components[89]. Further, it is vital for all countries to invest in scientific and technical tools necessary for effective forecasts and early warning systems[90]. It has been noted that scientific and technological solutions offer an opportunity for low-

[82] United Nations Office for Disaster Risk Reduction., 'Indigenous Disaster Early Warning, Preparedness, and Response' Available at https://www.unisdr.org/preventionweb/files/18123_indigenousdisasterearlywarningprepa.pdf (Accessed on 09/04/2024)
[83] Ibid
[84] Ibid
[85] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[86] Ibid
[87] Ibid
[88] African Union., 'African Union Climate Change and Resilient Development Strategy and Action Plan' Op Cit
[89] Ibid
[90] Ibid

cost advances in early warning systems, contributing to increased resilience[91]. These solutions can foster the automation and rapid processing of a series of fundamental steps within the early warning chain[92].

The foregoing among other approaches are vital in strengthening early warning systems for effective environmental governance.

4.0 Conclusion

Climate information and early warning systems are key elements of climate change adaptation and disaster risk reduction which aim to avoid or reduce the damages caused from hazards[93]. Strengthening climate information and early warning systems is vital in saving lives and jobs, land and infrastructures and supporting long-term sustainability[94]. Effective implementation of climate information and early warning systems can contribute to increasing the resilience of developing countries to natural disasters and climate-related events while offering simultaneous support for the achievement of the SDGs[95]. Despite their key role in climate action, several factors hinder effective uptake of climate information and early warning systems. These factors include gaps in legal, institutional and policy frameworks; and insufficient human and technical capacity[96]. It is necessary to address these challenges in order to strengthen climate information and early warning systems for effective environmental governance. This can be realized through enhancing dissemination of climate information[97]; building effective early warning systems[98]; embracing public participation and the role of indigenous knowledge

[91] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[92] Ibid
[93] Climate Adapt., 'Establishment of Early Warning Systems' Op Cit
[94] United Nations., 'Early Warning Systems' Op Cit
[95] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit
[96] Ibid
[97] Ibid
[98] United Nations Environment Programme., 'New UNEP Programme to Support Climate Resilience in Pacific Islands through Early Warning Systems' Op Cit

for enhanced climate information and early warning systems[99]; and strengthening the legal, institutional, policy, technical and human capacities for effective climate information and early warning systems[100]. Strengthening climate information and early warning systems for effective environmental governance is a goal that needs to pursued and realized by all countries.

[99] African Leaders Nairobi Declaration on Climate Change and Call to Action., Op Cit

[100] United Nations Development Programme., 'Five Approaches to Build Functional Early Warning Systems' Op Cit

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