



## Editorial

## A resilient and sustainable world: Contributions from cleaner production, circular economy, eco-innovation, responsible consumption, and cleaner waste systems



## ARTICLE INFO

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## ABSTRACT

This VSI focuses on what cross-cutting insights might be gained from research to increase the energy/materials circularity and the contribution of eco-innovation, cleaner consumption, and waste management to produce a logical body of knowledge that may lead to increased resilience and a sustainable Planet. The articles' collection shows development trends of sustainable, cleaner production under the Special Issue: A Resilient and Sustainable World. Some selected papers have been presented and emerged from the 10th and 11th International Workshop on Advances in Cleaner Production (IWACP), held in hybrid mode in Italy (Ferrara and Florence). The contribution of the articles in this Special Issue could be divided into efforts toward sustainable and cleaner production, aiming (i) Eco-innovation for cleaner production and circular economy, (ii) Proper monitoring and identification of cleaner production, circular economy, and eco-innovation, (iii) cleaner production, circular economy and eco-innovation targeting social wellbeing and cleaner environment, (iv) cleaner production, circular economy and eco-innovation targeting emission reduction, and (v) cleaner production, circular economy and eco-innovation targeting improved and optimized production processes.

### 1. Introduction

Engineers call this resilience: the ability to be distorted or deformed under a force and then return to the original form. Resilience is the ability to adapt to new circumstances after having suffered some external influence that has modified its characteristics. In ecology, resilience is a concept that concerns the ability of a system to recover its equilibrium after having suffered a disturbance. It is about enduring and recovering. It's about bouncing back and adapting to new situations, lasting long, and dealing with disruptions and maybe even catastrophic events.

Resilience is defined as the ability of a system to maintain key functions and processes in the face of stresses or pressures, resisting and then recovering or adapting to change. It includes three components: 1) endurance, 2) recovery and 3) transformation. Endurance refers to a system's ability to tolerate impacts, while recovery refers to a system's ability to recuperate. Transformation refers to the direction of changes from a historical baseline in response to given conditions. The modern concept of resilience emphasizes the ability of coupled socio-ecological systems to persist as they face upheaval and change, adapt to future challenges, and transform in ways that sustain the ability to function and provide ecosystem services.

Sometimes resilience is confused with sustainability, but it is undeniable that both are linked in many ways (Marchese et al., 2018; Xu et al., 2015). Reducing material and energy usage helps make the system less vulnerable to sudden shocks. In this sense, Cleaner Production (CP) has been contributing for decades by developing new technologies and

practices to reduce the use of materials and energy at the source, with products design, in which material and energy savings are the central point (Cheung et al., 2015) and developing new management forms and new business models (Diaz Lopez et al., 2019). CP also evolved by supplying subsidies to public policies to develop cities and regions. Materials and energy savings contribute to resilience and sustainability by preserving natural capital (Mou et al., 2021) and reducing emissions and waste (Sweetapple et al., 2019).

More recently, the circular economy (CE) has been complementing and connecting CP concepts to make materials and energy circulate for longer in each system, thus contributing to saving virgin materials and energy and also expanding the window of attention by including bio-materials circulation and their potential recovery (Leong et al., 2021; Haines-Gadd et al., 2021). The so-called "upcycling" drive attention to adding value to materials that have the potential to be recirculated in the system not only in the recycled or recovered forms but also in the development of more sophisticated materials that can be used in potential recuperative and restorative returns (Mahabir et al., 2021; Horodytska et al., 2020). In any case, the CE concepts organize and locate CP actions, complementing the technological branch with bioproduction, thus opening a range of options for action and research.

Consumption, in turn, is one of the main driving forces of the global economy but still relies on the use of natural capital in a way that continues to impact the planet's health. Economic and social progress overall human history has been accompanied by environmental resource misuse threatening the natural systems our future depends on. Decoupling economic growth from environmental degradation, increasing

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resource use efficiency, and promoting system resilience by establishing different consumption patterns may counteract economic and social hardship.

Another concept that often appears in sustainability discussions is ingenuity and eco-innovation (Scarpellini et al., 2020). It is worth opening parenthesis to note that many sustainable production and consumption actions were proposed and applied in this path between the application of CP concepts and the ideas propagated by the CE (Chiu et al., 2020; Wang et al., 2019). Developing a culture that embraces innovation and respects people’s contributions will step forward and help when things are falling apart.

The participation or inclusion of society as a consumer or producer of knowledge is becoming increasingly important. This leads to appropriate management to reduce material and energy usage and make the system less vulnerable to disruptions. In this sense, cleaner management systems may contribute to developing new resilient practices of material use and strategies in which material and energy recovery and upcycling are the central points.

Since 2007, academics have presented, debated, explored, and assessed ways to improve the environmental performance of industrial and agricultural production and consumption systems at the previous International Workshops on Advances in Cleaner Production (IWACP). The 10th and 11th IWACPs were co-organized by the Paulista University and the Advances in Cleaner Production Network, aiming at emphasizing and highlighting the roles of CP in contributing broadly to resilience and sustainable development.

The guest editors of this joint VSI of the JCLP, **A Resilient and Sustainable World**, welcomed articles based upon case studies, research papers, and comprehensive, integrative literature reviews that included but were not restricted to the topics presented during the IWACPs. This special issue concatenates and combines CP actions to increase the energy/materials circularity, the contribution of the eco-innovation, and responsible consumption integrated into cleaner waste management to produce a logical body of knowledge in which contributions interconnect, merge and complement or contrast ideas that may lead to increased resilience and a sustainable future.

The VSI is focused upon themes that are apparently different or belong to different fields, but, in one way or another, link their core interest and CP, CE, and eco-innovation, all of them becoming part of a vision, a strategy, or potentially contribute to formulate policies or improve management approaches (Table 1).

2. Concluding remarks

The development of human societies, lifestyles, and technologies is responsible for increasing worldwide consumption trends and related greenhouse emissions and widespread inequality and instability. Therefore, novel solutions are compulsory to address the global need for resources without further degrading natural ecosystems. The term “resilience” gained notoriety in the 1970s through work developed by Canadian ecologist Crawford Stanley Holling, who described the persistence of nature concerning changes in the ecosystem – whether for natural or anthropogenic reasons. Resilience is about enduring and recovering, and it is about adapting to new situations. Intending to close the loop of product life cycles and substitute for the linear economy, the CE and eco-innovation concepts have emerged as supported CP philosophies and practices. Although relatively novel, the link among these disciplines gained significant momentum worldwide. Aligning CE, CP and eco-innovations can potentially help to solve the problem of resource depletion and environmental degradation.

The guest editors had the pleasure of gathering different research perspectives aiming to bring progress toward a Resilient World. The article collection of this VSI focus on different aspects that cover managerial/policy-directed contributions; technical processes and products; metric/Assessment tool/model; emission/waste reduction; eco-innovation; circular economy; cleaner production; and resilience –

Table 1

CP, CE, and eco-innovation targeting different core areas and interpreted as an increase of the system resilience, where the symbols denote the link between the main topic covered and their direct or indirect contribution to the system resilience: Managerial/policy-directed contributions; Technical processes and products; Metric/Assessment tool/model; emission/waste reduction; eco-innovation; circular economy; cleaner production; and resilience – direct contribution.

	Research on Collaborative Management and Optimization of Ecological Risks in Urban Agglomeration	By analyzing transmission pathways of multiple ecological risks of an urban agglomeration, the authors deconstruct structure and connection types in urban agglomerations and explore the inherent mechanism of ecological risk governance.
	Sustainable Operations, Managerial Decisions, and Quantitative Analytics of Biomass Supply Chains: A Systematic Literature Review	A review of sustainable practices in the environment-friendly use of biomass, covering supply chain management, regulatory policies quantitative analytics tools. Authors highlight that the environmental pillar has attracted more attention than the social aspect.
	What are the challenges that make the journey towards Industrial Symbiosis complicated?	Authors model the challenges to Industrial Symbiosis in an emerging economy context. Findings may help practitioners implement policies by understanding the causal relationships among the addressed challenges.
	Is a multiple supply chain management perspective a new way to manage global supply chains toward sustainability?	The study explores the components needed to manage multiple supply chains toward sustainability from a focal company perspective. A conceptual model is proposed, considering four essential components: supply chain processes; relational mechanisms; monitoring and control mechanisms; and sustainability outcomes.
	Catalyzing Voluntary Pro-Environmental Behavior in the Textile Industry: Environmentally Specific Servant Leadership, Green Organizational Climate, Psychological Empowerment and Organizational Identity	This study examined the role played by environmentally specific servant leaders as a catalyst in creating a green organizational climate and fostering the organizational identity of employees. The findings also illuminate the psychological mechanism that connects a green organizational climate to voluntary pro-environmental behavior under high psychological empowerment.
	A proposed framework for product-service system business model design	This work proposes a framework for designing a PSS business model, considering the concurrent design of sustainable operations and business models. The framework enables the joint visualization of the components of the business model and their alignment. In particular, it extends the identification of challenges concerning the PSS business model design.
	A Recycling Reckoning: How Operation National Sword Catalyzed a Transition in the U.S. Plastics Recycling System	The paper uses a multi-level perspective transition framework for plastic production and recommend updates for a new U.S. plastics recycling system. The authors suggest that the emergence of multiple niche-innovations can support a sustainable, just, and methodical transition of the plastics recycling system more effectively and show a transition ‘pathway’ based on co-existing regimes.
		This study focuses on the adoption of ISO 9000, ISO 14000 and OHSAS

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	Are certified firms more prone to eco-product innovation?	18001 standards as managerial practices that can help firms in promoting eco-product innovation, considering slack resources as a moderator of this relationship. Analyzes simultaneously different combinations of certifications as potential drivers of eco-product innovation, as well as the moderating role of slack resources.
	Leveraging slack resources	
	Social network analysis and application for ecosystem service perceptions by stakeholders for coastal wetland conservation	Considering that stakeholders play a dominant role in shaping ecosystems and driving current environmental management a stakeholder network structure is explored and identified as non-cohesive with low density and high centrality. Improving the closeness among relevant stakeholder groups, optimizing their overall relationships, and enhancing the protection of ecosystem services are greatly needed to benefit ecosystem conservation.
	Survivability, Resilience and Sustainability of Supply Chains: the COVID-19 Pandemic	The paper provides basic foundation to conceptualize supply chains survivability by s for this new concept, which requires a larger scale studies than those adopted for the analysis of resilience. A framework shows the interdependencies between supply chains, society, and the environment and enables a shift from the classical product-profit view to a holistic view centered on the satisfaction of human needs.
	Sustainable Resilience Degree Assessment of the Textile Industrial by Size: Incremental Change in Cleaner Production Practices considering Circular Economy	The study assesses the degree of sustainable resilience by the size of the textile industry to drive incremental changes in CP practices considering the CE. It was found that the degree of sustainable resilience of companies is related to the environmental requirements of the market in which they operate. Practical solutions may help shareholders and managers to supply foreign market.
	Do circular economy practices matter for financial growth? An empirical study in China	This study draws upon the organizational capability view to investigate the impact of CE practices on financial performance through environmental and innovation performance. The study identifies a new path of CE practices in promoting financial performance and also guide managers to effectively implement ecological design and investment recovery to maximize company benefits.
	Unveiling coordination contracts' roles considering circular economy and eco-innovation toward pharmaceutical supply chain resiliency: evidence of an emerging economy	Authors measure the impact of Game Theoretical Coordination Contracts in Supply Chain Management by considering CE and Eco-Innovation principles. A Simultaneous Evaluation of Criteria and Alternatives is proposed to provide in-depth insights into challenges of CE and Eco-Innovation towards sustainability and resilience fulfillment.
	Sustainable Perspective of Ancillary Construction Materials in Infrastructure Industry: An Overview	The paper introduces a new dimension to construction materials by classifying them into exhaustive and mutually exclusive categories of major and ancillary construction materials, that add value to the

Table 1 (continued)

	Reflecting on circularity indicator challenges with a Functionality Over Use-Time Approach	In this article, authors discuss using the concept of functionality from Life Cycle Assessment over the time product systems used to measure circularity. The proposed indicators are exemplified in a comparative case study of a concrete double walls.
	A review of medicines reuse: thematic analysis and metaphors of return economies	The return of medicines has been re-signified in face of the circular and sharing/collaborative economies. The paper provides a review on medicines returns concepts, practices and advancements. Exploring the problem of wastage versus costs and affordability, and the role of pharmacists the article CE economy offers a limited contribution for medicines reuse, while sharing/collaborative economy provides more fruitful outcomes.
	Altruistic mode selection and coordination in a low-carbon closed-loop supply chain under the government's compound subsidy: A differential game analysis	This paper studies the altruistic mode selection and coordination of the low-carbon closed-loop supply chain under the compound subsidy of the government from a long-term dynamic perspective. Among the altruistic modes, the leading party manufacturer's unilateral altruistic mode was found to achieve higher levels of emission reduction, recycling rate, total profit, consumer surplus and social welfare.
	Modeling a Sustainable Vaccine Supply Chain for a Healthcare System	This study develops a vaccine supply chain to ensure sustainable distribution during a global crisis in a developing economy. The supply chain is designed to minimize the overall cost of distribution and ensure environmental and social sustainability by minimizing GHG emissions and maximizing job opportunities.
	Environmental assessment of a heating, cooling and electric energy grid from a geothermal source in Southern Italy.	This work proposes a sustainable medium enthalpy geothermal system capable of generating electricity and thermal energy with low environmental impacts.
	Temporal and spatial variations in the eco-environment in ASEAN from 2000 to 2021 based on information granulation	This study uses information granulation based on granular computing and spatial distribution characteristics evaluate ASEAN, considering the influence of countries and establishing the weight by scale transformation knowledge granularity entropy.
	Circularity Assessment Tool development for construction projects in emerging economies	This work proposed an assessment tool to measure the circularity of construction projects. Existing circularity measurement methods, tools, and actions associated with circularity in the construction industry were reviewed. A list of critical circularity actions was identified. energy and material efficiency practices.

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<p>✕</p> <p>✕</p> <p>✕</p>	<p>Valuing Regulating Services of Urban Ecosystems Towards More Comprehensive House Pricing</p>	<p>A method combining the advantages of econometric model with the emergy accounting approach is proposed to provide a new way for the evaluation of so-called ecosystem regulating services. This new framework not only ensures the accuracy of value accounting but also realizes the monetization of ecosystem service value. Results help design direction for future environmental urban planning and provide a basis for the implementation of relevant policies in the future, in so moving beyond the traditional pricing methods.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Measuring the Compliance of Management System in manufacturing SMEs: Piloting an Integrated Model</p>	<p>The paper proposes the Small and Medium Enterprise Compliance Assessment for SMEs aiming to detect compliance with mandatory requirements on environmental and social issues. A pilot application based on Chinese owned SMEs of the textile and fashion manufacturing district is provided.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Socio-environmental impact of mining activities in Guinea: the case of bauxite extraction in the region of Boké</p>	<p>A region in Guinean republic is used to illustrate the environmental and social threats caused by bauxite supply chain management to build effective political guidelines and actions. Based on the results the paper argues for enlarging the concept of sustainable mining towards truly integrating the wellbeing of local people.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Cross-Sectoral Linkages of the Urban Energy-Water-Land Nexus Within a Multiscale Economy: The Case of Chinese Megacities</p>	<p>This study introduced an urban ternary multidimensional nexus framework for modelling complex urban EWL nexus, connecting in- and trans-boundary interactions by the environmental extended multiscale input–output model. Results showed that construction, electricity and gas &amp; water sectors are the main energy consumers. The agriculture and food sectors are the major water and land consumers. The analysis can support industrial restructuring and collaborative management of EWL resources for future urban development plans.</p>
<p>✕</p> <p>✕</p> <p>✕</p> <p>✕</p>	<p>Anatomization of air quality prediction using neural networks, regression and hybrid models.</p>	<p>The study provides information and plays a vital role in competing for safety considerations and mitigating the air pollution issue by predicting the Air Quality Index and air pollutant concentration.</p>
<p>✕</p> <p>✕</p> <p>✕</p> <p>✕</p>	<p>How to map industrial waste metabolism at a geographical level? A proposal for a composite indicator</p>	<p>This paper focuses on the supply-side of waste production combining data on industrial waste production and treatment to the socio-economic features over the period 2015–2017, a composite indicator proxying the main waste metabolism constraints is proposed, to provide a geographical representation of waste-based territorial weaknesses. Accordingly, the use of the index can support place-based waste policies to improve manufacturing clusters' ecological transition.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>How carbon emission reduction is going to affect urban resilience</p>	<p>This study explores the impact of carbon emission reduction on urban resilience and its spatial-temporal characteristics. An urban resilience index is built to evaluate urban resilience and the impact of carbon</p>

Table 1 (continued)

<p>✕</p> <p>✕</p> <p>✕</p>	<p>Wild caught Alaska sockeye salmon: a case study of the food energy water nexus for a sustainable wild catch fishery</p>	<p>This work draws on primary and secondary data to assess, through a life cycle approach, the energy and water consumed to catch and process wild sockeye salmon. While not insignificant, the energy costs of fishery management are inconsequential and should provide adequate justification for continued sustainable management and forceful information for consumer choice.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Quantifying the Environmental Support to Wild Catch Alaskan Sockeye Salmon and Farmed Norwegian Atlantic Salmon: an emergy approach</p>	<p>This work draws on primary and secondary data used in an emergy analysis approach to assess environmental support and sustainability of a wild catch sockeye salmon fishery. Emergy sustainability indexes for both production systems were much higher than other aquaculture systems.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Sustainability assessment of commercial Brazilian organic and conventional broiler production systems under an Emergy analysis perspective</p>	<p>This study assesses and compares the sustainability of production of broilers reared in organic and conventional systems using Emergy analysis. Organic production showed better environmental performance while conventional better productive efficiency.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Sustainability comparison of commercial Brazilian organic and conventional broiler production systems under a 5SENSU model perspective</p>	<p>Authors evaluate the sustainability of a commercial organic broiler production system based on the concept of strong sustainability, using the FIVE SEctors of SUSTainability model. The environmental and social dimensions were considered as providers of resources for the system and receivers of products and negative externalities. The results show a trade-off between animal welfare and economic and environmental costs. When social results were considered, organic production showed more pathways to achieve a more sustainable commercial broiler production).</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Composting food waste or digestate? Characteristics, statistical and life cycle assessment study based on an Italian composting plant</p>	<p>A life cycle assessment was performed for the production of compost from both organic fraction of municipal solid waste and digestate fraction, processed by an Italian composting plant. The environmental footprint of the production of the two types of compost was determined by quantifying 19 impact categories. MSW fraction compost showed greater environmental impacts than digestate compost for 17 out of 19 categories.</p>
<p>✕</p> <p>✕</p> <p>✕</p>	<p>Climatic action zones identification through the GHG emissions spatial distribution within the administrative boundaries of an Italian municipality</p>	<p>A bottom-up GHG inventory at the sub-national level has been elaborated, following the most recent IPCC guidelines, to create site-specific knowledge and supporting local policies and help localize the areas under stress and categorize them into climate action zones.</p>
<p>✕</p>	<p>Modelling and Quantification of Time-Varying Flood Resilience for</p>	<p>The concept of resilience is employed to make infrastructure more reliable,</p>

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	Housing Infrastructure Using Dynamic Bayesian Network	robust and recoverable. It develops a framework to quantify time-varying resilience and implements this framework in a real case-study area to help public authorities provide resilience-based decisions.
		This study estimates energy and water demand per kg of catfish and describes business operator perceptions of potential strategies to reduce usage. Authors provide a comprehensive exploration of the environmental footprint of the largest U.S. aquaculture sector and identify multiple opportunities that could improve the industry's resource use.
	Analysis of Energy and Water Use in US Farmed Catfish: toward a more resilient and sustainable production system	The study engrosses in CP of biodiesel from novel feedstock of <i>Chamaerops humilis</i> with high nonedible seed oil content of 30% (w/w) to produce biodiesel with properties of in accord with international requirements.
	Cleaner production of biodiesel from Novel and Non-edible seed oil of <i>Chamaerops humilis</i> using recyclable Cobalt oxide nanoparticles: A contribution to Resilient and Sustainable World	The authors report on the design and operation of an advanced, innovative and environmentally friendly freshwater integrated multitrophic aquaculture system. The novel system facilitates fish production while controlling water quality using duckweed treatment units.
	A novel multitrophic concept for the cultivation of fish and duckweed: A technical note	The present manuscript reviews the suitability of technical lignin's for synthesizing hydrogels, showcases its present applications, challenges, and future directions. Different synthesis techniques have been also reviewed and are broadly classified into physical, chemical, and biological processes. Present applications of lignin hydrogels have been elaborated in four major sectors: Biomedical, Agriculture, Environment and Electronics.
	Technical lignin to Hydrogels: An Eclectic Review on Suitability, Synthesis, Applications, Challenges and Future Prospects	A polysaccharide-based liquid mulch with soil amendment function by an emulsification method was used as a sprayable and green alternative to the petroleum-based plastic mulch and a soil remediation agent for degraded soil. The developed low cost, yield-improving liquid mulch shows promising prospects for mulches and soil amendment in agriculture.
	Preparation and characterization of eco-friendly polysaccharide-based liquid mulch with soil amendment function	The production processes of H-Acid (HA) and Vinyl Sulphone (VS) are revisited while the sector adopts modern cleaner technologies for efficient resource utilization and minimizing waste.
	Cleaner Production Through Enhanced Resource Recovery and Reuse in Dye Intermediate Industry: Integration of Vinyl Sulphone with H-Acid Production	The present work investigates the air conditioning cost-saving potential of the duplex house designed with various phase change materials incorporated burnt clay bricks. The results showed which type of layer brick would provide the best annual energy cost saving.
	Strategic Design of Phase Change Material Integrated Burnt Clay Bricks	This study develops a techno-economic optimization model, with the objective of meeting the demand for electricity and plastic to the lowest cost, is developed. The model minimizes the investment and operating costs of electricity and
	Thermochemical plastic recycling – impact on the electricity system	

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	Valorization of wastewater through microalgae as a prospect for generation of biofuel and high-value products	This review focuses on different types of wastewater along with various challenges of microalgal cultivation systems applied in wastewater treatment. Various industrially important products that can be sustainably obtained from microalgal biomass through wastewater bioremediation are also highlighted. Finally, future perspectives in this field are presented.
	Circular product design maturity matrix: a guideline to evaluate new product development in light of the CE transition	The main innovation of this paper is proposing a maturity matrix for the gradual adoption of the CE in the new product development process. The matrix is composed of five maturity levels and eleven analysis dimensions, encompassing the CE-oriented design strategies. The matrix can guide companies to gradually improve CE integration through the design of new products, contributing to the theoretical and managerial debate about the transformation processes involved in the transition from a linear to a CE.

direct contribution. The guest editors believe that the selected papers of this VSI, which undergo the standard reviewing process, could be of interest to the broad readership community of the Journal of Cleaner Production and contribute to the current literature for a Resilient and Sustainable World.

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