


Circular Economy and Sustainable Rural Development

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1. Introduction

Rural communities are facing serious waste mismanagement practices around the world (e.g., open dumping, open burning, river dumping, plastic pollution, littering behavior, etc.) due to a lack of or poor access to formal waste management systems, particularly in low- and middle-income countries. Around 1.9 billion people lack access to regular waste collection schemes in rural communities in addition to the poor water and sanitation infrastructure, particularly in countries in Africa, Asia, Latin America, and Eastern Europe [1]. This unfavorable context necessitates the critical improvement of waste management services towards rural and remote communities around the globe [2,3] Therefore, linear economy prevails in most rural regions where improper waste disposal practices are still widespread. The most recent circularity gap report shows that global circularity decreased from 9.1% in 2018 to 7.2% due to the rise of virgin material extraction resources [4]. Linear economy models lead to natural resource depletion, massive pollution, socioeconomic inequalities, and marginalized societies. Rural lands are exposed to urbanization processes and other processes in agribusiness sectors that are detrimental to organic farming, natural landscapes, and local biodiversity. Rural communities are prone to natural hazards (floods, drought, erosion, etc.) under the climate change context in addition to socioeconomic threats (depopulation, poverty, poor infrastructure, etc). Reducing urban-rural socio-economic disparities and ensuring a better distribution of resources are key approaches to achieving both circular economy transition and sustainable development goals (SDGs).

Therefore, this Special Issue aims to address both environmental and societal issues of rural communities under the linear economy (the “make–take–dispose of” model). To achieve the SDGs of Agenda 2020 promoted by the United Nations [5], the transition towards circular economy approaches must be implemented in rural communities. This Special Issue aims to reveal sustainable development alternatives that could catalyze this transition toward circular and sustainable rural societies around the globe. Therefore, two major interconnected research directions, i.e., circular economy and sustainable development, are proposed to be examined for rural communities.

2. Articles

2.1. Circular Economy

Circular economy aims to shift the paradigm from a consumer society fed by a “take–make–dispose” linear model toward a resource-efficient management of resources. In recent years, circular economy has gained the attention of researchers and professionals in multi-disciplinary studies [6], but specific studies relating to rural communities are still scarce in comparison to urban areas.

Despite the decreasing trend of the rural population, the share of 44% of the global population in 2021 [7] highlights that rural regions must be part of circular economy initiatives to meet the SDGs by 2030. However, there are significant rural–urban gaps in terms of accessibility to a network of basic utilities (waste, sanitation, wastewater, water supply, clean energy), which require rapid actions and multi-level cooperation. On the other



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hand, innovation could provide local solutions to transform unmanaged waste fractions into natural fertilizers, bioenergy, or secondary materials for other economic activities.

The paper “Development of a Novel Helical-Ribbon Mixer Dryer for Conversion of Rural Slaughterhouse Wastes to an Organic Fertilizer and Implications in the Rural Circular Economy” [8] proposes a novel dryer (Indian patent) that uses the organic waste generated by rural slaughterhouses as feedstock. The particular waste flows used are blood and rumen digesta, which are mixed (3:1 ratio), with promising results for decentralized systems prone to rural communities. Animal waste management raises environmental concerns because of the lack of or poor related infrastructure, particularly in less developed regions. This paper provides a small-scale solution to manage the animal waste generated by local farms producing natural fertilizers for the organic farming process, providing additional economic and environmental benefits to local farmers. Therefore, innovative small-scale adaptable cost-efficient solutions are required to catalyze such circular economy mechanisms in rural communities.

The review paper entitled “Plastic Pollution, Waste Management Issues, and Circular Economy Opportunities in Rural Communities” [9] points out significant knowledge gaps relating to rural waste management practices and rural plastic pollution at the global level using a proxy analysis of current peer-reviewed literature and lessons learned by experienced professionals in the waste management sector. Rural communities are examined as *plastic pollution destination sites* and *contributors to plastic pollution*. In the latter case, rural communities contribute to plastic pollution due to domestic waste management deficiencies via illegal dumping, open burning practices, and macro- and microplastic pollution of water bodies (marine and freshwater environments). On the other hand, rural communities are exposed to plastic pollution through urban, industrial, and agricultural activities, where critical resources could be affected (water resources, soil, and natural habitats) with repercussions to key rural economic activities (farming, agri-food industries, and rural tourism) in addition to public health concerns. Illegal plastic waste trade activities raise further concerns for rural regions where law enforcement and domestic waste management services are more difficult to provide, particularly in less developed regions and countries. Rural communities of island communities face particular challenges due to geographical barriers; this paper argues that a global alliance on the waste management sector for island states could provide key knowledge and a cooperation platform to find solutions to the current plastic pollution crisis.

2.2. Sustainable Rural Development

Rural settlements face various threats associated with climate change, natural hazards, environmental pollution, food security, economic barriers, and urban expansion, which indicate rural lands having poor prospects to achieve the SDGs by 2030. Therefore, different methodologies and tools in line with interdisciplinary research are required to reveal the diverse range of rural regions’ challenges.

The article “Sustainability in the Case of Small Vegetable Farmers: A Matrix Approach” [10] proposes a matrix to assess the sustainability of vegetable farmers taking into account five dimensions (economic, social, environmental, cultural, and private) each with related subdimensions and indicators supported by data obtained through questionnaires and face-to-face interviews at a regional level (North-East Region) in Romania. For example, the environmental dimension comprises several sectors, such as natural resources (water consumption, soil quality, and used fertilizers), energy consumption and distribution, practices used, environmental concerns (reusing and recycling of transport packaging, plastic waste usage, and measures for environmental protection), and climate change (threats for agricultural activities). The matrix was applied to different vegetable production systems, such as conventional, ecological, natural, and mixed production systems, to determine the specific vulnerabilities of farmers. This approach provides a comprehensive analysis that could be further applied to other agricultural activities relevant to rural economies.

The article “An Agricultural Supply Chain Coordination Model: The Case of Trinity Comprehensive Cooperation Organization in China” [11] reveals the key role of small-scale cooperatives to combat the economic development barriers of local farmers in rural China. This paper proposes a new agricultural cooperative model prone to small-scale cooperatives, concluding with several policy recommendations. This alternative approach called “Three areas of Cooperation with Multiple Bodies” offers a resource optimization process (production resources, marketing and supply platforms, and financial aid resources) and multiple benefits (reducing operational costs, collaboration, and technical assistance), improving the sustainability of agricultural activities and rural economies.

The article “Spatial Characteristics of Suburban Villages Based on Spatial Syntax” [12] examines the spatial morphological features of suburban villages of Jilin Province in the context of the urban area expansion trend in China, using GIS and spatial syntax analysis. The reconversion from traditional agriculture-based morphology towards industrial settlement features has repercussions for the village’s territories of the study area. Suburban villages must cope with drastic changes imposed by industrial-like settlements and keep some of the rural economic functions in line with this new development paradigm. The effects of the industrialization process of suburban villages on rural spatial planning require further investigation in China and other countries where emerging urban expansion is consuming surrounding rural lands.

This Special Issue reveals that sustainable rural development implies research on small-scale agricultural activities (vegetable and animal farmers) and small-scale cooperation initiatives. Better cohesion policies at local levels should be complemented by improved spatial planning, particularly in peri-urban areas. Quantitative, qualitative, and spatial analysis methods are suitable to examine the different dimensions and barriers of sustainable rural development.

3. Future Research Perspectives

The topic of this Special Issue reveals the knowledge gaps that must be filled in the coming years related to plastic pollution, waste management, and circular economy applications and particular challenges to meet SDGs promoted by Agenda 2030.

Despite the improvement of waste management practices to implement zero-waste to landfill policies, the business sector must take the responsibility of phasing out the waste streams during the production stage as part of upstream innovation [13]. In line with circular economy principles, the concept of refuse, reduce, reuse, and repair must gain attention as prevalent policies by regional and local authorities, including rural settlements. Material recycling improvement of plastics and other waste fractions using innovative techniques is required to increase the capture rate of efficient recycling operations particularly for less demanded waste fractions by the current recycling market. China’s ban on importing plastic waste showed: (i) The incapacity of domestic recycling systems to deal with current plastic waste generation rates in high-income economies; (ii) The narrow recycling market for other plastic items compared to common packaging materials (e.g., PET bottles and HDPE); (iii) The reorientation of plastic waste trade towards South East Asia, Africa, and Turkey. On the other hand, the reusing and recycling facilities must be fed by clean source-separated waste collection schemes, waste banks, deposit–refund schemes, and community recycling centers, which is crucial that they are implemented across rural communities, while the support of the informal sector could be optimal in the context of a lack of or poor source-separated waste collection schemes.

The relationships between organic waste (agricultural or municipal origins) and natural fertilizers (compost and digestate), as well as organic farming and biogas production as sustainable pathways for rural economies must be further researched because they combines both circular economy and SDGs frameworks [14]. Further innovative mechanisms, as shown by [8], could capture various organic waste flows at the level of rural communities, which are otherwise neglected by the formal waste management system in remote rural localities.

Regarding the plastic pollution concern related to rural regions, some key future research areas are suggested to fill the current knowledge gaps [9]: (i) Microplastic pollution of soil associated with rural agricultural practices and unsound waste management systems; (ii) Macro- and microplastic pollution research in different freshwater environments (e.g., mountain and hilly rivers/creeks, lowland rivers, tributaries, lakes/ponds, groundwater, and deltas/estuaries) at national and regional levels; (iii) Domestic plastic waste management contribution to environmental pollution (soil–air–water–biosphere nexus); (iv) Role of illegal (plastic) waste trade in rural land contamination; (v) The role of tourism in rural plastic pollution; (vi) Urban plastic waste “export” towards rural communities; (vii) The role of the informal sector in improving rural waste management performances; (viii) The cooperation of island states at the international level on the waste management sector to address plastic pollution challenges for rural island communities.

Sustainable rural development research must cope with future and emerging societal, economic, and environmental challenges: (i) Cost-efficient and innovative technologies in wastewater supply, sanitation, energy, food sectors prone to small-scale or decentralized activities; (ii) Cooperative models, community participation, and policy recommendations to stimulate rural economies towards SDGs; (iii) Scaling-up the local best practices in other rural regions; (iv) Cohesion policies between urban and peri-urban regions and a reduction in rural–urban development gaps and socio-economic inequalities; (v) Improvement of spatial planning in rural regions; (vi) Development of rural entrepreneurship in line with SDGs; (vii) Holistic approach in assessing rural sustainability and vulnerabilities of rural economic actors; (viii) Effective policies to reduce environmental injustice towards marginalized and remote communities.

4. Concluding Remarks

This Special Issue draws attention to the fact that rural communities are exposed to environmental pollution associated with improper management of agricultural and municipal waste fraction. Plastic waste pollution concerns of the natural environment (water–soil–air–biosphere nexus) are increasing worldwide with contributions of both urban and rural communities. Therefore, rural communities must be regarded as *pollution destination sites and contributors to environmental pollution*, as shown in the case of macro- and microplastic pollution problems. Small-scale innovation techniques and small-scale cooperative initiatives could catalyze the sustainability of agricultural practices in rural communities around the globe. The development of organic farming and short-supply chains could play a key role in the circular bioeconomy of rural settlements. Sustainable rural development could be achieved by the intersection of circular economy approaches with other sustainable economic alternatives, such as bioeconomy, blue economy, green economy, and digital economy. Better spatial planning, statistical data, law enforcement, and monitoring of (plastic) pollution efforts with community participation are required in rural regions.

More studies are needed to reduce the rural–urban gaps and geographical inequalities around the globe in their sustainable efforts towards Agenda 2030. Multi- and interdisciplinary research contributions concerning various geographical areas are encouraged to be further developed.

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References

1. Mihai, F.-C. One Global Map but Different Worlds: Worldwide Survey of Human Access to Basic Utilities. *Hum. Ecol.* **2017**, *45*, 425–429. [[CrossRef](#)]
2. Vinti, G.; Vaccari, M. Solid Waste Management in Rural Communities of Developing Countries: An Overview of Challenges and Opportunities. *Clean Technol.* **2022**, *4*, 1138–1151. [[CrossRef](#)]
3. Salim, H.; Jackson, M.; Stewart, R.A.; Beal, C.D. Drivers-Pressures-State-Impact-Response of solid waste management in remote communities: A systematic and critical review. *Clean. Waste Syst.* **2023**, *4*, 100078. [[CrossRef](#)]
4. Circle Economy. *The Circularity Gap Report 2023*; Circle Economy: Amsterdam, The Netherlands, 2023; pp. 1–64.
5. United Nations. Transforming Our World: The 2030 Agenda for Sustainable Development. Available online: <https://sdgs.un.org/2030agenda> (accessed on 16 January 2023).
6. Rejeb, A.; Rejeb, K.; Zailani, S.; Kayikci, Y.; Keogh, J.G. Examining Knowledge Diffusion in the Circular Economy Domain: A Main Path Analysis. *Circ. Econ. Sust.* **2022**, 1–42. [[CrossRef](#)] [[PubMed](#)]
7. World Bank. Rural Population. Available online: <https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS> (accessed on 16 January 2023).
8. Bhowmik, A.; Bhunia, S.; Debsarkar, A.; Mallick, R.; Roy, M.; Mukherjee, J. Development of a Novel Helical-Ribbon Mixer Dryer for Conversion of Rural Slaughterhouse Wastes to an Organic Fertilizer and Implications in the Rural Circular Economy. *Sustainability* **2021**, *13*, 9455. [[CrossRef](#)]
9. Mihai, F.-C.; Gündoğdu, S.; Markley, L.A.; Olivelli, A.; Khan, F.R.; Gwinnett, C.; Gutberlet, J.; Reyna-Bensusan, N.; Llanquileo-Melgarejo, P.; Meidiana, C.; et al. Plastic Pollution, Waste Management Issues, and Circular Economy Opportunities in Rural Communities. *Sustainability* **2022**, *14*, 20. [[CrossRef](#)]
10. Brumă, I.S.; Ulman, S.-R.; Cautisanu, C.; Tanasă, L.; Hoha, G.V. Sustainability in the Case of Small Vegetable Farmers: A Matrix Approach. *Sustainability* **2021**, *13*, 10320. [[CrossRef](#)]
11. Shi, J.; Zhang, J.; Xie, N.; Yang, Z.; Luo, J. An Agricultural Supply Chain Coordination Model: The Case of Trinity Comprehensive Cooperation Organization in China. *Sustainability* **2022**, *14*, 8879. [[CrossRef](#)]
12. Li, R.; Mao, L. Spatial Characteristics of Suburban Villages Based on Spatial Syntax. *Sustainability* **2022**, *14*, 14195. [[CrossRef](#)]
13. Ellen Macarthur Foundation. Upstream Innovation: A Guide to Packaging Solutions. Available online: <https://ellenmacarthurfoundation.org/upstream-innovation/overview> (accessed on 16 January 2023).
14. Corral, F.J.G.; Vázquez, R.M.M.; García, J.M.; Valenciano, J.D.P. The Circular Economy as an Axis of Agricultural and Rural Development: The Case of the Municipality of Almócita (Almería, Spain). *Agronomy* **2022**, *12*, 1553. [[CrossRef](#)]

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