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Editor's Note

Welcome to the *Journal of Conflict Management and Sustainable Development,* Volume 11, No.5. The Journal is an interdisciplinary publication that focuses on key and emerging themes in Conflict Management, Sustainable Development and other related fields of knowledge.

Sustainable Development has been embraced at both the global and national levels as the blue print for socio-economic development and governance. The Journal interrogates and offers solutions to some of the current concerns in the Sustainable Development Agenda. It also explores the role of Conflict Management in the attainment of Sustainable Development.

The Journal has witnessed significant growth since its launch and is now a widely cited and authoritative publication in the fields of Conflict Management and Sustainable Development. The Editorial Team welcomes feedback and suggestions from our readers across the globe to enable us to continue improving the Journal.

The Journal is peer reviewed and refereed in order to adhere to the highest quality of academic standards and credibility of information. Papers submitted to the Journal are taken through a rigorous review by our team of internal and external reviewers.

This volume contains papers on various themes including: *Protecting Our Endangered Species for Sustainability; Changing The Narrative on the Right to a Clean and Healthy Environment: Analysing Ecocentrism as a Possible Method of Environmental Governance in Kenya; Integrating Environmental Social & Governance (ESG) Principles into Corporate Governance in Kenya: Trends, Challenges, and Best Practices; Problematic Overlaps and Duplication of Mandates of State and Governmental Agencies in Kenya: Proposals for Legal and Institutional Reform; Lesson Study: Towards an Improved Instruction in Stem Education in Junior Secondary Schools In Kenya; Management of Industrial Waste water in Kenya: Case study of Mavoko; Does the Law Work? A Case of Kenyan Prison Congestion and the Witchcraft Act; Fostering Sustainable Lifestyles for Posterity;*

Legislating to Protect and Compensate Whistleblowers in Kenya: An Appraisal of the Proposed Whistleblower Protection Bill, 2023; The Phenomena of Resource Curse and How to Navigate around it; Primary Teacher Education and Kenya's Vision 2030. The Lacuna in the Transformation Agenda; Mitigating the Environmental Impact of Oil: Strategies for Sustainable Development; and *The Implications of Implementing Kenya's Electronic Travel Authorisation (eTA) System: A Comparative Appraisal*. The Journal also contains a book review of *Towards Human Rights and Prosperity for All* and a review of *Journal of Appropriate Dispute Resolution (ADR) & Sustainability Volume 2 Issue 3.*

We welcome feedback, comments and critique from our readers to enable us to continue improving the Journal.

I wish to thank all those who have made this publication possible including reviewers, editors and contributors.

The Editorial Team also welcomes the submission of articles to be considered for publication in subsequent issues of the Journal. Submissions can be channeled to *admin@kmco.co.ke* and copied to editor@journalofcmsd.net.
Our readers can access the Journal online at https://journalofcmsd.net.

Hon. Prof. Kariuki Muigua Ph.D, FCIArb, Ch.Arb, OGW.
Professor of Environmental Law and Conflict Management
Editor, Nairobi,
November, 2024.

Embracing Science and Technology for Ecosystem Health, Community Resilience and Sustainability

By: ***Hon. Prof. Kariuki Muigua****

Abstract

The Post-2015 Agenda and Rio+20 follow-up efforts use technology, research, and capacity development. Science, technology, and innovation (STI) are key to building prosperous, inclusive, and environmentally sustainable economies in developing and developed countries, according to the 2030 Agenda for Sustainable Development.

The development, deployment, and distribution of environmentally friendly technologies in a Green Economy are linked to other key components and implementation processes. Sustainability studies must include ecosystem health as human activity harms or degrades ecosystems. Understanding human activity's effects on climate change, land use changes, biodiversity loss, and habitat degradation helps create ecosystem health initiatives.

Digital technology, especially ICT, drives industrial innovation and infrastructure development. By increasing productivity, employment, and entrepreneurship, ICT may boost economic growth. Smart manufacturing and circular economy frameworks help improve industrial sustainability.

Citizen science, which involves volunteers in scientifically supported activities like data gathering, can help achieve all 17 Sustainable Development Goals (SDGs) of poverty alleviation, health promotion, land, air, and water preservation, economic prosperity, peace, and justice.

Ecological sustainability requires resilience, balance, and equity, measures by an ecosystem's structural and functional recovery from shocks. Technology may reduce vulnerabilities and improve adaptive capacities to climate change and other natural disasters.

This paper critically discusses how science and technology can be explored and used in

enhancing ecosystem health, community resilience and sustainability.

1. Introduction

Technology, science, and capacity development are fundamental components of the Means of Implementation for the Post-2015 Agenda and the Rio+20 follow-up initiatives.[1]

The United Nations categorizes the methods of implementation for the Sustainable Development Goals (SDGs) as financing, technology, capacity development, trade, policy coherence, collaboration, data monitoring, and accountability.[2] The 2030 Agenda for Sustainable Development underscores science, technology, and innovation (STI) as a crucial catalyst for fostering affluent, inclusive, and ecologically sustainable economies in both developing and developed nations.[3] Science for sustainable development must provide the evidence necessary to overcome existing socio-economic and particularly political stalemates, allowing innovative and revolutionary solutions that yield significant, if not enduring, improvements.[4] An essential method for implementing sustainable development objectives, integral to the 2030 Agenda,

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PhD in Law (Nrb), FCIArb (Chartered Arbitrator), LL. B (Hons) Nrb, LL.M (Environmental Law) Nrb; Dip. In Law (KSL); FCPS (K); Dip. In Arbitration (UK); MKIM; Mediator; Consultant: Lead expert EIA/EA NEMA; BSI ISO/IEC 27001:2005 ISMS Lead Auditor/ Implementer; Advocate of the High Court of Kenya; Professor of Environmental Law at the University of Nairobi, Faculty of Law.

[1] 'Technology | Department of Economic and Social Affairs' <https://sdgs.un.org/topics/technology> accessed 4 November 2024.

[2] Gervas E. Assey, 'The Role of Science, Technology and Innovation in Implementation of Sustainable Development Goals', *The Cradle of Knowledge: African Journal of Educational and Social Science Research,* Volume 8, No.1, 2020 ISSN 2304-2885-p, 2617-7315e.

[3] Ibid.; see also 'Digital Technologies Directly Benefit 70 Percent of SDG Targets, Say ITU, UNDP and Partners' (*UNDP*) <https://www.undp.org/press-releases/digital-technologies-directly-benefit-70-percent-sdg-targets-say-itu-undp-and-partners> accessed 5 November 2024.

[4] Ibid.

is the efficient utilisation of science, technology, and innovation.[5]

The research, development, deployment, and extensive dissemination of environmentally sustainable technologies within a Green Economy are intricately connected to other fundamental components and implementation mechanisms, such as innovation, business prospects and growth, trade in environmental goods and services, financing and investment, and institutional competencies.[6]

The health of ecosystems is a vital term in sustainability studies, since ecosystems are increasingly harmed or deteriorated by pressures linked to human activity.[7] An intact ecosystem delivers vital services for humanity and the natural world, with considerable social and economic worth.[8] Comprehending the impact of human activity on climate change, land use alteration, biodiversity decline, and habitat degradation enables the formulation of strategies to attain and sustain ecosystem health.[9] Ecosystem health denotes the condition and capacity of an ecosystem to sustain its structural integrity, functional vitality, and resilience in the face of stress, while consistently delivering high-quality ecosystem services

[5] Ibid.
[6] 'Technology | Department of Economic and Social Affairs' <https://sdgs.un.org/topics/technology> accessed 4 November 2024.
[7] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015) 1 Ecosystem Health and Sustainability 1 <https://spj.science.org/doi/10.1890/EHS14-0013.1> accessed 4 November 2024.
[8] Ibid.
[9] Ibid.; Sintayehu DW, 'Impact of Climate Change on Biodiversity and Associated Key Ecosystem Services in Africa: A Systematic Review' (2018) 4 Ecosystem Health and Sustainability 225; Wang Z and others, 'Biodiversity Conservation in the Context of Climate Change: Facing Challenges and Management Strategies' (2024) 937 Science of The Total Environment 173377; Weiskopf SR and others, 'Climate Change Effects on Biodiversity, Ecosystems, Ecosystem Services, and Natural Resource Management in the United States' (2020) 733 Science of The Total Environment 137782; Dejene S, 'Impact of Climate Change on Biodiversity and Associated Key Ecosystem Services in Africa: A Systematic Review' (2018) 4 Ecosystem Health and Sustainability 225.

for current and future generations indefinitely.[10] It has been characterized via several viewpoints, including sickness, vital signs and system integrity, resilience, and environmental stressors shaped by social and cultural norms.[11] An ecosystem is deemed healthy when it is sustainable, signifying its ability to preserve its structure and function throughout time despite external stressors.[12]
It has rightly been pointed out that people are now more empowered thanks to digital technology, economic diversity brought about by innovation that makes countries more resilient to shocks, and new technologies may be able to separate environmental deterioration from economic growth.[13] According to SDG 9, technology, especially Information and Communication Technology (ICT), is a crucial facilitator of industry innovation and infrastructural advancement.[14] Information and Communication Technology (ICT) may stimulate economic development by improving productivity, generating employment, and promoting entrepreneurship.[15] Furthermore, it may enhance industrial sustainability by promoting the shift towards smart manufacturing and circular economy frameworks.[16]

Through the use of modern technology, citizen science involves volunteers in scientifically supported activities like data gathering.[17] Citizen science presents an innovative, multifaceted method for enhancing physical activity and other

[10] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015) 1 Ecosystem Health and Sustainability 1 <https://spj.science.org/doi/10.1890/EHS14-0013.1> accessed 4 November 2024.
[11] Ibid.
[12] Ibid.
[13] United Nations Conference on Trade and Development., *The Role of Science, Technology and Innovation in Building Resilient Communities, Including through the Contribution of Citizen Science* ([Erscheinungsort nicht ermittelbar] United Nations 2020 2020).
[14] 'Technology | Sustainable Development Goals - Resource Centre' <https://sdgresources.relx.com/technology-0> accessed 4 November 2024.
[15] Ibid.
[16] Ibid.
[17] United Nations Conference on Trade and Development., *The Role of Science, Technology and Innovation in Building Resilient Communities, Including through the Contribution of Citizen Science* ([Erscheinungsort nicht ermittelbar] United Nations 2020).

healthful behaviours in both affluent and under-resourced, marginalised communities.[18] This approach enables residents to gather diagnostic data regarding their community environment, identify priority issues, and collaborate across sectors to develop effective and meaningful solutions.[19] Scientists must thus engage with society, use new technologies for knowledge generation, and enhance their research via collaboration with people and volunteers.[20] The public engaged in scientific research stands to benefit significantly, from the development of scientific competencies to a profound feeling of contributing to societal progress.[21] Citizen science establishes a connection between science and education that, when integrated with modern technology, broadens the horizons of ecological research and public involvement.[22]

Digital technologies may positively contribute to the attainment of all 17 Sustainable Development Goals (SDGs), including the alleviation of poverty and hunger, the promotion of health and education, the preservation of land, air, and water, and the enhancement of economic prosperity, peace, and justice.[23]

Resilience, balance, and equality are the three main attributes indicative of ecological sustainability.[24] Resilience is quantified by an ecosystem's ability to

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[18] King AC and others, 'Leveraging Citizen Science and Information Technology for Population Physical Activity Promotion' (2016) 1 Translational journal of the American College of Sports Medicine 30.
[19] Ibid.
[20] Roberto, 'Public Participation in Scientific Programmes: Citizen Science for Biodiversity' (*International Science Council*, 6 January 2023) <https://council.science/current/blog/public-participation-in-scientific-programmes-citizen-science-for-biodiversity/> accessed 5 November 2024.
[21] Ibid.
[22] Newman, Greg, Andrea Wiggins, Alycia Crall, Eric Graham, Sarah Newman, and Kevin Crowston, "The future of citizen science: emerging technologies and shifting paradigms." *Frontiers in Ecology and the Environment* 10, no. 6 (2012): 298-304.
[23] Dennehy D and others, 'Technology and Analytics for Global Development: Transforming Agriculture, Empowering Sustainable Livelihoods, and Ensuring Planetary Well-Being' (2024) 43 IEEE Technology and Society Magazine 44.
[24] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015) 1 Ecosystem Health

recover structurally and functionally from disturbances.[25] Resilience refers to an ecosystem's ability to recuperate from dysfunction, but resilience also denotes the capability to sustain ecological function throughout stress.[26] Resilience measurements may concentrate on the recovery rate and extent of the variables assessed to gauge resistance.[27]

Research indicates that citizen science methodologies can enhance community resilience at the institutional level by augmenting emergency and recovery planning capabilities; at the infrastructural level by aiding land use planning and urban design; and at the social level by fostering community connections and social capital.[28]

More and more, communities are realising that technology can help them better withstand the effects of climate change and other natural catastrophes.[29] Reducing vulnerabilities and strengthening adaptive capabilities becomes critical

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and Sustainability 1 <https://spj.science.org/doi/10.1890/EHS14-0013.1> accessed 4 November 2024.

[25] Ibid.

[26] Ibid.; see also Zabaniotou A, 'A Systemic Approach to Resilience and Ecological Sustainability during the COVID-19 Pandemic: Human, Societal, and Ecological Health as a System-Wide Emergent Property in the Anthropocene' (2020) 2 Global Transitions 116.

[27] Ibid.; see also Asheim GB and others, 'The Measurement of Resilience' (2020) 189 Journal of Economic Theory 105104.

[28] Daniel AD and Fernandes J, 'Promotion of Community Resilience: Do Citizens Have a Role to Play?' (2024) 29 Local Environment 987 <https://www.tandfonline.com/doi/full/10.1080/13549839.2024.2345621> accessed 4 November 2024; see also Law E and others, 'The Science of Citizen Science: Theories, Methodologies and Platforms', *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing* (Association for Computing Machinery 2017) <https://doi.org/10.1145/3022198.3022652> accessed 4 November 2024.

[29] 'The Role of Technology in Enhancing Community Resilience to Climate Change and Natural Disasters. - Consensus Academic Search Engine' <https://consensus.app/questions/role-technology-enhancing-community-resilience-climate/> accessed 4 November 2024.

as climate change amplifies the frequency and severity of natural catastrophes.[30] One way to do this is by harnessing technology breakthroughs.[31] Technology provides effective instruments for preventing and adapting to climate change in relation to SDG 13.[32] Renewable energy technology may mitigate greenhouse gas emissions, whilst climate information services can bolster resistance to climate effects.[33] Moreover, digital technology may enhance the monitoring and reporting of climate initiatives, so fostering increased openness and accountability.[34]

This paper critically discusses how science and technology can be explored and used in enhancing ecosystem health, community resilience and sustainability.

2. Ecosystem Health, Community Resilience and Sustainability: Challenges and Prospects

The evaluation of ecosystem health is measuring a system's resistance and resilience by introducing distresses or stressors and noting the extent of initial deformation and subsequent recovery.[35] Key indicators for assessing ecosystem health encompass biological indicators at the ecosystem, community, population, and individual levels; physicochemical indicators; soil physical and chemical characteristics; soil structure; soil enzyme activity; and socioeconomic indicators.[36]

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[30] Ibid.
[31] Ibid.
[32] 'Technology | Sustainable Development Goals - Resource Centre' <https://sdgresources.relx.com/technology-0> accessed 4 November 2024.
[33] Ibid.
[34] Ibid.
[35] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015) 1 Ecosystem Health and Sustainability 1 <https://spj.science.org/doi/10.1890/EHS14-0013.1> accessed 4 November 2024.
[36] Ibid.; see also Bhaduri D and others, 'A Review on Effective Soil Health Bio-Indicators for Ecosystem Restoration and Sustainability' (2022) 13 Frontiers in Microbiology <https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2022.938481/full> accessed 5 November 2024.

An ecological system is deemed healthy and devoid of distress syndrome if it exhibits stability and sustainability, remains active while preserving its structure and autonomy throughout time, and demonstrates resilience to stress.[37] The health of an ecosystem is crucial for its ability to provide services that confer social and economic benefits to the human population. Ecosystem services are often classified into four categories: supplying, regulating, sustaining, and cultural services.[38] Enhancing human welfare via improved ecosystem services necessitates a deeper comprehension of the integrated social-ecological system, alongside advancements in the design of suitable finance, policy, and governance frameworks, as well as their implementation across varied social and ecological contexts.[39]

The health of ecosystems is intrinsically linked to sustainability, which is defined as the capacity to meet present and future societal demands for ecological services.[40] The capacity to perpetually provide ecosystem services for future

[37] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015), op. cit.; Costanza, Robert, and Michael Mageau. "What is a healthy ecosystem?" *Aquatic ecology* 33 (1999): 105-115.

[38] Ibid.; Danley B and Widmark C, 'Evaluating Conceptual Definitions of Ecosystem Services and Their Implications' (2016) 126 Ecological Economics 132.

[39] Ibid.; You C and others, 'Trade-off and Synergistic of Ecosystem Services Supply and Demand Based on Socio-Ecological System (SES) in Typical Hilly Regions of South China' (2024) 160 Ecological Indicators 111749; Yang W and others, 'An Integrated Approach to Understanding the Linkages between Ecosystem Services and Human Well-Being' (2015) 1 Ecosystem Health and Sustainability 19; Chaplin-Kramer R and others, 'Integrated Modeling of Nature's Role in Human Well-Being: A Research Agenda' (2024) 88 Global Environmental Change 102891; Huntsinger L and Oviedo J, 'Ecosystem Services Are Social–Ecological Services in a Traditional Pastoral System: The Case of California's Mediterranean Rangelands' (2014) 19 Ecology And Society 8.

[40] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015)op. cit.; Norton B, 'Sustainability, Human Welfare, and Ecosystem Health' (1992) 1 Environmental Values 97; Ellis EC, Pascual U and Mertz O, 'Ecosystem Services and Nature's Contribution to People: Negotiating Diverse Values and Trade-Offs in Land Systems' (2019) 38 Current Opinion in Environmental Sustainability 86; Butler CD and Soskolne CL, 'Ecosystems, Stable and Sustainable' in Marc D Gellman and J Rick Turner (eds), *Encyclopedia of*

generations has been emphasised as a significant concern in environmental justice.[41]

Communities may cultivate resilience by proactively enhancing their potential to prosper in a dynamic environment, and community resilience serves as a crucial measure of social sustainability.[42] Community resilience is the presence, cultivation, and involvement of community resources by members to prosper in an environment marked by change, uncertainty, unpredictability, and surprise.[43] The primary emphasis of community resilience is on risk and hazard management, specifically the capacity of a community to recover to its prior state following a disturbance.[44] A more comprehensive definition of this type of resilience encompasses the community's ability to pursue a shared goal, foster self-sufficiency, and enhance its inherent capacity to mitigate vulnerability to shocks.[45]

Behavioral Medicine (Springer 2013) <https://doi.org/10.1007/978-1-4419-1005-9_1394> accessed 5 November 2024.

[41] Lu Y and others, 'Ecosystem Health towards Sustainability' (2015)op. cit.; Langemeyer J and others, 'Ecosystem Services Justice: The Emergence of a Critical Research Field' (2024) 69 Ecosystem Services 101655; Calderón-Argelich A and others, 'Tracing and Building up Environmental Justice Considerations in the Urban Ecosystem Service Literature: A Systematic Review' (2021) 214 Landscape and Urban Planning 104130; Kronenberg J, 'Environmental Impacts of the Use of Ecosystem Services: Case Study of Birdwatching' (2014) 54 Environmental Management 617; Aragao A, Jacobs S and Cliquet A, 'What's Law Got to Do with It? Why Environmental Justice Is Essential to Ecosystem Service Valuation' (2016) 22 Ecosystem Services; Lele S and others, 'Ecosystem Services: Origins, Contributions, Pitfalls, and Alternatives' (2013) 11 Conservation and Society 343.

[42] Magis K, 'Community Resilience: An Indicator of Social Sustainability' (2010) 23 Society & Natural Resources 401 <http://www.tandfonline.com/doi/abs/10.1080/08941920903305674> accessed 4 November 2024.

[43] Ibid.

[44] Quaranta, Giovanni, Cristina Dalia, Luca Salvati, and Rosanna Salvia. "Building resilience: an art–food hub to connect local communities." *Sustainability* 11, no. 24 (2019): 7169.

[45] Ibid.; Lv Y, Sarker MNI and Firdaus RBR, 'Disaster Resilience in Climate-Vulnerable Community Context: Conceptual Analysis' (2024) 158 Ecological Indicators 111527;

Fostering resilience in communities necessitates capitalizing on possibilities across several domains, including the acquisition of financial and human capital resources via collaborations with governmental bodies, non-profit organisations, and private sector companies.[46] Collaboration and community involvement may bolster resilience initiatives by consolidating resources, expertise, and competencies from community members, stakeholders, and local organisations.[47] Technological improvements provide opportunities, like digital technologies, data analytics, and predictive modelling, which may be used to enhance community resilience.[48]

Norris F and others, 'Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness' (2008) 41 American journal of community psychology 127; Carlson J and others, *Resilience: Theory and Application* (2012); Carmen E and others, 'Building Community Resilience in a Context of Climate Change: The Role of Social Capital' (2022) 51 Ambio 1371; Ungar M, 'Systemic Resilience: Principles and Processes for a Science of Change in Contexts of Adversity' (2018) 23 Ecology and Society <https://www.jstor.org/stable/26796886> accessed 5 November 2024.

[46] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023) 10 Bhumi The Planning Research Journal 33.

[47] Ibid.; Elkady S, Hernantes J and Labaka L, 'Towards a Resilient Community: A Decision Support Framework for Prioritizing Stakeholders' Interaction Areas' (2023) 237 Reliability Engineering & System Safety 109358; Ma C, Qirui C and Lv Y, '"One Community at a Time": Promoting Community Resilience in the Face of Natural Hazards and Public Health Challenges' (2023) 23 BMC Public Health; Castañer X and Oliveira N, 'Collaboration, Coordination, and Cooperation Among Organizations: Establishing the Distinctive Meanings of These Terms Through a Systematic Literature Review' (2020) 46 Journal of Management 965; Jensen O and Ong C, 'Collaborative Action for Community Resilience to Climate Risks: Opportunities and Barriers' (2020) 12 Sustainability 3413; Haque CE, Khan SA and Choudhury M, 'Role of Multi-Level Institutions in Facilitating Innovation and Adaptation Technologies for Reducing Climate Risk and Impact: Evidence from Coastal Communities of Bangladesh' (2024) 111 International Journal of Disaster Risk Reduction 104669.

[48] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*; Argyroudis SA and others, 'Digital Technologies Can Enhance Climate Resilience of Critical Infrastructure' (2022) 35 Climate Risk Management 100387; Samarakkody A, Amaratunga D and Haigh R, 'Technological Innovations for Enhancing Disaster Resilience in Smart Cities: A Comprehensive Urban Scholar's Analysis' (2023) 15 Sustainability 12036; 'UNDP Digital Guides - Livelihoods and Economic Recovery' <https://digitalguides.undp.org/guide/livelihoods-and-economic-recovery> accessed

Obstacles to developing resilience include limited resource availability, isolated or rural areas unable to access vital infrastructure and services, and disadvantaged groups facing disproportionate effects and diminished recovery capability.[49] Concentrated efforts and specific assistance are required to tackle resource limitations, enhance access to infrastructure and services, and guarantee the involvement and resilience of marginalised communities in community resilience programs.[50]

Public-private collaborations are essential for disseminating ICTs to all countries, populations, and communities.[51] Collaborations are essential for constructing the physical infrastructure necessary to provide Internet services in remote regions and underserved communities, as well as to promote the investment, inclusiveness, and innovation needed for the comprehensive achievement of the Sustainable Development Goals (SDGs).[52]

3. Place of Science and Technology in Promoting Sustainability

Sustainability science has recently developed as a dynamic domain of study and

5 November 2024; Girotto CD and others, 'A Critical Review of Digital Technology Innovations for Early Warning of Water-Related Disease Outbreaks Associated with Climatic Hazards' (2024) 100 International Journal of Disaster Risk Reduction 104151; 'Digital Technologies Enhance the Resilience of Individuals and Communities - Degrees' (19 June 2017) <https://degrees.fhi360.org/2017/06/digital-technologies-enhance-the-resilience-of-individuals-and-communities/, https://degrees.fhi360.org/2017/06/digital-technologies-enhance-the-resilience-of-individuals-and-communities/> accessed 5 November 2024.

[49] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' *op cit.*.

[50] Ibid.

[51] 'Digital Technologies to Achieve the UN SDGs' (*ITU*) <https://www.itu.int:443/en/mediacentre/backgrounders/Pages/icts-to-achieve-the-united-nations-sustainable-development-goals.aspx> accessed 4 November 2024.

[52] Ibid.; see also 'Digital Technologies Directly Benefit 70 Percent of SDG Targets, Say ITU, UNDP and Partners' (*UNDP*) <https://www.undp.org/press-releases/digital-technologies-directly-benefit-70-percent-sdg-targets-say-itu-undp-and-partners> accessed 5 November 2024.

innovation.[53] The motives are rooted in the World Commission on Environment and Development's designation of the paramount problem of our era: to "make development sustainable – ensuring that it satisfies current needs without jeopardising the capacity of future generations to fulfil their own requirements."[54] Its foundations are established in the scientific and social sciences, engineering, medicine, and several practical knowledge domains.[55] Its methodologies are integrative and translational, aiming to connect knowledge with action at the intersection of fundamental research and technology innovation.[56]

Sustainability science encompasses the disciplines of science, technology, and innovation aimed at fostering sustainable development—addressing human needs, alleviating hunger and poverty, while preserving the planet's life support systems.[57]

Through the provision of efficient channels of communication and information

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[53] Kates, Robert W. "Readings in sustainability science and technology." *CID Working Paper Series* (2010).

[54] Ibid.; 'Sustainability (World Commission on Environment and Development Definition) | Request PDF' <https://www.researchgate.net/publication/303929235_Sustainability_World_Commission_on_Environment_and_Development_Definition> accessed 5 November 2024; Hajian M and Kashani S, 'Evolution of the Concept of Sustainability. From Brundtland Report to Sustainable Development Goals' (2021); Lutteken, A., and K. Hagedorn. "Concepts and Issues of Sustainability in Countries in Transition-an Institutional Concept of Sustainability as a Basis for the Network. Central and Eastern European Sustainable Agriculture Network." In *First Workshop Proceedings. Rome: REU Technical Series*, vol. 61, pp. 26-36. 1999; 'Discover Why We Must Innovate towards Sustainable Abundance' (*World Economic Forum*, 16 August 2024) <https://www.weforum.org/stories/2024/08/the-next-frontier-innovating-toward-sustainable-abundance/> accessed 5 November 2024.

[55] Ibid.

[56] Ibid.; Zamiri M and Esmaeili A, 'Methods and Technologies for Supporting Knowledge Sharing within Learning Communities: A Systematic Literature Review' (2024) 14 Administrative Sciences 17; Renn O, 'Transdisciplinarity: Synthesis towards a Modular Approach' (2021) 130 Futures 102744.

[57] Ibid.

exchange, technology is crucial in bolstering community resilience.[58] Communities may swiftly convey critical information to citizens using technology during emergencies and crises, empowering them to make educated choices and take necessary measures.[59]

By facilitating data collection and analysis, technology also plays an important role in community resilience. Communities may better prepare for and recover from catastrophes if they collect and analyse a variety of data points that reveal weak spots, potential dangers, and opportunities.[60] Furthermore, technology allows communities to use the power of big data and predictive analytics. Communities may anticipate future dangers and prepare ahead of time by analysing historical data and trends. This proactive strategy assists communities in catastrophe preparation, resource allocation, and effect mitigation.[61]

Technology also promotes community participation and cooperation, both of which are necessary for resilience development. Residents, community organisations, and government agencies may use online platforms and forums to interact, exchange ideas, and collaborate on shared resilience objectives.[62]

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[58] 'The Role of Technology in Enhancing Community Resilience Initiatives' (*FasterCapital*) <https://fastercapital.com/content/The-Role-of-Technology-in-Enhancing-Community-Resilience-Initiatives.html> accessed 4 November 2024.

[59] 'The Role of Technology in Enhancing Community Resilience Initiatives' (*FasterCapital*), *op cit.*; Myers N, 'Information Sharing and Community Resilience: Toward a Whole Community Approach to Surveillance and Combatting the "Infodemic"' (2021) 13 World Medical & Health Policy 581.

[60] Ibid.; McAllister, Therese, Therese McAllister, Christopher Clavin, Bruce Ellingwood, John Van de Lindt, David R. Mizzen, and Francis M. Lavelle. *Data, information, and tools needed for community resilience planning and decision-making*. Washington, DC: US Department of Commerce, National Institute of Standards and Technology, 2019.

[61] Ibid.; see also Tabish, S. A., and Nabil Syed. "Disaster preparedness: current trends and future directions." *Int J Sci Res* 4, no. 6 (2015): 227-52.

[62] 'The Role of Technology in Enhancing Community Resilience Initiatives' (*FasterCapital*) <https://fastercapital.com/content/The-Role-of-Technology-in-Enhancing-Community-Resilience-Initiatives.html> accessed 4 November 2024.

Furthermore, technology enables remote meetings and webinars, making it simpler for community members to join in resilience efforts.[63] Residents may use these forums to express their concerns, exchange experiences, and work with experts and legislators, resulting in more inclusive and effective resilience initiatives.[64]

In summary, technology significantly enhances community resilience by facilitating communication, granting access to emergency services, allowing data collecting and analysis, and promoting collaborative platforms for community participation.[65] Utilising technology enables communities to enhance their preparedness and response to calamities, so fostering a more resilient future.[66]

While some studies suggest that digital technologies have been essential in bolstering community resilience by facilitating virtual communication, distant resource access, and community involvement, gaps in digital access and literacy have impacted their efficacy.[67] Mitigating the digital gap and guaranteeing fair

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[63] Ibid.

[64] Ibid.; see also 'Connecting Communities Through Community Engagement' (5 August 2024) <https://blog.zencity.io/resources/engagement-beyond-borders-connecting-communities-through-technology> accessed 5 November 2024; 'The Importance Of Technology In Community Resilience' (*FasterCapital*) <https://fastercapital.com/keyword/the-importance-of-technology-in-community-resilience.html> accessed 5 November 2024; Zamiri M and Esmaeili A, 'Methods and Technologies for Supporting Knowledge Sharing within Learning Communities: A Systematic Literature Review' (2024) 14 Administrative Sciences 17; 'Digital Technologies Will Help Build Resilient Communities after the Coronavirus Pandemic | PreventionWeb' (29 September 2020) <https://www.preventionweb.net/news/digital-technologies-will-help-build-resilient-communities-after-coronavirus-pandemic> accessed 5 November 2024.

[65] 'The Role of Technology in Enhancing Community Resilience Initiatives' (*FasterCapital*) *op. cit.* ; see also Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023) 10 Bhumi The Planning Research Journal 33.

[66] Ibid.; Baraldo M and Di Giuseppantonio Di Franco P, 'Place-Centred Emerging Technologies for Disaster Management: A Scoping Review' (2024) 112 International Journal of Disaster Risk Reduction 104782.

[67] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023)

access is essential, alongside the provision of continuous assistance, capacity development, and community involvement.[68]

4. Embracing Science and Technology for Ecosystem Health, Community Resilience and Sustainability

Technology is pivotal in realising the Sustainable Development Goals (SDGs), especially SDG 9 (Industry, Innovation, and Infrastructure), SDG 4 (Quality Education), SDG 3 (Good Health and Well-being), and SDG 13 (Climate Action).[69] Technology's transformational capacity may expedite advancement towards all the Sustainable Development Goals by stimulating economic development, reducing inequities, improving access to essential services, and fostering sustainability.[70]

Digital technologies have the capacity to augment community development and resilience by fostering relationships, enhancing communication, and granting access to resources.[71] Nonetheless, assessing their effects and tackling related problems is essential.[72]

The intricate and interrelated characteristics of social, environmental, and economic sustainability objectives generate conflicts in the design and execution of digital technology solutions, potentially resulting in design-reality

op cit..
[68] Ibid.
[69] 'Technology | Sustainable Development Goals - Resource Centre' <https://sdgresources.relx.com/technology-0> accessed 4 November 2024.
[70] Ibid.
[71] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*
[72] See Bhambri P and Kautish S, 'Technological Advancements in Promoting Ecosystem Health' in Walter Leal Filho and others (eds), *Digital Technologies to Implement the UN Sustainable Development Goals* (Springer Nature Switzerland 2024) <https://doi.org/10.1007/978-3-031-68427-2_21> accessed 5 November 2024.

discrepancies.[73] A collaborative endeavour among academic disciplines, policymakers, practitioners, and the target beneficiaries of the SDGs would facilitate the identification and development of more effective strategies to attain these global objectives.[74] Communities should embrace and use digital technologies judiciously, taking into account their unique requirements while providing equal access, safeguarding privacy, and promoting long-term sustainability.[75] Consequently, the advantages of technology are not inherent, and substantial obstacles must be addressed, such as the digital divide, cybersecurity dangers, and ethical concerns over privacy and data ownership.[76] As a result, legislative interventions and multi-stakeholder collaborations are essential to guarantee that technology acts as a driver for sustainable development rather than intensifying inequality.[77]

There is a need for a complete resiliency action plan to be established to enhance resilience, including vulnerability assessment, goal establishment, and identification of particular activities.[78] Multi-sector cooperation is a crucial technique that unites government agencies, non-profit organisations, business sector companies, and community people to successfully tackle resilience concerns.[79] Investing in education and capacity-building initiatives is essential,

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[73] Dennehy D and others, 'Technology and Analytics for Global Development: Transforming Agriculture, Empowering Sustainable Livelihoods, and Ensuring Planetary Well-Being' (2024) 43 IEEE Technology and Society Magazine 44.
[74] Ibid.
[75] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*
[76] 'Technology | Sustainable Development Goals - Resource Centre' <https://sdgresources.relx.com/technology-0> accessed 4 November 2024.
[77] Ibid.
[78] Ibid.; Vaughan, E. and Henly-Shepard, S. (2018). Resilience Measurement Practical Guidance Note Series 1: Risk and Resilience Assessments. Produced by Mercy Corps as part of the Resilience Evaluation,
Analysis and Learning (REAL) Associate Award.
[79] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*; Taylor LA and others, 'Building Resilient Partnerships: How Businesses and Nonprofits Create the Capacity for Responsiveness' (2023) 3 Frontiers in Health Services

as they provide people with the necessary information and skills to effectively react to and recover from catastrophes.[80] Policy and governance are essential in establishing supporting rules and policies that promote resilience initiatives.[81] Concerning SDG 4, technology can significantly improve access to high-quality education.[82] Digital technology, including e-learning platforms, may eliminate obstacles to education, including geographical distance, socio-economic position, and physical limitations.[83]

Upon the formulation of the resilience action plan, the subsequent stage involves selecting and deploying the necessary technologies to establish and sustain resilient communities.[84] These instruments may include disaster preparation and

1155941; Xue Y and others, 'Multi-Sector Partnerships in the Urban Development Context: A Scoping Review' (2020) 268 Journal of Cleaner Production 122291; Wirba AV, 'Corporate Social Responsibility (CSR): The Role of Government in Promoting CSR' (2024) 15 Journal of the Knowledge Economy 7428.

[80] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*; Muttarak R and Lutz W, 'Is Education a Key to Reducing Vulnerability to Natural Disasters and Hence Unavoidable Climate Change?' (2014) 19 Ecology and Society <https://www.jstor.org/stable/26269470> accessed 5 November 2024; 'Capacity Building for Disaster Risk Management' (*PrepareCenter*) <https://preparecenter.org/topic/capacity-building-disaster-risk-management/> accessed 5 November 2024; Fu Q and Zhang X, 'Promoting Community Resilience through Disaster Education: Review of Community-Based Interventions with a Focus on Teacher Resilience and Well-Being' (2024) 19 PLOS ONE e0296393; Hoffmann R and Muttarak R, 'Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand' (2017) 96 World Development 32; Shaw R, Takeuchi Y and Rouhban B, 'Education, Capacity Building and Public Awareness for Disaster Reduction' [2009] Landslides - Disaster Risk Reduction 499.

[81] Ibid.; Beunen R, Patterson J and Van Assche K, 'Governing for Resilience: The Role of Institutional Work' (2017) 28 Current Opinion in Environmental Sustainability 10.

[82] 'Technology | Sustainable Development Goals - Resource Centre' <https://sdgresources.relx.com/technology-0> accessed 4 November 2024.

[83] Ibid.

[84] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*; Cardoso M and others, 'Following a Step by Step Development of a Resilience Action Plan' (2020) 12 Sustainability 9017; Alibašić H, *Strategic Resilience and Sustainability*

response plans, risk management techniques, and capacity-building activities.[85] Assessing and quantifying the performance of these activities is crucial for guaranteeing the efficacy of resilience programs and the allocation of resources.[86] Relevant stakeholders may implement appropriate resilient solutions to prepare for and recover from natural catastrophes and public health concerns.[87] By implementing a localized plan, stakeholders may cooperate to cultivate a culture of preparedness and resilience, therefore fostering more sustainable and robust communities.[88]

Digital technologies are essential for enhancing community resilience in the Global South, where conventional communication methods and resource accessibility are often constrained.[89] These instruments improve several facets of

Planning: Management Strategies for Sustainable and Climate-Resilient Communities and Organizations (2022); 'Resilience Roadmap: Resilience Roadmap Stage Assessment | Making Cities Resilient 2030' (15 August 2023) <https://mcr2030.undrr.org/resilience-roadmap> accessed 5 November 2024.

[85] Ibid.

[86] Ibid.; Sharifi A, 'A Critical Review of Selected Tools for Assessing Community Resilience' (2016) 69 Ecological Indicators 629; Bruckler M and others, 'Review of Metrics to Assess Resilience Capacities and Actions for Supply Chain Resilience' (2024) 192 Computers & Industrial Engineering 110176; Campbell B and others, 'Assessing the Performance of Natural Resource Systems' (2001) 5 Conservation Ecology <https://www.ecologyandsociety.org/vol5/iss2/art22/> accessed 5 November 2024; Dodman D, Diep L and Colenbrander S, *Resilience and Resource Efficiency in Cities* (2017).

[87] Ma C, Qirui C and Lv Y, '"One Community at a Time": Promoting Community Resilience in the Face of Natural Hazards and Public Health Challenges' (2023) 23 BMC Public Health 2510.

[88] Ibid.

[89] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op. cit.*; 'Widening Digital Gap between Developed, Developing States Threatening to Exclude World's Poorest from Next Industrial Revolution, Speakers Tell Second Committee | Meetings Coverage and Press Releases' <https://press.un.org/en/2023/gaef3587.doc.htm> accessed 5 November 2024; 'How to Leverage Digital Tools for Social Protection | World Economic Forum' <https://www.weforum.org/stories/2024/10/digital-tools-social-protection-foster-community-resilience-equality/> accessed 5 November 2024; Aker JC, 'Chapter 8. Using Digital Technology for Public Service Provision in Developing Countries', *Digital*

community existence, including financial inclusion, healthcare, disaster readiness, and sustainable development.[90]

5. Conclusion

Information and communication technology (ICTs) may expedite advancements towards all 17 United Nations Sustainable Development Goals (SDGs).[91] In summary, digital technology has transformed community development by facilitating access to extensive information, enhancing communication and cooperation, and advancing renewable energy initiatives.[92] By using these breakthroughs, communities may promote sustainable and resilient growth, establishing interconnected, efficient, and environmentally friendly habitats.[93]

There is a need for not only exploring the potential ways through which science and technology can be used to enhance ecosystem health, community resilience and sustainability but also to empower communities fully to enable them participate meaningfully and also contribute to these efforts.

Embracing Science and Technology for Ecosystem Health, Community Resilience and Sustainability is an ideal that is achievable.

Revolutions in Public Finance (International Monetary Fund) <https://www.elibrary.imf.org/display/book/9781484315224/ch008.xml> accessed 5 November 2024.

[90] Ibid.; Morris J, Morris W and Bowen R, 'Implications of the Digital Divide on Rural SME Resilience' (2022) 89 Journal of Rural Studies 369.

[91] 'Digital Technologies to Achieve the UN SDGs' (*ITU*) <https://www.itu.int:443/en/mediacentre/backgrounders/Pages/icts-to-achieve-the-united-nations-sustainable-development-goals.aspx> accessed 4 November 2024.

[92] Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023), *op cit.*

[93] Ibid.; Martínez-Peláez R and others, 'Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology' (2023) 15 Sustainability 11221; Olabi AG and others, 'Renewable Energy Systems: Comparisons, Challenges and Barriers, Sustainability Indicators, and the Contribution to UN Sustainable Development Goals' (2023) 20 International Journal of Thermofluids 100498.

References

'Capacity Building for Disaster Risk Management' (*PrepareCenter*) <https://preparecenter.org/topic/capacity-building-disaster-risk-management/> accessed 5 November 2024.

'Connecting Communities Through Community Engagement' (5 August 2024) <https://blog.zencity.io/resources/engagement-beyond-borders-connecting-communities-through-technology> accessed 5 November 2024.

'Digital Technologies Directly Benefit 70 Percent of SDG Targets, Say ITU, UNDP and Partners' (*UNDP*) <https://www.undp.org/press-releases/digital-technologies-directly-benefit-70-percent-sdg-targets-say-itu-undp-and-partners> accessed 5 November 2024.

'Digital Technologies Directly Benefit 70 Percent of SDG Targets, Say ITU, UNDP and Partners' (*UNDP*) <https://www.undp.org/press-releases/digital-technologies-directly-benefit-70-percent-sdg-targets-say-itu-undp-and-partners> accessed 5 November 2024.

'Digital Technologies Enhance the Resilience of Individuals and Communities - Degrees' (19 June 2017) <https://degrees.fhi360.org/2017/06/digital-technologies-enhance-the-resilience-of-individuals-and-communities/, https://degrees.fhi360.org/2017/06/digital-technologies-enhance-the-resilience-of-individuals-and-communities/> accessed 5 November 2024.

'Digital Technologies to Achieve the UN SDGs' (*ITU*) <https://www.itu.int:443/en/mediacentre/backgrounders/Pages/icts-to-achieve-the-united-nations-sustainable-development-goals.aspx> accessed 4 November 2024.

'Digital Technologies Will Help Build Resilient Communities after the Coronavirus Pandemic | PreventionWeb' (29 September 2020)

<https://www.preventionweb.net/news/digital-technologies-will-help-build-resilient-communities-after-coronavirus-pandemic> accessed 5 November 2024.

'Discover Why We Must Innovate towards Sustainable Abundance' (*World Economic Forum*, 16 August 2024) <https://www.weforum.org/stories/2024/08/the-next-frontier-innovating-toward-sustainable-abundance/> accessed 5 November 2024.

'How to Leverage Digital Tools for Social Protection | World Economic Forum' <https://www.weforum.org/stories/2024/10/digital-tools-social-protection-foster-community-resilience-equality/> accessed 5 November 2024.

'Resilience Roadmap: Resilience Roadmap Stage Assessment | Making Cities Resilient 2030' (15 August 2023) <https://mcr2030.undrr.org/resilience-roadmap> accessed 5 November 2024.

'Sustainability (World Commission on Environment and Development Definition) | Request PDF'<https://www.researchgate.net/publication/303929235_Sustainability_World_Commission_on_Environment_and_Development_Definition> accessed 5 November 2024.

'Technology | Department of Economic and Social Affairs' <https://sdgs.un.org/topics/technology> accessed 4 November 2024.

'The Importance Of Technology In Community Resilience' (*FasterCapital*) <https://fastercapital.com/keyword/the-importance-of-technology-in-community-resilience.html> accessed 5 November 2024.

'The Role of Technology in Enhancing Community Resilience Initiatives' (*FasterCapital*) <https://fastercapital.com/content/The-Role-of-Technology-in-Enhancing-Community-Resilience-Initiatives.html> accessed 4 November 2024.

'The Role of Technology in Enhancing Community Resilience to Climate Change and Natural Disasters. - Consensus Academic Search Engine' <https://consensus.app/questions/role-technology-enhancing-community-resilience-climate/> accessed 4 November 2024.

'UNDP Digital Guides - Livelihoods and Economic Recovery' <https://digitalguides.undp.org/guide/livelihoods-and-economic-recovery> accessed 5 November 2024.

'Widening Digital Gap between Developed, Developing States Threatening to Exclude World's Poorest from Next Industrial Revolution, Speakers Tell Second Committee | Meetings Coverage and Press Releases' <https://press.un.org/en/2023/gaef3587.doc.htm> accessed 5 November 2024.

Aker JC, 'Chapter 8. Using Digital Technology for Public Service Provision in Developing Countries', *Digital Revolutions in Public Finance* (International Monetary Fund) <https://www.elibrary.imf.org/display/book/9781484315224/ch008.xml> accessed 5 November 2024.

Alibašić H, *Strategic Resilience and Sustainability Planning: Management Strategies for Sustainable and Climate-Resilient Communities and Organizations* (2022).

Aragao A, Jacobs S and Cliquet A, 'What's Law Got to Do with It? Why Environmental Justice Is Essential to Ecosystem Service Valuation' (2016) 22 Ecosystem Services.

Argyroudis SA and others, 'Digital Technologies Can Enhance Climate Resilience of Critical Infrastructure' (2022) 35 Climate Risk Management 100387.

Asheim GB and others, 'The Measurement of Resilience' (2020) 189 Journal of Economic Theory 105104.

Baraldo M and Di Giuseppantonio Di Franco P, 'Place-Centred Emerging Technologies for Disaster Management: A Scoping Review' (2024) 112 International Journal of Disaster Risk Reduction 104782.

Beunen R, Patterson J and Van Assche K, 'Governing for Resilience: The Role of Institutional Work' (2017) 28 Current Opinion in Environmental Sustainability 10.

Bhaduri D and others, 'A Review on Effective Soil Health Bio-Indicators for Ecosystem Restoration and Sustainability' (2022) 13 Frontiers in Microbiology <https://www.frontiersin.org/journals/microbiology/articles/10.3389/fmicb.2022.938481/full> accessed 5 November 2024.

Bhambri P and Kautish S, 'Technological Advancements in Promoting Ecosystem Health' in Walter Leal Filho and others (eds), *Digital Technologies to Implement the UN Sustainable Development Goals* (Springer Nature Switzerland 2024) <https://doi.org/10.1007/978-3-031-68427-2_21> accessed 5 November 2024.

Bruckler M and others, 'Review of Metrics to Assess Resilience Capacities and Actions for Supply Chain Resilience' (2024) 192 Computers & Industrial Engineering 110176.

Butler CD and Soskolne CL, 'Ecosystems, Stable and Sustainable' in Marc D Gellman and J Rick Turner (eds), *Encyclopedia of Behavioral Medicine* (Springer 2013) <https://doi.org/10.1007/978-1-4419-1005-9_1394> accessed 5 November 2024.

Calderón-Argelich A and others, 'Tracing and Building up Environmental Justice Considerations in the Urban Ecosystem Service Literature: A Systematic Review' (2021) 214 Landscape and Urban Planning 104130.

Campbell B and others, 'Assessing the Performance of Natural Resource Systems' (2001) 5 Conservation Ecology

<https://www.ecologyandsociety.org/vol5/iss2/art22/> accessed 5 November 2024.

Cardoso M and others, 'Following a Step by Step Development of a Resilience Action Plan' (2020) 12 Sustainability 9017.

Carlson J and others, *Resilience: Theory and Application* (2012); Carmen E and others, 'Building Community Resilience in a Context of Climate Change: The Role of Social Capital' (2022) 51 Ambio 1371.

Castañer X and Oliveira N, 'Collaboration, Coordination, and Cooperation Among Organizations: Establishing the Distinctive Meanings of These Terms Through a Systematic Literature Review' (2020) 46 Journal of Management 965.

Chaplin-Kramer R and others, 'Integrated Modeling of Nature's Role in Human Well-Being: A Research Agenda' (2024) 88 Global Environmental Change 102891.

Costanza, Robert, and Michael Mageau. "What is a healthy ecosystem?" *Aquatic ecology* 33 (1999): 105-115.

Daniel AD and Fernandes J, 'Promotion of Community Resilience: Do Citizens Have a Role to Play?' (2024) 29 Local Environment 987 <https://www.tandfonline.com/doi/full/10.1080/13549839.2024.2345621> accessed 4 November 2024.

Danley B and Widmark C, 'Evaluating Conceptual Definitions of Ecosystem Services and Their Implications' (2016) 126 Ecological Economics 132.

Dejene S, 'Impact of Climate Change on Biodiversity and Associated Key Ecosystem Services in Africa: A Systematic Review' (2018) 4 Ecosystem Health and Sustainability 225.

Dennehy D and others, 'Technology and Analytics for Global Development:

Transforming Agriculture, Empowering Sustainable Livelihoods, and Ensuring Planetary Well-Being' (2024) 43 IEEE Technology and Society Magazine 44.

Development Goals', *The Cradle of Knowledge: African Journal of Educational and Social Science Research,* Volume 8, No.1, 2020 ISSN 2304-2885-p, 2617-7315e.

Dodman D, Diep L and Colenbrander S, *Resilience and Resource Efficiency in Cities* (2017).

Elkady S, Hernantes J and Labaka L, 'Towards a Resilient Community: A Decision Support Framework for Prioritizing Stakeholders' Interaction Areas' (2023) 237 Reliability Engineering & System Safety 109358.

Ellis EC, Pascual U and Mertz O, 'Ecosystem Services and Nature's Contribution to People: Negotiating Diverse Values and Trade-Offs in Land Systems' (2019) 38 Current Opinion in Environmental Sustainability 86.

Fu Q and Zhang X, 'Promoting Community Resilience through Disaster Education: Review of Community-Based Interventions with a Focus on Teacher Resilience and Well-Being' (2024) 19 PLOS ONE e0296393.

Gervas E. Assey, 'The Role of Science, Technology and Innovation in Implementation of Sustainable.

Girotto CD and others, 'A Critical Review of Digital Technology Innovations for Early Warning of Water-Related Disease Outbreaks Associated with Climatic Hazards' (2024) 100 International Journal of Disaster Risk Reduction 104151.

Hajian M and Kashani S, 'Evolution of the Concept of Sustainability. From Brundtland Report to Sustainable Development Goals' (2021).

Haque CE, Khan SA and Choudhury M, 'Role of Multi-Level Institutions in Facilitating Innovation and Adaptation Technologies for Reducing Climate Risk

and Impact: Evidence from Coastal Communities of Bangladesh' (2024) 111 International Journal of Disaster Risk Reduction 104669.

Hoffmann R and Muttarak R, 'Learn from the Past, Prepare for the Future: Impacts of Education and Experience on Disaster Preparedness in the Philippines and Thailand' (2017) 96 World Development 32.

Huntsinger L and Oviedo J, 'Ecosystem Services Are Social–Ecological Services in a Traditional Pastoral System: The Case of California's Mediterranean Rangelands' (2014) 19 Ecology and Society 8.

Jensen O and Ong C, 'Collaborative Action for Community Resilience to Climate Risks: Opportunities and Barriers' (2020) 12 Sustainability 3413.

Kates, Robert W. "Readings in sustainability science and technology." *CID Working Paper Series* (2010).

King AC and others, 'Leveraging Citizen Science and Information Technology for Population Physical Activity Promotion' (2016) 1 Translational journal of the American College of Sports Medicine 30.

Kronenberg J, 'Environmental Impacts of the Use of Ecosystem Services: Case Study of Birdwatching' (2014) 54 Environmental Management 617.

Langemeyer J and others, 'Ecosystem Services Justice: The Emergence of a Critical Research Field' (2024) 69 Ecosystem Services 101655.

Law E and others, 'The Science of Citizen Science: Theories, Methodologies and Platforms', *Companion of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing* (Association for Computing Machinery 2017) <https://doi.org/10.1145/3022198.3022652> accessed 4 November 2024.

Lele S and others, 'Ecosystem Services: Origins, Contributions, Pitfalls, and Alternatives' (2013) 11 Conservation and Society 343.

Lu Y and others, 'Ecosystem Health towards Sustainability' (2015) 1 Ecosystem Health and Sustainability 1 <https://spj.science.org/doi/10.1890/EHS14-0013.1> accessed 4 November 2024.

Lutteken, A., and K. Hagedorn. "Concepts and Issues of Sustainability in Countries in Transition-an Institutional Concept of Sustainability as a Basis for the Network. Central and Eastern European Sustainable Agriculture Network." In *First Workshop Proceedings. Rome: REU Technical Series*, vol. 61, pp. 26-36. 1999.

Lv Y, Sarker MNI and Firdaus RBR, 'Disaster Resilience in Climate-Vulnerable Community Context: Conceptual Analysis' (2024) 158 Ecological Indicators 111527.

Ma C, Qirui C and Lv Y, '"One Community at a Time": Promoting Community Resilience in the Face of Natural Hazards and Public Health Challenges' (2023) 23 BMC Public Health 2510.

Magis K, 'Community Resilience: An Indicator of Social Sustainability' (2010) 23 Society & Natural Resources 401 <*http://www.tandfonline.com/doi/abs/10.1080/08941920903305674*> *accessed 4 November 2024.*

Martínez-Peláez R and others, 'Role of Digital Transformation for Achieving Sustainability: Mediated Role of Stakeholders, Key Capabilities, and Technology' (2023) 15 Sustainability 11221.

McAllister, Therese, Therese McAllister, Christopher Clavin, Bruce Ellingwood, John Van de Lindt, David R. Mizzen, and Francis M. Lavelle. *Data, information, and tools needed for community resilience planning and decision-making*. Washington, DC: US Department of Commerce, National Institute of Standards and

Technology, 2019.

Mehan A, 'The Role of Digital Technologies in Building Resilient Communities' (2023) 10 Bhumi The Planning Research Journal 33.

Morris J, Morris W and Bowen R, 'Implications of the Digital Divide on Rural SME Resilience' (2022) 89 Journal of Rural Studies 369.

Muttarak R and Lutz W, 'Is Education a Key to Reducing Vulnerability to Natural Disasters and Hence Unavoidable Climate Change?' (2014) 19 Ecology and Society <https://www.jstor.org/stable/26269470> accessed 5 November 2024.

Myers N, 'Information Sharing and Community Resilience: Toward a Whole Community Approach to Surveillance and Combatting the "Infodemic"' (2021) 13 World Medical & Health Policy 581.

Newman, Greg, Andrea Wiggins, Alycia Crall, Eric Graham, Sarah Newman, and Kevin Crowston, "The future of citizen science: emerging technologies and shifting paradigms." *Frontiers in Ecology and the Environment* 10, no. 6 (2012): 298-304.

Norris F and others, 'Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness' (2008) 41 American journal of community psychology 127.

Norton B, 'Sustainability, Human Welfare, and Ecosystem Health' (1992) 1 Environmental Values 97.

Olabi AG and others, 'Renewable Energy Systems: Comparisons, Challenges and Barriers, Sustainability Indicators, and the Contribution to UN Sustainable Development Goals' (2023) 20 International Journal of Thermofluids 100498.

Quaranta, Giovanni, Cristina Dalia, Luca Salvati, and Rosanna Salvia. "Building

resilience: an art–food hub to connect local communities." *Sustainability* 11, no. 24 (2019): 7169.

Renn O, 'Transdisciplinarity: Synthesis towards a Modular Approach' (2021) 130 Futures 102744.

Roberto, 'Public Participation in Scientific Programmes: Citizen Science for Biodiversity' (*International Science Council*, 6 January 2023) <https://council.science/current/blog/public-participation-in-scientific-programmes-citizen-science-for-biodiversity/> accessed 5 November 2024.

Samarakkody A, Amaratunga D and Haigh R, 'Technological Innovations for Enhancing Disaster Resilience in Smart Cities: A Comprehensive Urban Scholar's Analysis' (2023) 15 Sustainability 12036.

Sharifi A, 'A Critical Review of Selected Tools for Assessing Community Resilience' (2016) 69 Ecological Indicators 629.

Shaw R, Takeuchi Y and Rouhban B, 'Education, Capacity Building and Public Awareness for Disaster Reduction' [2009] Landslides - Disaster Risk Reduction 499.

Sintayehu DW, 'Impact of Climate Change on Biodiversity and Associated Key Ecosystem Services in Africa: A Systematic Review' (2018) 4 Ecosystem Health and Sustainability 225.

Tabish, S. A., and Nabil Syed. "Disaster preparedness: current trends and future directions." *Int J Sci Res* 4, no. 6 (2015): 227-52.

Taylor LA and others, 'Building Resilient Partnerships: How Businesses and Nonprofits Create the Capacity for Responsiveness' (2023) 3 Frontiers in Health Services 1155941.

Ungar M, 'Systemic Resilience: Principles and Processes for a Science of Change in Contexts of Adversity' (2018) 23 Ecology and Society <https://www.jstor.org/stable/26796886> accessed 5 November 2024.

United Nations Conference on Trade and Development., *The Role of Science, Technology and Innovation in Building Resilient Communities, Including through the Contribution of Citizen Science* ([Erscheinungsort nicht ermittelbar] United Nations 2020 2020).

Vaughan, E. and Henly-Shepard, S. (2018). Resilience Measurement Practical Guidance Note Series 1: Risk and Resilience Assessments. Produced by Mercy Corps as part of the Resilience Evaluation.

Wang Z and others, 'Biodiversity Conservation in the Context of Climate Change: Facing Challenges and Management Strategies' (2024) 937 Science of The Total Environment 173377.

Weiskopf SR and others, 'Climate Change Effects on Biodiversity, Ecosystems, Ecosystem Services, and Natural Resource Management in the United States' (2020) 733 Science of The Total Environment 137782.

Wirba AV, 'Corporate Social Responsibility (CSR): The Role of Government in Promoting CSR' (2024) 15 Journal of the Knowledge Economy 7428.

Xue Y and others, 'Multi-Sector Partnerships in the Urban Development Context: A Scoping Review' (2020) 268 Journal of Cleaner Production 122291.

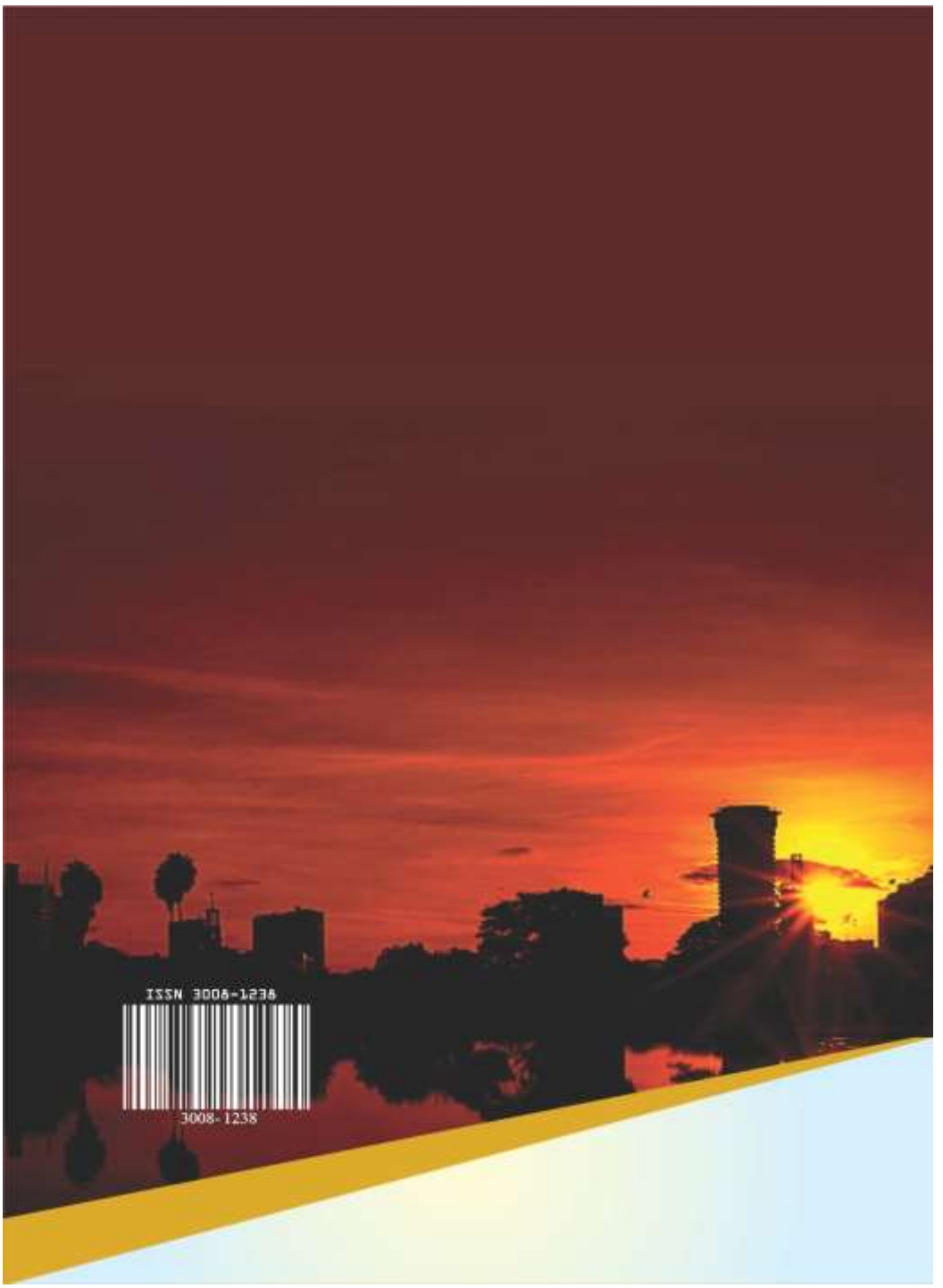
Yang W and others, 'An Integrated Approach to Understanding the Linkages between Ecosystem Services and Human Well-Being' (2015) 1 Ecosystem Health and Sustainability 19.

You C and others, 'Trade-off and Synergistic of Ecosystem Services Supply and Demand Based on Socio-Ecological System (SES) in Typical Hilly Regions of

South China' (2024) 160 Ecological Indicators 111749.

Zabaniotou A, 'A Systemic Approach to Resilience and Ecological Sustainability during the COVID-19 Pandemic: Human, Societal, and Ecological Health as a System-Wide Emergent Property in the Anthropocene' (2020) 2 Global Transitions 116.

Zamiri M and Esmaeili A, 'Methods and Technologies for Supporting Knowledge Sharing within Learning Communities: A Systematic Literature Review' (2024) 14 Administrative Sciences 17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