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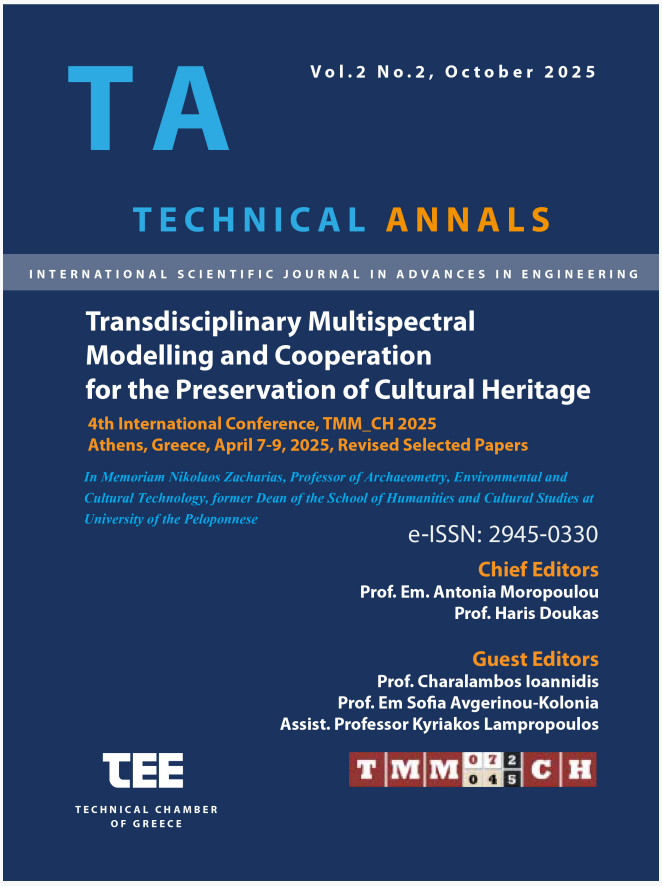

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Reflection on Materiality in the Age of the Anthropocene

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Abstract. The relationship between human activities and the material transformations of the Earth during the Anthropocene is critically examined, with particular emphasis on the enduring impacts of industrial materials such as plastics and concrete. These substances have become geological markers of human intervention, reshaping ecosystems and altering planetary systems on an unprecedented scale. The analysis underscores the urgent need to transition toward sustainable practices and ethical modes of production, while highlighting the necessity of institutional reforms to restore ecological balance and long-term environmental resilience. The discussion juxtaposes two influential theoretical frameworks. Benjamin Bratton conceptualizes technological and ecological systems as layered and hierarchical structures that connect industrial production with geopolitics and digital infrastructures, emphasizing stability, organization, and control. In contrast, Karen Barad's new materialism proposes a dynamic and relational understanding of materiality, where matter and meaning continuously co-evolve through interaction. This contrast reveals divergent interpretations of global flows: Bratton views them as structured and relatively stable, whereas Barad considers them fluid, contingent, and constantly transforming. Furthermore, the analysis explores the consequences of human consumption and waste for the planet's geological and biological trajectories. It engages with the concept of degrowth, which challenges perpetual economic expansion and promotes reduced consumption, social justice, and ecological well-being. Degrowth advocates limiting resource extraction and redistributing wealth more equitably. Objects are not mere commodities but components of economic, geopolitical, and environmental power relations. Materials such as lithium batteries and semiconductors exemplify how capitalist production intensifies ecological degradation.

Keywords: Anthropocene, Layered structure, New materialism, Sustainability, Degrowth

1 A Review of Materiality in the Anthropocene Era

1.1 The Theory of Layered Structure by Benjamin Bratton

The analysis of materiality within the context of the Anthropocene, as presented in the following text, highlights the connection between human activities and environmental changes. Plastics, concrete, and other technologies have left irreversible marks on the Earth, affecting ecosystems and the geological structure of the planet. In the

Anthropocene, the production and use of materials are not only about the construction of tools but have acquired a geological dimension. Modern ecological thinking, such as the concepts of circular economy and degrowth, suggests solutions for reducing overconsumption and resource depletion, emphasizing the need for new strategies based on sustainable and ethical methods of production. However, these strategies require institutional changes and the restructuring of global supply chains to incorporate the values of ecological balance and sustainability. Overall, the comparison of the theories of Bratton and Barad offers valuable perspectives for understanding contemporary technology and society, revealing the complex and interactive nature of materials, production processes, and ecological challenges in the modern world.

The exploration of materiality and industrial production in the modern world raises questions about the interconnection of objects, production processes, and usage. To address these questions, we must refer to the following theoretical approaches: Benjamin Bratton, with his theory of layered structure in *The Stack: On Software and Sovereignty* [1], proposes a model for understanding the global infrastructure of technology and information through six stratified levels: a. Earth–This level pertains to geopolitical and ecological conditions (the physical layer, connected with the natural environment, resources, and infrastructures such as telecommunications, energy resources, and energy systems), b. Cloud–This level relates to cloud computing networks (the digital layer that includes cloud computing systems, which enable the storage, processing, and dissemination of information through distributed computational resources), c. City–This includes urban and local infrastructures (the level of modern urban areas and their infrastructure, as cities are connected to digital networks and technologies for organization and management), d. Address–This is concerned with data and identity management (the level of addresses, dealing with the management of digital addresses and networks, such as IP addresses and DNS servers), e. Interface–This involves human-machine communication (the level of the interface, where users interact with systems through various tools and platforms, e.g., mobile phones, computers, applications), f. User–This includes the end-user who interacts with the system (the level of users, where the human dimension of technology is located, i.e., the end-users who shape, influence, and experience the consequences of technological systems).

Benjamin Bratton's theory argues that objects of industrial production are not isolated but embedded in a complex system that includes computational processing, political regulations, and geoeconomic relationships. By following Bratton's theory of layered structure, the production and use of objects are inscribed in a complex system of stratifications, where different levels–from infrastructure and computational processing to geopolitics and everyday practices–are interconnected. According to this perspective, objects do not merely belong to a public circulation route but are nodes in a global system that encompasses the extraction of raw materials, industrial production, the logistics chain, and their final use on both digital and physical platforms.

Bratton's theory can be linked to broader theoretical approaches in the field of Media Studies and Digital Infrastructure Theory. Specifically, it can be interpreted through the concept of invisible infrastructure, as analyzed by Manuel Castells [2], one of the most important theorists of the information society and networks, in his theory of the networked society, where technological infrastructures shape and influence social and

political relationships. Moreover, the concept of the layer can be compared to theoretical ideas within post-human thought [3], where technological networks redefine the relationship between human and machine. Additionally, Bratton's analysis of industrial production offers a holistic view of materiality and production processes, where objects are not isolated but integrated into a global system that connects raw material extraction with industrial production and final use. Here, we can refer to the theories of emerging materiality [4] and industrial ecology [5], which highlight the significance of natural resources and the production chain in a globalized economy.

Specifically, the use of information infrastructure and digital platforms can be linked to the deconstruction of materiality through new technological applications, as discussed in Luciano Floridi's [6] research on digital and material reality. Furthermore, the study of industrial production is connected to the concept of green industry and sustainability, as proposed by Michael Braungart and William McDonough [7] in their work *Cradle to Cradle: Remaking the Way We Make Things*, which analyzes circular economy and sustainability in the production of objects. At the same time, Bratton's theory incorporates the geopolitical dimension of technological systems, which is directly related to the analysis of production and consumption in the global system. The geopolitical dimension of these processes can be linked to the analysis of the global value chain [8], which examines how production processes are influenced by international political relations and the strategies of large corporations.

1.2 Karen Barad's New Materialism

In contrast, Karen Barad's new materialism, presented in *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* [9], introduces the concept of intra-action, which rejects the idea that objects and material processes are discrete and pre-exist independently. Instead, Barad argues that materiality and meaning co-constitute each other through practices, where industrial processes are not merely fragmented stages but interact with cultural and epistemological terms. Production, in this view, is a dynamic process where the very materiality of objects emerges from relations within the network. This approach can offer a critical contrast to Bratton's theory, as it rejects the idea of distinct layers and focuses on the relationships and dynamics that create industrial and technological structures. Through her new materialist approach and agential realism Barad would view the production and use of objects not as static phases but as dynamic, intra-active relationships that co-create materiality and the world. Rather than speaking of fixed production phases, Barad would argue that raw materials, production, and the use of objects are in a constant process of reconfiguration through their relationships with subjects, technologies, and the environments in which they operate.

More specifically, the concept of intra-action that Barad introduces in her work *Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning* (2007) is fundamental to her critique of the traditional notion of the distinctness of objects and subjects. Instead of distinguishing entities into separate and independent elements, Barad suggests that objects and processes co-constitute each other through practices. This concept highlights the ongoing dynamic interaction between material and cultural practices and proposes a contrast to traditional linear conceptions

of the world. Furthermore, Barad rejects the idea of distinct layers and emphasizes that industrial and technological structures should not be seen as static but as dynamic processes co-constructed through relationships. This notion of the dynamic formation of reality provides a critical dimension to technological and cultural development, focusing on interaction rather than separate entities. Finally, Barad's agential realism links the process of production and use of objects to the dynamic interactions between subjects and materials. Production and use are not static phases but continuously evolving processes where the materiality of objects and their conditions are in a constant state of reconfiguration. This approach dismantles traditional, mechanistic conceptions of production.

The ideas of Karen Barad regarding the connection between materiality, subjectivity, and power relations are extended and redefined in Donna Haraway's *Staying with the Trouble: Making Kin in the Chthulucene* [10], where she introduces the concept of the Chthulucene. Haraway, in this study, proposes a new, non-linear and interconnected understanding of our relationship with the world, based on the concept of coexistence (staying with) and the co-creation of existence, rather than a simple dominative explanation of nature. The concept of the Chthulucene, which combines the chthonic and essential dimensions of the world, suggests a reality beyond anthropocentric perception, in which human and non-human entities coexist and co-create the world in various ways. Haraway uses this term to describe an epoch on a higher level, where the boundaries between human and non-human, organic and inorganic, are erased and redefined, creating new forms of interaction and coexistence. This theoretical approach incorporates Barad's ideas on the entanglement of materiality and subjectivity, focusing on the interaction and power dynamics that emerge through these exchanges. Haraway advocates for a reflective politics of relationships that avoids individualism and humanism, emphasizing the importance of collective responsibility and ecological thinking. This collective recognition of interdependence and co-creation opens new perspectives on how we can address the challenges of the contemporary era, such as the climate crisis and social inequalities.

The comparison between the theories of Benjamin Bratton and Karen Barad is crucial for understanding contemporary concepts of cohesion and dynamics in global flows, which are often associated with globalization, technological advancement, and sociopolitical changes. The disagreement between these two theoretical approaches ultimately concerns how we understand the cohesion and dynamics of global flows. We can view them as stable, hierarchical, and stratified (Bratton) or as fluid, unpredictable, and continuously shifting relationships between the material and the immaterial (Barad). Specifically, Bratton's approach conceptualizes global flows as stable, hierarchical, and stratified. This means that, according to Bratton, the various factors (technological, social, political) that constitute global flows may function within well-defined and distinct levels. These levels are typically hierarchical, with some exerting more influence than others, emphasizing the stability and structure of the global system. In contrast, Barad's approach views global flows as fluid, unpredictable, and continuously evolving relationships between the material and the immaterial. Barad, as reflected in the concept of intra-action that she introduces, argues that the world's flows are neither linear nor predetermined but are instead shaped through dynamic,

interdependent relationships that co-construct reality. Barad's perception of ever-changing relationships and the interaction between the material and the immaterial proposes a conception of reality that rejects the discreteness of individual elements and instead focuses on the processes of intra-action. According to this perspective, various factors interact and co-constitute one another, shaping reality dynamically.

2 Anthropocene, Materiality, and Capitalist Production

2.1 Materiality and Ecological Dimensions

Recognizing the dynamics of materiality in the Anthropocene highlights the need for new economic and political strategies. One such approach is the circular economy, which advocates for reducing dependence on non-renewable raw materials, reusing objects and resources, and developing new recycling and material decomposition technologies. However, critical perspectives argue that the circular economy can be integrated into the capitalist system without challenging its structural inequalities [11]. On the other hand, more radical ecological theories, such as degrowth, propose a systemic shift aimed at reducing overconsumption and the material depletion of the planet [12]. The focus on decreasing consumption and production as a means of curbing environmental destruction stands in opposition to models centered on growth and perpetual expansion, which dominate mainstream economic thought.

The theory of degrowth [13, 14] advocates for a new way of life that is not based on the exploitation of natural resources but on redistribution and social justice, directly linking social values with ecological balance. Degrowth emphasizes that the overconsumption of natural resources and the depletion of ecosystems are directly tied to relentless economic growth. This theory highlights the importance of limited consumption, recycling, and the redistribution of resources. Degrowth proposes the need for a sustainable life that does not rely on the ongoing depletion of the natural environment. It supports transforming the production model into a more robust, ecologically sensitive, and socially just model. Rather than focusing solely on changes to specific policies or practices, it calls for a radical rethinking of the economic system and societal values, rejecting the belief that economic growth can continue indefinitely without negative consequences.

Serge Latouche, one of the leading theorists of the degrowth movement, in his work *Farewell to Growth* (2009), argues for the need for a comprehensive social and political change. For Latouche, degrowth is connected to the liberation of societies from the logic of continuous economic growth and the renegotiation of values around production and consumption. His theory critiques the dominance of the economic model that seeks perpetual expansion, proposing alternative approaches to prosperity and sustainability. The materiality of objects in the Anthropocene cannot be understood in a one-dimensional way. On the one hand, analyzing production through a layered structure highlights global material flows and their economic impacts. On the other hand, new materialism offers a more dynamic understanding of materiality, focusing on the interactions between humans, materials, and the environment. Recognizing these different

perspectives is crucial for shaping new ecological and economic strategies that will address the challenges of the Anthropocene.

2.2 Objects as Economic and Geopolitical Factors

In the Anthropocene, objects are not merely commodities but carriers of energy, power, and geopolitical relations. For example, lithium batteries for electric vehicles are linked to mining policies in Latin America and Africa, semiconductor production is tied to geopolitical tensions between the US, China, and Taiwan, while cloud computing (such as servers, data storage, databases, networking, software, and other computing services) and cryptocurrency mining have a massive energy footprint, contributing to climate change. Objects function as economic, political, and geopolitical factors that shape international relations, global power balances, and environmental policies. From raw materials to technological goods and data, the materiality of objects interacts with economic and political structures, creating new forms of dependency, competition, and innovation. In the context of the globalized economy, the production and consumption of objects follow transnational value chains (*Global Value Chains - GVCs*), where different countries and companies control various stages.

The exploitation of natural resources and labor by global capital is the primary driving force behind the economic structures of the Anthropocene, as documented by Jason W. Moore [15] through the concept of the *Capitalocene*. Objects become the material expressions of this dynamic. In *Capitalism in the Web of Life* (2015), Jason W. Moore redefines the relationship between capitalism and nature, rejecting the dualistic distinction between the human and non-human world. He argues that capitalism is not merely an economic system but an ecological regime that shapes and transforms the planet. Moore introduces the concept of cheap nature, illustrating how the capitalist system relies on the inexpensive exploitation of natural resources, labor, and energy. Extraction, production, and the circulation of objects are not merely economic processes; they are embedded in a geological and environmental transformation that accelerates the ecological crisis of the Anthropocene. Moore's book proposes the concept of world-ecology, in which social and environmental relations must be analyzed as a single system, rejecting the traditional view of nature as merely a backdrop for the economy. His approach is crucial to discussions on the materiality of objects, as it reveals that every industrial object is the result of historical and geopolitical relations of exploitation.

In response to the concentration of power and inequality generated by the global distribution of objects, alternative approaches have been proposed. These include the circular economy, which promotes sustainable production by emphasizing recycling, repair, and remanufacturing; production localization, which focuses on reducing dependence on multinational supply chains by fostering regional economies; and digital sovereignty, where countries like France and India are developing national cloud infrastructures and AI platforms to decrease their reliance on the U.S. and China. As a result, the objects of the Anthropocene are not merely consumer goods but instruments of control, influence, and global reconfiguration. Whether referring to natural resources, technological infrastructures, or data, their economic and geopolitical significance is central to the modern world. Under these conditions, the key questions arise: How can sustainable and equitable production of objects be developed in the Anthropocene?

How can countries and communities reduce their dependence on global supply chains? What is the relationship between technological objects and political freedom? What is certain is that objects in the Anthropocene do not merely function as consumer goods but as mechanisms of economic, geopolitical, and social restructuring. Let us now examine the three fundamental questions concerning sustainability, economic autonomy, and the relationship between technological objects and political freedom.

The transition to a sustainable and fair production of goods requires a shift from the dominant linear production model (extraction–production–consumption–disposal) to circular and regional systems that reduce the ecological footprint and promote social equity. Jason W. Moore (2015), in *Capitalism in the Web of Life*, analyzes how capitalism relies on the uncontrolled exploitation of natural resources and labor, leading to ecological crisis. He proposes an alternative approach in which production must take ecological and social impacts into account. Kate Raworth, in *Doughnut Economics: Seven Ways to Think Like a 21st-Century Economist* [16], introduces the doughnut economy model, where production and consumption must operate within planetary boundaries while simultaneously ensuring socially just working conditions and access to basic goods. Murray, in *The Circular Economy* [17], demonstrate how the circular economy model can transform the production of goods by reusing materials and reducing waste. For example, Fairphone, a Dutch company, produces ethically manufactured smartphones by reducing the use of rare metals and improving working conditions, while Interface Inc., in the carpet industry, uses 100% recycled materials, promoting a circular production model. In any case, sustainable production of goods requires institutional regulations, circular economic models, and changes in consumer habits toward more inclusive and environmentally responsible practices.

The COVID-19 pandemic and geopolitical crises (such as the war in Ukraine) have exposed the vulnerability of global supply chains and highlighted the importance of economic autonomy and the reorganization of production at a local level. Benjamin Bratton (2015) analyzes how global production chains are not only economic but also digitally controlled. Multinational corporations and governments impose technological restrictions (e.g., export bans on semiconductors), making digital sovereignty crucial for national independence. Ha-Joon Chang, in *Bad Samaritans: The Myth of Free Trade and the Secret History of Capitalism* [18], explains that developed countries use protectionism and state intervention to strengthen their industrial base, contradicting the neoliberal rhetoric of free markets. Dani Rodrik (2011) in *The Globalization Paradox: Democracy and the Future of the World Economy* [19], argues that countries must balance globalization with national economic policies, reducing reliance on external markets through domestic production development strategies. In this context, the European Union is implementing a new strategy for semiconductors (*European Chips Act*), aiming to reduce the EU's dependence on microchip imports from Asia. Meanwhile, in India, the Make in India policy seeks to strengthen local industrial production instead of relying on multinationals. Thus, countries can reduce their dependence on global supply chains through national industrial policies, investments in technological self-sufficiency, and the development of local production networks.

Technology and data have become new instruments of power, capable of influencing political freedom, citizens' rights, and democracy. Specifically, Shoshana Zuboff, in

The Age of Surveillance Capitalism: The Fight for a Human Future at the New Frontier of Power [20], analyzes how major technology companies (Google, Facebook, Amazon) exploit users' personal data, turning them into a commercial commodity. This restricts personal privacy and reinforces forms of digital surveillance. Meanwhile, Evgeny Morozov, in *The Net Delusion: The Dark Side of Internet Freedom* [21], warns that digital technologies do not always promote democracy; on the contrary, authoritarian regimes can use them for surveillance and repression. Furthermore, Wendy Hui Kyong Chun, in *Updating to Remain the Same: Habitual New Media* [22], explores how continuous technological renewal reproduces the same forms of control and user compliance, despite the illusion of innovation. Notably, within the European Union, the GDPR (*General Data Protection Regulation*) legislation represents an effort to curb the commodification of personal data. The relationship between technology and political freedom is dual–while digital technologies offer opportunities for liberation, they can also function as mechanisms of surveillance and control. Consequently, objects in the Anthropocene are not neutral entities but carriers of power.

2.3 Future Prospects, Policy Implications and Governance Strategies

In light of the above theoretical discussion, this section extends its scope to include policy implications and governance strategies, translating the conceptual framework into concrete and actionable directions. The Anthropocene compels us to rethink what production and object mean in the 21st century–not only as human-made artifacts but also as ecological and geopolitical forces. Therefore, the question of whether objects, their production, and their use are connected through public pathways or dissolve into separate stages can be examined both through Bratton's technological and computational lens and through Barad's new materialist approach, which emphasizes interactions rather than discrete phases. In any case, the discussion on the materiality of objects in the Anthropocene cannot rely solely on theoretical approaches but must also take into account parameters that link production, ecology, and the geopolitics of material goods. In *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* [23], Anna Lowenhaupt Tsing explores the commodification of nature through the production and trade of the matsutake mushroom, which thrives in environmentally devastated landscapes. Lowenhaupt Tsing examines the relationship between material objects, environmental destruction, and capitalist flows, demonstrating that commodification is never a linear process but rather relies on unpredictable ecological interactions. She underscores that the materiality of objects is not merely a product of human production but emerges from interlocal relationships between humans, plants, animals, and microorganisms. She also analyzes the ecology of ruins, where the production of objects depends on fragile and degraded ecosystems, such as deforested or industrially polluted lands. Lowenhaupt Tsing's approach enables a post-capitalist analysis of materiality, revealing how objects are not merely items of consumption but biological and geopolitical processes in continuous flux. Consequently, the emergence of a new way of understanding production–one that transcends the traditional notion of factories and supply chains–recognizes that objects are dynamic entities interconnected with nature, technology, and global politics. The discussion surrounding the Anthropocene,

materiality, and post-capitalist approaches to production is crucial for understanding global economies and the environmental challenges of the 21st century.

The theoretical engagement with materiality in the Anthropocene, as established in the discussion above via the comparison between Benjamin Bratton's layered infrastructure and Karen Barad's new materialism, calls for the corresponding shift towards the concrete elaboration of policy strategies. Although the previous chapters have addressed the ontological and epistemological aspects of materiality in sufficient detail, the present moment in history, marked by pressing environmental and geopolitical crises, demands translating these ideas into tangible governance models. In this regard, policy is not simply a tool of regulation; it is also a mediating construct that organizes interactions between material flows, technological systems, and socio-ecological dynamics.

To begin with, in light of Bratton's *The Stack* model of technological infrastructure, governance is inherently multi-scalar and infrastructural. The stratified nature of technological systems and material flows requires that policy actions be performed on multiple levels rather than being confined to one particular layer. For instance, concerning the Earth layer, it would be appropriate to establish an international regulatory framework for regulating resource extraction and exploitation, particularly critical raw materials such as lithium, cobalt, and rare earth elements, which constitute the material basis for the majority of modern technological production yet generate extensive ecological damage. Likewise, at the Cloud level, policy needs to address the growing energy footprint of data centers, cloud computing, and artificial intelligence systems by implementing policies for reducing carbon emissions, enforcing energy efficiency standards, and promoting renewable energy sources. Similarly, regarding the urban (City) layer, policies must be designed around the idea of constructing circular urban systems, which involve sustainable construction practices, waste reduction infrastructures, and localized production networks.

Furthermore, from the standpoint of the Interface and the User layers, policies must account for the cultural and behavioral aspect of material consumption by introducing right-to-repair legislation, restricting planned obsolescence, and promoting consumption models that emphasize durability, reusability, and reparability. Therefore, Bratton's conceptualization of layered infrastructure offers an adequate approach to understanding how policy could be distributed across multiple infrastructural domains in a coherent manner. Contrarily, the concept of new materialism developed by Barad entails a fundamental criticism of hierarchal and top-down approaches to governance. Namely, according to Barad, policy must embrace an alternative paradigm based on relationality, entanglement, and co-constitution of matter and meaning. In light of this idea, environmental policy must consider the cultural and relational aspects of human-environment interaction and adopt a more holistic view that encompasses the interconnectivity of ecological and socio-economic systems.

In this context, Barad's relational approach to materiality implies the need for community-based models of governance that would grant local communities agency in decision-making processes related to resource use, environmental conservation, and technological implementation. Additionally, Barad's philosophy requires incorporating indigenous knowledge systems and alternative epistemologies that oppose the hegemonic

extractive paradigm. Finally, the idea of intra-action developed by Barad prompts policy to acknowledge the inseparability of ecological and social spheres and promote interdisciplinary frameworks that combine environmental science, social theory, and political practice.

Based on the theoretical considerations presented above, the economic alternatives reviewed previously in this work, namely degrowth, circular economy, and production localization, could be formulated as specific policy proposals. For example, degrowth offers a fundamental critique of the relationship between economic activity and ecological boundaries. In this regard, policy measures congruent with degrowth could entail imposing caps on resource extraction, reducing working hours, introducing non-growth-based economic indicators, and redistributing wealth and resources to address social inequalities. Thus, whereas policy actions inspired by the degrowth paradigm emphasize efficiency and optimization, degrowth prioritizes sufficiency and ecological equilibrium.

Additionally, the idea of circular economy can be applied as a basis for designing policy measures that mandate recycling, reusing, and eco-designing across various industrial sectors. The latter entails introducing extended producer responsibility schemes, implementing material traceability systems, promoting the production of recyclable and biodegradable materials, and so forth. However, as pointed out by critics, circular economy policies should avoid being subsumed within existing capitalist growth paradigms and instead form part of broader structural transformations that tackle systemic inequalities.

Besides, the localization of production emerges as another important strategy for increasing economic resilience and minimizing the ecological impacts of global supply chains. For instance, policies in this sphere could involve creating regional manufacturing ecosystems, investing in local infrastructures, and developing decentralized energy systems. The localization of production contributes to enhanced economic autonomy and social stability while mitigating ecological damage. Finally, the geopolitical implications of materiality imply the necessity of establishing comprehensive international policy frameworks capable of addressing technological sovereignty, ethical governance of global value chains, and environmental justice on a planetary scale. In this regard, the global rivalry over semiconductors, rare materials, and digital infrastructures demonstrates that material objects are powerful instruments of power within complex economic and political relations. Thus, policy measures in this sphere could involve drafting international agreements on critical materials, enforcing labor and environmental standards, and implementing cooperative mechanisms for resource sharing and technological transfer.

Lastly, the connection between technology and political freedom calls for special attention in the realm of policy discourse. The expansion of digital infrastructures increases the risks of state surveillance, data commodification, and algorithmic governance. Hence, regulatory frameworks such as data protection laws, transparency requirements, and democratic oversight mechanisms are crucial for maintaining citizens' rights and liberties amid technological development. Thus, policy must balance innovation and accountability by recognizing the non-neutrality of technological systems. To conclude, the combination of Bratton's layered infrastructure analysis and Barad's

relational ontology provides a solid ground for developing holistic policy strategies in the Anthropocene. The materiality of technology and geopolitics involves the interplay between structural and dynamic factors, which facilitates a deeper understanding of material systems and opens up avenues for systemic, ecological, and socially informed governance models. The transition towards sustainable and equitable futures hinges not only on technological innovation but also on reconfiguring the political and economic structures shaping the production, circulation, and meanings of material objects.

3 Conclusion

The analysis highlights key themes in understanding the ecological and technological challenges of the Anthropocene and potential paths for transformation. Human activity, particularly the production and consumption of materials like plastics and concrete, has left irreversible marks on the planet, underscoring the urgent need for ethical and sustainable resource use. Theoretical perspectives on materiality, such as Bratton's hierarchical view of infrastructures and Barad's fluid, interconnected approach, challenge static models of production and emphasize the unpredictable and relational nature of material existence.

Degrowth emerges as a crucial response to the environmental crisis, rejecting unlimited economic expansion in favor of reduced consumption, resource redistribution, and economic models that prioritize social and ecological sustainability. Objects are not merely passive commodities but are deeply embedded in geopolitical, economic, and environmental power structures, as seen in materials like lithium batteries and semiconductors. To counter the adverse effects of global capitalism, the text advocates for alternative economic models such as localized production, circular economies, and digital sovereignty, which aim to reduce dependency on exploitative global supply chains.

Technology plays a dual role in shaping political freedom, offering opportunities for empowerment while also posing risks of surveillance and control, necessitating a more critical engagement with its societal implications. The text ultimately calls for a reevaluation of production and objects beyond traditional capitalist frameworks, recognizing materiality as a dynamic force shaped by human, ecological, and geopolitical interactions. By integrating radical theories such as degrowth and new materialism, this perspective promotes a more sustainable and equitable approach to production and consumption, urging a fundamental shift in how we engage with the world's resources to secure a just and ecologically responsible future.

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