Toward a responsive approach: Reimagining technology in environmental governance

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Abstract
This chapter explores responsiveness as a critical framework for integrating AI and data technologies into environmental governance, focusing on its dual dimensions: empathetic perception and resolute engagement. Building on critiques of technosolutionism, it examines how AI often redefines socio-environmental challenges in ways that align with technological capabilities, sidelining systemic issues and participatory approaches. Responsiveness offers an alternative, emphasizing inclusivity and the capacity to act within broader governance systems. Using the Polish forestry sector as a case study, the chapter highlights the interplay between institutional capacities, societal demands, and technological infrastructures. It argues that while traditional data technologies dominate in this context, they provide valuable insights into the challenges and possibilities of AI integration. By situating AI within existing institutional and ecological frameworks, the chapter underscores the need for governance systems that move beyond isolated technological fixes, embracing nuanced and adaptive approaches to environmental challenges.

Keywords: Responsiveness, Technosolutionism, Environmental governance, AI integration, forestry

Introduction

As AI and data-driven technologies become central to environmental governance, they are often portrayed as transformative tools for solving pressing ecological challenges. Media narratives and policy frameworks hail AI as a silver bullet for issues like climate change adaptation and sustainable resource management. Examples such as AI-driven wildfire detection, energy grid optimization, and satellite-based deforestation monitoring highlight its potential to revolutionize ecosystem management. This enthusiasm is echoed in headlines—"Can AI Save the Amazon?"—and corporate campaigns from Big Tech. Political discourse also reflects this narrative, with the EU's "twin transition" positioning digital innovation as key to sustainability.

Scholars emphasize that the vision of "green AI" warrants critical scrutiny, particularly regarding its role in enabling sustainable practices. Van Wynsberghe identifies two key dimensions of the AI-environment relationship: the sustainability of AI itself, which examines the environmental costs of energy-intensive data centres and rare earth metal extraction; and the use of AI for sustainability, where technologies optimize energy grids, model climate scenarios, monitor deforestation, and enhance precision agriculture (van Wynsberghe, 2021). While these applications offer predictive insights and efficiency, they risk entrenching technocratic oversight, favouring market-driven metrics, and marginalizing democratic, context-sensitive approaches.

Building on these critiques, this chapter examines the integration of AI into environmental governance (Kloppenburg et al., 2022; Turnbull et al., 2023), exploring how digital technologies reshape governance processes for natural environments. As AI becomes embedded in policy frameworks, it not only influences how solutions are implemented but also redefines problems to align with technical capabilities. This reflects technosolutionism—a tendency to reduce complex socio-ecological challenges to narrowly defined technical issues (Bakker & Ritts, 2018; Gabrys et al., 2022; Nost & Goldstein, 2022). By prioritizing efficiency and predictive precision, technosolutionism obscures systemic drivers of environmental crises, such as socio-economic inequality and unsustainable resource use. It also entrenches technological control, sidelines public debate, and promotes short-term technical fixes over long-term, systemic change.

In response to the challenges posed by technosolutionism, this chapter proposes a responsiveness framework as a critical approach to integrating AI into environmental governance. Rather than merely critiquing technosolutionism, responsiveness invites deeper questions about the role of technology in defining governance problems and its relationship with existing public organizations and infrastructures. This framework emphasizes two interconnected dimensions: empathetic perception and resolute engagement. Empathetic perception involves listening to diverse societal voices and incorporating their perspectives into governance processes. Resolute engagement, meanwhile, focuses on the institutional capacity to act effectively on these insights.

This chapter grounds its framework in the case of Poland's forestry sector, where traditional data-driven tools, alongside emerging AI applications, are used to manage deforestation, monitor biodiversity, and respond to extreme weather events. While these technologies are not always cutting-edge, they offer valuable lessons for understanding how digital systems can shape governance. By analysing this example, the chapter contributes to the book's broader themes of sustainability, infrastructures, and governance, urging a reconsideration of how AI and similar technologies are embedded into socio-technical systems.

The chapter is structured as follows: it begins by outlining the critique of technosolutionism in the context of AI for sustainability and "green AI," examining its limitations and implications for addressing ecological challenges. It then develops the concept of responsiveness as a governance framework, emphasizing its two key dimensions: empathetic perception and resolute engagement. Finally, it applies this framework to the Polish forestry sector, demonstrating how digital tools influence the governance of natural environments.

Green AI and limits of techno-solutionism

Environmental policies have long relied on technological solutions to address complex ecological challenges, often treating these technologies as quick fixes. Geoengineering, for example, has been proposed for decades to combat climate change through interventions like solar radiation management or carbon capture, reflecting a belief that technology can resolve systemic problems (Goldstein, 2018; Huesemann & Huesemann, 2011; Levidow & Raman, 2020). Similarly, digital and AI-driven tools are frequently framed as transformative solutions, promising to optimize energy use, monitor deforestation, or model climate scenarios (Certomà et al., 2024; McLean, 2020; Nost & Colven, 2022). However, these approaches often follow the same technosolutionist path—relying on oversimplified, depoliticized narratives that overlook the root causes of environmental crises. This technosolutionist perspective also permeates major policy frameworks, such as the European Union's "twin transition," which links digital innovation with environmental sustainability(Kovacic et al., 2024).

To better understand the implications of this mindset, this section engages with the conceptual underpinnings of technosolutionism by distinguishing it from the related concept of technological fixes (Siffels & Sharon, 2024). While both technosolutionism and technological fixes involve using technology to address societal problems, they differ in logic and impact. Technological fixes, as Weinberg described in 1960s (Johnston, 2018), work within pre-defined problem spaces, providing pragmatic solutions without altering how the problems themselves are framed. In contrast, technosolutionism, as Morozov (2014b) and Siffels and Sharon (2024) argue, operates with a backward-

looking dynamic: the existence of a solution drives the definition of the problem. This distinction highlights how technosolutionism reshapes societal challenges to align with the capabilities of existing technologies, often neglecting systemic drivers and alternative perspectives.

Technological fixes, as originally described by Weinberg (Johnston, 2018), are pragmatic solutions that leverage technological innovation to address specific challenges, often characterized by their efficiency and directness. For example, deploying a device to reduce pollution in a factory aligns with the concept of a technological fix—it addresses the immediate issue without necessarily engaging with the systemic causes of pollution, such as industrial overproduction or weak regulatory frameworks. Critics have long highlighted the limitations of this approach, pointing out how it isolates problems from their broader socio-political and ecological contexts (Rosner, 2004; Siffels & Sharon, 2024).

Technosolutionism, in contrast, moves beyond this pragmatic logic. As Morozov (2014b) argues in his seminal critique, technosolutionism involves constructing or reframing societal phenomena as "problems" only after a technological solution has been proposed. Siffels and Sharon (2024) extend this critique, noting that technosolutionism often produces poorly constructed problems, shaped more by the available technological capabilities than by thoughtful consideration of societal needs. For instance, in digital governance, the proliferation of AI systems for monitoring or predictive modeling frequently narrows environmental challenges to quantifiable terms, sidelining holistic or participatory approaches (Bakker & Ritts, 2018; Nost & Colven, 2022).

A key feature of technosolutionism is its reliance on pre-existing technological affordances to redefine problems. This backward orientation contrasts with the forward-thinking deliberation expected in democratic policymaking. For example, a satellite-based deforestation tracker might redefine deforestation not as a systemic issue tied to economic exploitation or governance failures, but merely as a problem of insufficient monitoring. As a result, the technological solution becomes self-justifying, while deeper structural issues remain unaddressed (Siffels & Sharon, 2024).

Another critical issue is the institutional dependence these technologies create. AI tools do not operate in isolation; their effectiveness hinges on pre-existing governance structures, resource availability, and institutional capacity(Morozov, 2014a). For instance, platforms like Global Forest Watch generate real-time deforestation alerts, yet their impact is often undermined by enforcement gaps, limited local capacity, or conflicting stakeholder priorities. While these technologies provide valuable data, they cannot enforce laws, allocate resources, or build the coalitions needed for meaningful action. This disconnect underscores a key limitation of technosolutionism: its reliance on existing institutions, which are often ill-equipped to address the systemic challenges these tools are intended to solve.

Siffels and Sharon (2024) further emphasize the harms associated with technosolutionism, including the erosion of democratic decision-making, the empowerment of powerful actors like Big Tech, and the creation of "orphan problems"—issues that are abandoned or transformed when they no longer align with a predefined solution. These harms demonstrate how technosolutionism not only oversimplifies but also depoliticizes complex societal challenges, framing them to prioritize technological intervention while neglecting systemic reform or community-driven solutions. This narrow focus often shifts attention toward "design ethics," where efforts concentrate on procedural tweaks and technical adjustments to AI systems (Powels, 2018). While not inherently negative, this approach has significant limitations, as it avoids deeper engagement with the structural and systemic issues underpinning governance and inequality.

Taking seriously the differences between technological fixes and technosolutionism, this chapter approaches both as significant challenges to the integration of AI into governance. Two interconnected logics are particularly critical. The first concerns the definition of problems—how socio-environmental challenges are defined and whose perspectives shape these definitions. By privileging top-down approaches, both technosolutionism and technological fixes often marginalize participatory and systemic understandings of environmental issues. The second relates to the systemic context within which these technologies operate—whether governance systems can realistically support AI's promises or whether these tools merely mask deeper institutional weaknesses. Together, these logics underscore the limitations and possibilities of integrating AI into environmental governance, often reinforcing inequities and inefficiencies rather than fostering transformative change.

While critiques of technosolutionism are essential for understanding the limitations of AI in environmental governance, this chapter aims to engage in a broader conversation about what lies beyond solutionism. Rather than focusing solely on building better technologies, it seeks to grapple with the deeper question of how integration can be approached in a more humble and holistic way. This involves treating AI's limitations not as mere technical constraints but as opportunities to rethink the relationship between technology and socio-political problems.

Responsiveness as a critical approach

Building on these critiques, this section joins the broader conversation on responsiveness, examining its potential to reshape the integration of AI in environmental governance. Rooted in the framework of Responsible Innovation (RI), responsiveness is highlighted as one of its core dimensions, alongside anticipation, reflexivity, and inclusion (Stilgoe et al., 2013). It emphasizes the capacity to adapt to societal values, emerging challenges, and feedback loops within governance structures. Responsiveness shifts governance from reactive, retrospective measures to proactive engagement, aligning technological development with ethical considerations, sustainability goals, and public acceptability.

Stilgoe et al. (2013) argue that responsiveness goes beyond reactionary measures, embedding dynamic mechanisms into governance that continuously address societal and ecological concerns. This shifts focus from product-based risk assessments to the broader purposes and processes of innovation. Similarly, Röd et al. (Rödl et al., 2022) emphasize a historically informed approach, integrating past technological trajectories into present decision-making to foster adaptability and long-term systemic awareness. However, while RI provides a valuable framework, it struggles to tackle deeper systemic issues like entrenched power imbalances and structural inequalities. For example, mutual responsiveness may bring diverse perspectives into innovation, but it often fails to shift decision-making power, leaving disparities between corporate actors and local communities unaddressed (Pellizzoni, 2020). As a result, RI's approach tends to prioritize procedural inclusion over structural transformation.

Pellizzoni (2004, 2020) critiques this narrow interpretation of responsiveness, arguing that governance systems must go beyond reactionary adjustments. He identifies responsiveness as a neglected yet crucial aspect of governance, emphasizing the need for fundamental openness to external inputs. This enables a rethinking of institutional norms and governance goals in response to societal and environmental complexities. Pellizzoni's vision aligns responsiveness not only with adaptability but also with a proactive commitment to structural and relational justice. By rejecting the "close-ended logic" that dominates current governance practices, he envisions responsiveness as a means to challenge entrenched inequalities and foster meaningful contestation within governance frameworks.

Martha Fineman's theory of vulnerability offers a compelling perspective on responsiveness, emphasizing the role of strong, active institutions in addressing structural inequalities and fostering resilience (Fineman, 2010). Her concept of the responsive state envisions governance systems that proactively mitigate vulnerabilities and create equitable frameworks to address societal needs. By advocating for a shift from reactive, minimalist governance to proactive and inclusive approaches, Fineman highlights the importance of justice and equity as foundational principles in governance.

In natural resource management, responsive governance builds on these principles by emphasizing participatory decision-making and adaptive administration. Mustalahti (2018) highlights the importance of interactive governance, where state institutions and local communities collaborate to co-produce knowledge and solutions. This contrasts with top-down models that often marginalize local voices and fail to incorporate local knowledge effectively. A key component of responsive governance is its adaptability, which allows policies to evolve in response to changing environmental conditions. Mustalahti and colleagues (Mustalahti et al., 2020) critique the practice of responsibilization, where communities are tasked with governance roles without adequate resources or support, exacerbating inequalities. Instead, they argue that responsive governance must empower communities through capacity-building programs, structural support, and meaningful participation.

Reviewing the concept of responsive governance and responsiveness, a striking duality emerges that is particularly relevant to the integration of AI and data technologies in environmental governance. Responsiveness requires not only including diverse voices and listening to their concerns but also acting meaningfully on those concerns. This duality—between openness to inclusion and the capacity to act—is essential. Listening without action risks tokenism, while action without inclusion leads to top-down

governance that alienates stakeholders and entrenches inequities. Building on this, I propose a perspective on responsiveness that emphasizes two dimensions: empathetic perception and resolute engagement.

Empathetic perception reflects an openness to diverse perspectives and forms of knowledge in defining and addressing governance challenges. Much of the discussion around this openness has focused on participatory processes such as citizens' assemblies or the co-design of ethical technologies (Hintz, 2021; Kloppenburg et al., 2022). These mechanisms aim to bring stakeholder perspectives into governance, but they often fall into the trap of framing participation as a solution in itself and prioritizing well-designed processes over deeper engagement with the political and contested nature of governance (Sadowski, 2020).

Empathetic perception opens space for modes of engagement beyond structured participation. Echoing Pellizzoni's call for "fundamental openness," it recognizes the significance of activist interventions, direct actions, and grassroots mobilizations in reframing problems and challenging dominant assumptions. Such engagements compel governance systems to confront embedded biases, creating opportunities for alternative understandings and priorities. Empathetic perception, therefore, involves more than listening—it requires rethinking the purposes and trajectories of governance, moving beyond technosolutionist approaches toward more pluralistic and contested understandings of environmental governance. Repoliticizing governance in this way underscores the importance of contestability as a core feature of environmental decision-making (Accetti, 2021). Rather than seeking closure or consensus, governance systems must remain open to normative disagreements and value-based conflicts, allowing contestation to drive more inclusive and dynamic approaches to socio-environmental challenges.

If empathetic perception emphasizes openness and inclusion, resolute engagement focuses on the capacity to act. Governance requires more than deliberation; it depends on the ability to make decisions and implement them effectively. This capacity is shaped by resources, institutions, and infrastructures, which together enable or constrain action (Tompkins & Neil Adger, 2005). Importantly, governance capacity is not static but relational, reflecting the systems and power structures in which it operates.

If empathetic perception emphasizes openness and inclusion, resolute engagement focuses on the capacity to act. Governance requires more than deliberation; it depends on the ability to make decisions and implement them effectively. This perspective highlights the structures, networks, and resources that enable or constrain action, revealing that capacity is not static but shaped by the systems and contexts in which it operates.

Capacity is shaped by material resources, institutions, and infrastructures. AI systems, for instance, rely on ecosystems of data, skilled expertise, and public infrastructure, which require funding, operational structures, and coordination across various levels of governance. Action, as the realization of governance decisions, builds on these pre-existing capacities, raising critical questions: Do our institutions have the capacity to act on the insights technologies generate? How do AI systems interact with and enhance—or strain—these organizational capacities?

Resolute engagement underscores that action is not merely about execution but about creating and sustaining the conditions for systemic responsiveness. Governance capacity is deeply relational, involving sustained investments in infrastructure, careful navigation of interdependencies, and a balance between public and private actors. By addressing these dynamics, resolute engagement becomes a mechanism for ensuring that governance systems can act decisively and effectively, aligning technological interventions with public goals and broader systemic needs.

Empirical Focus: Polish Forests as Political and Technological Arenas

Building on the conceptual framework of responsiveness, this chapter turns to the Polish forestry sector as an empirical site where governance, technology, and political conflicts converge.

Forests in Poland cover approximately 30% of the country's territory, with nearly 80% managed by the State Forests (Lasy Państwowe), a public institution that combines the characteristics of an administrative authority with those of a public corporation. Employing over 25,000 people, the State Forests oversee a highly centralized system of forest management, characterized by a hierarchical bureaucracy, professional expertise, and significant social prestige. Although formally supervised by the

Ministry of Climate and Environment, the institution wields considerable autonomy. It maintains a monopoly over the wood market, exerts significant control over its financial operations, and exercises discretion in setting management priorities and methods. Notably, the State Forests is one of the largest and oldest public institutions in Poland, not only in terms of the number of people it employs but also in its organizational values and territorial reach (Niedziałkowski & Putkowska-Smoter, 2021).

This centralized governance model is supported by a vast network of institutional actors, such as the Forest Research Institute and the Bureau of Forest Management. These specialized public institutions create a dense and interconnected governance framework for forestry. However, this concentration of power and expertise also aligns with traditional definitions of technocracy, as decision-making processes are heavily centralized and reliant on professionalized knowledge.

Forestry governance in Poland integrates traditional practices with advanced digital tools. Technologies such as drones, LiDAR, and machine learning have been adopted to enhance precision and efficiency in forest management. The State Forests' internal data infrastructures, including the State Forest Information System and the publicly accessible Forest Data Bank, are enabling comprehensive monitoring and decision-making processes.

For a long time, forest institutions have ranked among the most trustworthy of Poland's public institutions. However, Polish forests have also become spaces of political tension, shaped by competing visions of governance and sustainability. Since the 1990s, environmental civil society organizations and forest ecology scientists have challenged the legitimacy of the State Forests' management practices. These conflicts have intensified in recent years, with disputes over logging, forest planning, and conservation gaining visibility at both local and national levels. For instance, the 2016 Białowieża Forest controversy—where increased logging in one of Europe's last primeval forests provoked widespread protests and legal battles—highlighted the enduring tensions between economic imperatives and ecological preservation. Such struggles illustrate how forests serve as arenas where divergent priorities and values collide, making governance a contested and politicized process (Blicharska & Van Herzele, 2015; Niedziałkowski & Chmielewski, 2023).

The politicization of forestry governance has deepened under the rule of the Law and Justice (PiS) party (2015–2024), which has embedded forestry into nationalistic narratives, framing conservation debates in terms of national identity and sovereignty. This dynamic has tied forest management to broader issues of democratic backsliding, authoritarian tendencies, and political polarization. The centralized structure of the State Forests, while administratively efficient, has become a site of political struggle, with ecological concerns often subordinated to party politics. Forestry policies became a significant topic in recent parliamentary elections, with all major political parties addressing forestry in their platforms. Following the victory of a centrist coalition, there are pledges to strengthen forest protection, signaling potential shifts in governance but also raising questions about the practical implementation of these promises.

Amid these debates, technology plays a dual role—as both an enabler of governance and a source of contention. Digital tools and data systems have enhanced the capacity of the State Forests to monitor and manage vast territories, but they have also amplified power asymmetries and raised questions about inclusivity and accountability. While technologies such as drones and machine learning optimize operations, they also reinforce the centralized control of the State Forests, often sidelining alternative voices and participatory approaches.

This chapter draws on a study I conducted over the last two years, exploring the proliferation of data technologies in Polish public forestry. This research involved 35 interviews with state officials, foresters, and activists, complemented by extensive fieldwork examining various sites of technology implementation in forestry. The study also looked at struggles over governance and emerging ways of understanding the interconnected roles of the state, nature, and technology. Insights from this research will now be analysed through the framework of responsiveness outlined above, focusing on the interplay between resolute engagement and empathetic perception. These two dimensions highlight how technology is linked—or not linked—to democratic contestation and input, as well as the capacity to act on insights generated by these tools within pre-existing organizational and infrastructural contexts. While these findings provide rich empirical evidence, they also reflect broader political observations about the contested nature of governance, the role of the state, and the implications of technological intervention in managing ecological challenges.

Thinking with responsiveness

Having outlined responsiveness as a critical framework, this section explores how its dual dimensions—empathetic perception and resolute engagement—intersect in environmental governance. Using the case of Polish forestry, these ideas are examined as intertwined processes rather than separate analytical categories. While AI tools are increasingly part of forestry governance, many examples from Poland highlight the use of more traditional data technologies, offering valuable insights for understanding and guiding AI integration. Thinking with responsiveness in this context involves reflecting on how governance systems navigate societal demands, technological infrastructures, and institutional capacities. It is in the connections and frictions between these elements that the potential of responsiveness as a governance framework becomes visible.

Empathetic Perception: Contesting Problem Definitions in Polish Forestry Governance

Empathetic perception begins with the act of listening—understanding what constitutes socio-political problems and whose perspectives are included in their definition. Yet, as Siffels and Sharon (2024) argue, technosolutionism often narrows problem definitions, aligning them with the capabilities of existing technologies while sidelining alternative voices and limiting genuine public debate. In Polish forestry governance, a centralized, top-down approach dominates (Niklas, 2024). Institutions such as the State Forests rely on specialized expertise to frame problems, leaving little room for public debate or alternative perspectives on forest management.

This approach has long characterized Polish forestry governance, where problem definitions are shaped within a narrow institutional framework and reinforced by expert-driven systems. As one civil society representative observed:

"*There's no real space for negotiation. Forest management is framed as a technical issue, and decisions are made behind closed doors. Communities and activists are left to react rather than participate*" (COS5).

These dynamics marginalize broader ecological and community concerns, leaving governance systems ill-equipped to address the full complexity of forestry challenges. However, civil society actors have resisted these top-down practices, using protests, grassroots mobilizations, and creative re-appropriation of institutional tools to push for alternative narratives.

The Forest Data Bank provides a clear example of how these governance dynamics play out. While not an archetypal example of technosolutionism, it illustrates how data technologies shape the framing of environmental problems. Designed in the 2010s to centralize environmental data from over 300 forestry districts, the system reflects a traditional, data-driven approach to forestry management. As one forester explained:

"It's a tool that shows a lot and helps us manage forests effectively. It's built to integrate massive amounts of information in one place" (FE4).

While celebrated for its technical sophistication, the Bank overwhelmingly emphasizes metrics like timber yield and pest control. These priorities align with economic imperatives, sidelining concerns such as biodiversity conservation or the cultural significance of forests. As an NGO leader noted: *"These systems are designed for foresters, not for communities. They open the door just enough to say they're being transparent, but not enough for anyone to walk through" (COS8).*

Civil society actors have responded by contesting the problem definitions embedded in the Forest Data Bank. A notable example is the Logging Map, an NGO-driven platform that transforms the Bank's data into accessible visualizations of planned logging activities. By reframing these institutional outputs, the Logging Map emphasized local impacts and sparked public engagement. As one activist described: *"The map wasn't just data—it was a way to connect people to these decisions. It gave them a voice*" (COS3).

The interaction between the Forest Data Bank and the Logging Map reveals the dual dynamics of empathetic perception. On one hand, centralized systems like the Bank illustrate how governance institutions define problems in ways that reflect their priorities. On the other, civil society actors show how these systems, despite their limitations, can become tools for accountability and contestation. As one NGO representative critically noted:

"The problem isn't access to data; it's what they do with it. They're happy to show you the numbers, but don't expect them to act on what you say" (COS6).
This interplay highlights how listening in governance is inherently complex but, in contested ways, can still enable change. Empathetic perception in Polish forestry governance is not a harmonious process but one mediated by institutional rigidity and civil society resistance. By pushing back against narrow definitions and reframing institutional outputs, activists expose the limitations of governance systems and create space for alternative problem definitions.

Resolute Engagement: Public Capacity and Embeddedness of Technological Systems

Resolute engagement invites us to consider the capacities, actions, and ways in which data technology integrates with broader governance structures in response to socio-environmental demands. In the context of Polish forestry, this capacity is rooted in the institutional strength, technological investments, and autonomy of the State Forests. These factors enable decisive action in certain areas, while also revealing the tensions inherent in balancing operational efficiency with societal and ecological priorities.
The State Forests stand as one of the largest public institutions in Poland, with extensive resources and infrastructure at their disposal. This institutional strength underpins their ability to act decisively. As one representative emphasized: "*Scale is what makes this impressive. Our size is the size of the Bank… 25,000 employees, 8 million hectares*" (P4).
This scale is accompanied by significant informational capacity, supported by advanced data systems and a steady flow of resources: "*We are informationally strong… we produce data every day, millions of records*" (FE5).
The institutional architecture of the State Forests has its roots in the socialist era of the 1970s but underwent significant transformation in the 1990s following Poland's political and economic transition. The introduction of the State Forests Information System (SFIS) marked a turning point, enabling centralized data collection and integration. As one specialist recalled: "*Building the system in the '90s was quite an adventure—a true transformation story. We had money flowing in from the West… endless testing, and somehow, we managed to piece it all together into something that actually worked*" (P6).
This transformation was made possible in part by the financial and operational autonomy of the State Forests. Unlike many other public institutions, they retained the ability to make independent decisions about resource allocation. As one specialist explained: "If we didn't have this level of autonomy, there's no way we could have spent that much money. We had freedom to invest in these new systems, to push where others might not have been able to" (FE6).
This autonomy also allowed the State Forests to acquire a technology company, bringing IT operations in-house and reducing reliance on external contractors. As one forester noted: "*By keeping IT operations in-house, we have more flexibility to adapt systems to our needs. It's about ensuring the technology works for us, not the other way around*" (FE9).
However, autonomy comes with its own challenges. While it has enabled bold investments and operational resilience, it has also fostered a perception of insularity. The State Forests are sometimes seen as resistant to external critique and societal feedback, particularly when public demands for transparency and ecological sensitivity conflict with institutional priorities. This paradox highlights a central tension in resolute engagement: the same autonomy that enables effective action can also limit responsiveness to broader societal concerns.
A key success story of resolute engagement in Polish forestry is the wildfire detection and response system, which integrates real-time data from observation towers, drones, and machine learning algorithms with on-the-ground firefighting teams. As one expert in forest fires noted: "*What really works is that the information is directly connected to action. It's not just data sitting on a screen… there are firefighters, foresters, and those lookout towers out there in the field. There's a real-time connection between what we know and what we do*" (FE7).
This system, regarded as one of the most advanced in Europe, demonstrates how resolute engagement can function effectively in crisis scenarios. However, its success is not simply the result of technological innovation. As one forester remarked: "*You can't just throw technology at a problem and expect it to work. It needs a foundation—trained people, processes, and the resources to sustain it*" (P8). Decades of investment in infrastructure, training, and coordination have created the conditions for such rapid and

effective responses. The integration of technology into governance here reflects not just a reliance on tools but an embeddedness within durable systems that align data collection with actionable outcomes. At the same time, this focus on operational efficiency in crisis management contrasts with the State Forests' limited effectiveness in addressing long-term systemic challenges like biodiversity conservation. As one NGO leader observed: "*They're excellent at dealing with emergencies, but when it comes to thinking long-term about biodiversity, the system falters. It's not just about technology; it's about priorities*" (COS6).
This selective capacity for action reveals a structural bias within the State Forests' priorities, where economic imperatives often overshadow broader ecological concerns. While the autonomy and resources of the State Forests enable them to excel in certain areas, they also highlight the challenges of aligning resolute engagement with societal and ecological goals.

The analysis of Polish forestry governance reveals a gap between the two analysed dimensions of responsiveness. While instances of listening and inclusion, such as civil society's reframing of forestry data, demonstrate the potential for contestation and alternative narratives, these efforts often fail to translate into meaningful institutional action. Similarly, the operational strength and autonomy of the State Forests enable decisive responses in certain areas, such as wildfire management, but these actions remain disconnected from broader societal input and long-term ecological priorities. This disconnect underscores a central critique of technosolutionism: the focus on technological fixes and isolated capacities often obscures the deeper work needed to align governance systems with public values and systemic complexity. What emerges is not a cohesive framework of responsiveness but fragmented practices that highlight the challenges of integrating empathetic perception and resolute engagement in governance. These reflections invite a crucial question: how can governance systems approach technology not as isolated tools but as embedded within and shaped by broader institutional, social, and ecological contexts? Addressing this requires treating technological integration in environmental governance with greater nuance, acknowledging the ways technologies are politically constructed.

Conclusion

This chapter argues for responsiveness as a critical approach to environmental governance that moves beyond the constraints of technosolutionism. By focusing on the dual dimensions of empathetic perception and resolute engagement, it highlights an alternative framework for integrating AI and data technologies into governance systems. Empathetic perception challenges institutions to move past narrow, technical problem definitions, inviting diverse perspectives and contestation into the process of defining socio-environmental priorities. Resolute engagement complements this by emphasizing the capacity to act decisively, rooted in durable infrastructures, institutional investments, and the ability to align action with ecological and societal goals.
This approach invites a rethinking of how AI is positioned within sustainability and environmental governance. Rather than framing these technologies as standalone solutions or saviors, responsiveness places them in the broader context of existing organizations and infrastructures. AI tools do not operate in isolation; they interact with human expertise, institutional frameworks, and material infrastructures. These interactions are critical, as they shape both the potential and the limitations of AI in addressing environmental challenges. A responsive approach calls for a deeper understanding of these dependencies and relationships, ensuring that AI complements rather than replaces the systemic capacities and values required for sustainable governance.
By situating AI within the fabric of governance systems, this framework underscores the need to move beyond superficial narratives of technological fixes. Responsiveness highlights the importance of embedding AI within adaptive, inclusive, and resilient infrastructures that support long-term sustainability. This means addressing not only how technologies are made and deployed but also how they align with broader societal and ecological objectives. In this sense, responsiveness offers a way to ensure that AI contributes to a more equitable and sustainable future, not by simplifying complex environmental challenges but by engaging with and strengthening the systems that enable meaningful and lasting change.

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