Civic surveillance mediation: How NGOs facilitate, translate and negotiate the use of surveillance technology for environmental enforcement

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ABSTRACT

Environmental NGOs using satellite imagery and remotely sensed data for environmental monitoring and enforcement must negotiate their role within a broader Earth Observation (EO) ecosystem. When harnessing EO technologies for environmental good, these NGOs neither fully resist nor wholly reproduce traditional surveillance logics. Instead, they act as civic surveillance mediators: intermediaries that shape the direction and ethical use of monitoring technologies in pursuit of civic- and justice-oriented goals. Their use of EO data cannot be categorised as either fully counter-balancing or entirely disciplinary. Rather, they are actively mediating the civic potential of surveillance technologies. However, as EO tools continue to evolve and surveillance becomes increasingly automated, NGOs may face pressure to clarify their ethical commitments and formalise their protocols. The model of civic surveillance mediation helps to name and situate this role, highlighting the need for intentional EO research design, participatory engagement and ethical consideration in shaping future surveillance practices for environmental justice.

KEYWORDS: *ethics, surveillance, crime, environment, NGOs*

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Abbreviations

AI	Artificial intelligence
AI4EO	Artificial intelligence for Earth Observation research
API	Application Programming Interface
ASM	Illegal artisanal and small-scale mining
CAR	Brazil's *Cadastro Ambiental Rural* (Rural Environmental Registry)
eLENS	Copernicus for Environmental Law Enforcement Support
EO	Earth Observation
ESA	European Space Agency
EU	European Union
GDPR	General Data Protection Regulation
GEE	Google Earth Engine
GFW	Global Forest Watch
GIS	Geographic information systems
GPS	Global positioning system
LGPD	*Lei Geral de Proteção de Dados* (General Data Protection Law)
ML	Machine learning
MOU	Memoranda of understanding
MPF	*Ministério Público Federal* (Federal Public Ministry)
NGO	Non-governmental organization
NOAA	National Oceanic and Atmospheric Administration
TA	Thematic analysis
UAV	Unmanned aerial vehicle
US	United States
WWF	World Wildlife Fund

1. Introduction

In 2021, a special report on violence against Brazil's Indigenous populations found that 176 murders and 148 suicides took the lives of Indigenous people across the country that year. The violent attacks had reportedly escalated in part due to the expansion of illegal mining, logging, land grabbing and other illicit land use operations in Indigenous territories. Notably, the Brazilian federal government was criticised for failing to respond to complaints of widespread environmental crime and violence in these communities (Rangel et al., 2021, p. 8).

At around the same time this report was published, an international environmental non-governmental organisation (NGO) provided drones, computers and training to the Environmental Policing Battalion in Brazil's state of Acre (World Wildlife Fund-Brazil [WWF], 2021, para. 2). This new technology was reportedly critical for inspecting rivers and remote areas, deterring crime by increasing police presence and building trust between the unit and the state's Indigenous communities (WWF, 2021, paras. 7–8). From September 2020 to May 2021, 82 drone-based operations were conducted, including monitoring Indigenous lands and conservation areas affected by deforestation, fires and illegal activity. Drone-based monitoring allowed for more targeted and efficient surveillance, leading to multiple arrests of environmental criminals (WWF, 2021, para. 10).

In this case, the environmental NGO occupies a space between grassroots activism and state surveillance. Its work is not as bottom-up as Indigenous activism nor as top-down as the state's surveillance apparatus. On the one hand, the purpose of the project was to protect Indigenous lands and peoples by supporting the detection, investigation and prosecution of environmental crime and violence in Acre. On the other hand, to achieve this goal, the NGO partnered with state actors, notably police forces, effectively expanding the state's surveillance capacity. Using its technical expertise and access to advanced surveillance tools, it acted as a bridge between Indigenous communities and the state, representing a distinct intermediary role.

NGO-led technological efforts to support environmental law enforcement do not fit neatly into existing theories of surveillance. While the use and expansion of surveillance technologies may help to counter harmful practices and empower marginalised communities, they still function within dominant power structures including state institutions, legal frameworks and national enforcement agendas.

1.1 Civic Surveillance Mediation

This study proposes a novel term for the use and expansion of surveillance by civic- and justice-oriented institutions such as environmental NGOs: civic surveillance mediation. This term captures how environmental NGOs shape surveillance practices to account for social, cultural and environmental dimensions. The term "mediation" softens the coercive undertones often linked to surveillance, emphasising instead a role of negotiation, ethical engagement and intervention between civilians (the surveilled) and the state (the surveiller). These organisations help translate technological capabilities into practices that are more context-sensitive, accountable and inclusive. Environmental NGOs may influence the norms around how surveillance data is collected, interpreted and mobilised, ensuring that enforcement aligns with both environmental protection goals and the rights of local communities. Civic surveillance mediation thus describes a space between the state's top-down surveillance and grassroots sousveillance, which is a term for countersurveillance by non-state individuals (Mann et al., 2003, p. 332). This type of mediation describes civic institutions actively co-producing legitimacy, knowledge and enforcement strategies. In this intermediary space, surveillance is both a tool of oversight and a collaborative practice shaped by a diverse set of stakeholders.

This study advances the theory of civic surveillance mediation through research into environmental NGOs' application of a particular surveillance technology: remote sensing and satellite imagery analysis. Remote sensing is the science of collecting data and information about land or objects from a distance. This data is typically gathered by aircraft or satellites (National Oceanic and Atmospheric Administration [NOAA], n.d.(b), para. 1). Satellite imagery refers to pictures of the Earth taken from space. These images are captured by sensors in satellites that measure the reflectance, meaning the amount of light a surface reflects, of the Earth's land cover to generate images of clouds, water vapour or land (NOAA, n.d.(a), para. 1). When referring to both remotely sensed data and satellite imagery, the term Earth Observation (EO) data or technology will henceforth be used.

This technology has been selected for three primary reasons. First, EO data has often been utilised to improve and expand environmental enforcement. Of the many published studies on technical approaches to harnessing this data for environmental stewardship and monitoring, most fall into one of two categories. One type of study focuses on using this technology to detect and document a specific environmental crime such as illegal dumping (Glanville & Chang, 2015, p. 13053; Massarelli & Uricchio, 2024, p. 1) or illegal logging (Mahfud et al., 2021, p. 273; Patias et al., 2020, p. 1491). The other category focuses on comprehensive environmental forensics and enforcement transformations using the power of

geographic information systems (GIS), satellite imagery analysis and remote sensing (Formosa et al., 2013, p. 1; Lega et al., 2014, p. 8291; Lega & Teta, 2016, p. 709; Sitorus et al., 2024, p. 46). The present study does not contribute a technical approach to using EO data for environmental enforcement.

Second, although EO data is often lauded as accessible to all, its value for knowledge production is far from democratic. Collections of satellite images taken of every corner of the Earth have become freely available through national observatories such as the US Landsat programme and the EU Sentinel mission. This has put data into the hands of everyone. Satellite imagery therefore offers researchers, governments and communities an opportunity to witness environmental crime in near real time. However, there is still a significant barrier that prevents EO technology from being considered fully democratised surveillance: the images themselves require interpretation, regardless of how high the resolution or image quality may be. Someone must decipher what land features the shapes and colours represent. Analysts work to construct meaning from the images through illustrations and captions, rendering them legible for public understanding (Witjes & Olbrich, 2017, p. 525). So although the data is freely available and out there for the taking, it still requires a level of technical knowledge and institutional credibility to be useful, disseminated or of interest to authorities and journalists.

Third, EO-based knowledge production is highly contested in social science literature. Some scholars point to the democratic potential of open-source EO for crowdsourcing environmental and security knowledge production. Others put forward more critical arguments, often focusing on power differentials between the observed and the observers (Witjes & Olbrich, 2017, p. 525). This paper positions its theory of civic surveillance mediation between the two perspectives, arguing that NGOs sit at a critical intersection of these dynamics. While they leverage the openness of EO data to produce compelling evidence of and mobilise action against environmental violations, they also rely on and are constrained by established systems of authority. Their work exemplifies how bottom-up surveillance practices cannot always escape the gravitational pull of top-down knowledge regimes. In this way, civic surveillance mediation reflects both the empowering and bounded nature of satellite-based transparency.

1.2 Potential Consequences of AI and Automation

Artificial intelligence (AI) is likely to reshape NGO operations in the near future. As AI and automation increasingly pass analysis and decision making to machines, human involvement in project design and implementation is expected to fall. Advanced

technologies enable the systematic processing of huge amounts of data collected by satellites, allowing for the development of predictive models capable of identifying a wide range of events, objects and phenomena, even in cases where ground truth data is scarce or unavailable (Kochupillai et al., 2022, pp. 90–91). This shift is redefining the degree of human involvement in the processing and analysis of satellite data. For example, the European Space Agency's (ESA) Copernicus programme generates vast quantities of imagery at varying resolutions. Processing and analysing such volumes of data manually would be both time-consuming and inefficient. AI accelerates this process and offers insights such as predictions and pattern recognition that are often perceived as more reliable and accurate than those produced through human analysis alone. In this way, AI is said to "enhance human agency" and "increase individual and societal capabilities" (Kochupillai et al., 2022, p. 93).

The theories of algorithmic governance and automated surveillance examine the implications of delegating decision-making power to machines. Algorithmic governance highlights how automated systems shape how institutions operate, often displacing traditional forms of human judgement and accountability (Katzenbach & Ulbricht, 2019, p. 4). In governance systems, "The degree of automation matters greatly because the legitimacy of governance regimes relies on the responsibility and accountability of a human decision-maker in her role as a professional (a judge, a doctor, a journalist) and ethical subject" (Katzenbach & Ulbricht, 2019, p. 8). Automated surveillance suggests that the rise of automated data collection and processing enables predictive surveillance, intervening in the present based on anticipated future behaviour and taking humans out of the loop even further (Andrejevic, 2019, p. 7). Together, these theories illuminate the tension between NGOs' ethical commitments and the operational demands of AI-driven environmental monitoring, raising urgent questions about the future of civic action in an increasingly automated world.

As NGOs move towards automating key components of their analysis, such as classification, detection and prediction, the space for deliberation and ethical reflection will narrow. This shift is especially problematic within organisations that lack formal ethical frameworks or governance structures for AI use. AI does not ask ethical questions related to how mapping a region might endanger its inhabitants or how releasing findings might contribute to forced displacement or criminalisation. As humans become more and more distanced from the work of mapping environmental violations, the ethical positioning of NGOs engaged in this work may be called into question. Without explicit mechanisms for

embedding ethical review into automated workflows, the capacity for NGOs to act responsibly and with integrity is undermined. This may harm trust among NGOs' stakeholders, including local communities, state actors and donors. Thus, the very practices that once legitimised NGO involvement, such as participatory engagement, local knowledge integration and moral deliberation, risk being sidelined by a paradigm that privileges speed, scale and technical efficiency. As the use of AI accelerates, NGOs may face pressure to demonstrate balance between their technical competence and their ethical credibility. Doing so will require adoption of new tools and training, but also a reassertion of the value of human judgement at the heart of their work to protect the planet.

1.3 Research Question and Structure of the Study

This paper investigates how two environmental NGOs navigate the ethical use of EO technologies in their work to combat environmental crime. The operationalisation of ethical principles in environmental NGO workflows is a largely unexplored topic. Much of the existing academic and policy discourse focuses on articulating ethical safeguards in abstract terms, without examining how these principles are interpreted, negotiated or implemented in practice. To address this gap, the study poses the following research question: what practical strategies do NGOs employ to ensure responsible use of satellite imagery in the fight against environmental crime? Practical strategies refer to the concrete, micro-level activities, processes and practices through which institutions function day-to-day (Golsorkhi et al., 2010, p. 1). The theoretical framework draws from the interdisciplinary field of surveillance studies and engages directly with recent work on ethical considerations associated with artificial intelligence for Earth Observation (AI4EO) research, particularly the framework proposed by Kochupillai et al. (2022). This dual lens provides a foundation for understanding the complex role of NGOs as civic actors operating within data-driven enforcement landscapes.

The next section introduces the theoretical framework followed by a detailed description of the methodology. The results section is organised in three parts. First, key empirical findings from expert interviews are presented with particular attention to how ethical principles are interpreted and applied in practice. Second, a conceptual model of civic surveillance mediation is introduced, grounded in theories explored in the theoretical framework. Finally, the Kochupillai et al. (2022) method is put into practice through two case studies: illegal deforestation and ocean pollution by artisanal fisheries. The paper concludes with a summary of findings and academic contributions as well as recommendations for future research.

2. Theoretical Framework

This study incorporates several theories in surveillance studies, explores scholarly debate on EO research as knowledge production and presents recent AI4EO ethical research, particularly the study by Kochupillai et al. (2022). This section of the paper is therefore divided into three main parts: *Surveillance Studies*, *Satellite Imagery Used for the Production of Knowledge* and *Ethics and AI4EO*, with several sub-sections delineating specific theories relevant to the conceptual model of civic surveillance mediation.

2.1 Surveillance Studies

Surveillance studies is a multidisciplinary field concerned with how personal data is collected and exploited to influence individuals and populations. Surveillance can involve both physical observation and technological monitoring, whereby technology does not replace watching but enhances it (Lyon, 2002, p. 1). Those undertaking surveillance (governments or companies) can classify and group individuals, abstracting human beings into categories based on collected data, such as income or criminal history, in order to better control and manage them. This process, known as "social sorting," is central to understanding surveillance (Lyon, 2002, p. 3).

The field has undergone three thematic phases. The first phase focused on architectural theories of surveillance (Galič, 2017, p. 9). Foucault (2008, pp. 5–6) draws on the concept of the panopticon, a prison design proposed by philosopher Jeremy Bentham in the 18th century, in which inmates are constantly visible to a watchtower, although they are unaware of whether they are being observed at any given moment. For Foucault, the panopticon symbolises a new form of power that extends beyond the prison and into societal institutions such as factories, schools and hospitals. A panoptic structure used across different sectors of society could promote self-discipline through the internalisation of surveillance.

The second phase addressed infrastructural theories of surveillance (Galič, 2017, p. 9). Deleuze (1992, pp. 3–4) extends Foucault's framework by arguing that disciplinary societies have evolved into what he terms "societies of control." While Foucault described a world of enclosed institutions, Deleuze maintains that these are now in decline. Rather than fixed enclosures that mould individuals, people now exist within flexible, continuous systems of control that modulate behaviour through constant access and adaptation. The shift from enclosure to modulation represents a transformation in how power is exercised: not through rigid discipline but through seamless, often invisible, mechanisms of control. Haggerty and Ericson (2000, pp. 609–11) propose the concept of "the surveillant

assemblage" to describe the fluid, interconnected yet fragmented nature of contemporary surveillance. Rather than a single, centralised institution, the surveillant assemblage refers to a complex network of heterogeneous elements, such as technologies, institutions, individuals and desires, that collectively observe, track, control and manage flows of information.

The third phase refines and extends these earlier conceptual frameworks, engaging with transitions from physical to digital surveillance, state to corporate control and top-down to self-surveillance (Galič et al., 2017, p. 9). This phase explores how surveillance is increasingly automated, distributed across peer networks and embedded in everyday infrastructures, leading to the emergence of concepts such as algorithmic governance. The present study contributes to this phase by situating satellite-based environmental monitoring within the field's evolving conceptual terrain.

Across surveillance studies literature, the social sorting process, or "the Panoptic sort" (Gandy, 2021, p. 29), is empirically, theoretically and ethically examined through investigations into its nature, impact and effects on society. This involves collecting information about a governance domain of interest, dissecting the interlinked and distributed institutions, bureaucracies and social connections associated with that domain, then isolating and observing the effects of those interconnected systems on everyday human life (Ball et al., 2012, p. 1). This study's governance domain of interest is environmental governance. Environmental governance refers to interventions, such as regulation, aimed at improving environmental incentives, knowledge, institutions, decision-making or behaviours. Actors involved in governance are often both state and non-state entities, such as businesses or NGOs (Lemos & Agrawal, 2006, p. 298). Governance thus acknowledges that authority and power operate across different, multilayered scales, in contrast to the more centralised notion conveyed by the term government (Bridge & Perreault, 2009, p. 476).

As Bridge and Perreault (2009, p. 475) observe, the widespread use of the term environmental governance across disciplines has given rise to a range of meanings and applications. Among the six distinct usages of governance they identify, this study adopts a focus on governance as political participation, with particular attention to non-state actors involved in environmental decision-making. This approach views governance as a response to the expansion of the political realm beyond formal institutions of representative democracy, whereby actors outside the state exercise influence. Nowhere is this shift more apparent than in the environmental sphere, particularly due to the rise of environmental NGOs. These organisations engage in diverse forms of political action, leading to what scholars have termed a decentring of environmental authority (Bridge & Perreault, 2009, p.

481). This decentralisation is institutional and epistemological, as it redirects authority to define and solve environmental problems, thereby challenging the state's monopoly over environmental decision-making.

NGOs reshape power relations that have historically favoured states and corporations. Through various forms of surveillance, NGOs monitor global actions and behaviours, promote transparency and, in doing so, discipline actors, shape global norms and restructure traditional hierarchies of authority. Their influence spans multiple domains, particularly in transnational security and environmental governance. For instance, NGOs have filled governance gaps in addressing threats such as terrorism and arms proliferation, which are issues that often transcend borders and disproportionately affect individuals rather than states. In such contexts, NGOs have proved valuable partners to states, particularly when issues of national sovereignty complicate the handling of diffuse, networked threats. NGOs, with their operational flexibility and capacity to forge transnational coalitions, may be better equipped to address such challenges (Krahmann, 2005, p. 9).

In the environmental domain, NGOs exert influence through three interconnected functions: critique, collaboration and implementation. First, NGOs act as critics of dominant environmental knowledge systems and regulatory frameworks. Drawing on local knowledge and on-the-ground experience, they challenge top-down scientific paradigms and expose blind spots in mainstream policy approaches. This often includes highlighting the socio-environmental impacts on individuals and communities (Jasanoff, 1997, pp. 580–1). Second, NGOs engage collaboratively in environmental monitoring. They foster inclusive epistemic networks that connect policymakers, scientists and communities. In doing so, they integrate environmental objectives with broader social concerns such as Indigenous rights, poverty alleviation and gender equality. This approach enhances the legitimacy of environmental governance and increases compliance by embedding lived experiences into environmental laws, policies and regulations. Third, NGOs contribute to implementation by disseminating information and facilitating technology transfer. In contexts where state capacity is limited, NGOs engage in education, advocacy, monitoring and even enforcement. Scholars of international environmental regimes have underscored the importance of NGO participation in securing compliance, particularly in regions with weak or under-resourced government oversight (Jasanoff, 1997, p. 581).

However, the influence of environmental NGOs is far from universal or guaranteed. Their effectiveness often depends on contextual factors such as the openness of a country's political system or its vulnerability to international pressure. One study finds these factors

particularly relevant in non-OECD states (Pacheco-Vega & Murdie, 2022, pp. 180–181). While advocacy tools such as lobbying and large-scale campaigns can be powerful (Keck & Sikkink, 1998, pp. 128–131), their impact ultimately hinges on the receptiveness of political elites. For example, a comparative analysis of NGO efforts in China revealed that opposition to the Three Gorges Dam failed, while campaigns against the Nu River Dam achieved partial success, due to shifting government attitudes and informal political openness (Xie & Van Der Heijden, 2010, pp. 62–63). A state's susceptibility to international pressure is also highly contingent. Governments more embedded in global markets or reliant on international goodwill may be more responsive to NGO influence (Brysk, 1993, p. 261). In contrast, states with limited global interdependence, or those aligned with authoritarian regimes and resource-backed economies, may be more insulated from such pressure (Pacheco-Vega & Murdie, 2022, p. 185). Comparative case studies reinforce these dynamics. For instance, Brazil's openness to international environmental norms and its relatively strong domestic institutional capacity facilitated NGO impact. Conversely, countries with weaker civil societies and closed economies have resisted similar forms of influence (Hochstetler, 2002, pp. 37–38).

This study positions NGOs as enablers of environmental crime detection, investigation and prosecution, often in coordination with state actors around the world. As such, NGOs represent a form of hybrid authority, bridging local knowledge with national governance mechanisms.

2.1.1 *Sousveillance*

In 2003, a group of scholars introduced a new term for democratised surveillance: *sousveillance*. This concept was envisioned as an "inverse panopticon," whereby the watched could turn surveillance back on the watchers (Mann et al., 2003, p. 332). The term simply means "watching from below" (Mann & Ferenbok, 2013, p. 19). Surveillance technologies in the hands of individuals enable the monitoring of those who have historically accumulated and exercised power through the surveillance of populations (Newell, 2019, p. 63). Sousveillance takes many forms across digitalised societies (Ganascia, 2010, p. 491). A common example is the use of mobile phone cameras to record powerful state institutions such as law enforcement (Newell, 2020, p. 258).

There are two forms of sousveillance: hierarchical and participatory. Hierarchical sousveillance occurs when an actor without formal authority observes or records those in power, such as civilians filming police officers or activists using drones to document illegal logging. Participatory sousveillance refers to monitoring from within an activity, such as

live-streaming a protest which the streamer is actively participating in (Newell, 2020, p. 259). In the context of this study, environmental NGOs using satellite imagery and remote sensing to monitor deforestation, mining or pollution represent a form of hierarchical sousveillance. These organisations often lack the legal authority to enforce environmental regulations. Instead, they rely on publicly available or open-source geospatial data, which they neither control nor produce. Their processing and analysis of such data enables them to observe the actions of more powerful state and corporate actors.

However, this positioning is not fixed. When NGOs partner with states, contribute data to formal investigations or gain access to privileged tools or enforcement mechanisms, they shift from operating "below" to facilitating institutional surveillance. In these cases, they move beyond pure sousveillance into more hybrid forms of veillance, blending grassroots monitoring with top-down authority. This fluidity suggests that environmental NGOs may transition between veillance roles depending on their access to power, data and enforcement mechanisms. Since their role in governance is not always oppositional but often contingent, NGOs oscillate between acting as watchdogs from below and as collaborators within institutional frameworks. Understanding NGO environmental monitoring through the lens of sousveillance highlights the complexities of power and authority in contemporary surveillance ecosystems.

2.1.2 *Algorithmic Governance*

The theory of algorithmic governance examines how algorithms produce rule-based coordination among users, developers and institutions, with rules often encoded into software systems. Unlike traditional regulatory frameworks, algorithmic governance captures how coordination emerges both intentionally and unintentionally through digital infrastructures. It reflects a system of governance that is decentralised, often opaque and shaped by dynamic interactions between technical systems and their social, legal and institutional contexts (Katzenbach & Ulbricht, 2019, p. 2). Algorithmic systems are therefore not neutral technologies. They are entangled in power relations and embedded with institutional priorities (Katzenbach & Ulbricht, 2019, p. 1).

This framework is particularly relevant to the study of environmental NGOs that rely on AI4EO applications, as these organisations operate within diffuse networks of actors that constitute the environmental governance landscape. As NGOs increasingly embed algorithmic tools into their environmental monitoring workflows, algorithmic governance offers a critical lens for understanding how these organisations come to govern, and be governed by, the systems they adopt. Whether the algorithms in question are rule-based,

statistical or AI-driven, the theory of algorithmic governance provides a useful framework for examining how digital systems structure action and decision-making in decentralised environments. Transparency, for instance, is a key governance challenge. As Ananny and Crawford (2017, p. 973) argue, disclosing source code or model architecture rarely provides meaningful insight into how algorithmic decisions are made. For NGOs using automated methods to classify satellite data, ethical responsibility lies in making visible the assumptions embedded in the analysis ("What counts as deforestation?" or "Which spatial and temporal parameters are applied?"). These decisions shape how environmental harm is visualised and interpreted, influencing public narratives and policy responses. In algorithmic governance terms, transparency concerns the visibility of the decision rules and value judgements embedded within systems (Ananny & Crawford, 2017, p. 984).

The theory also addresses concerns regarding human agency. It emphasises that algorithms mediate, rather than replace, human judgement, often redistributing agency across human and non-human actors in complex ways (Katzenbach & Ulbricht, 2019, p. 6). As NGOs adopt automated tools, their analytical authority becomes entangled with machines. Decisions are co-produced by data scientists, satellite systems and software, raising important questions about accountability when outputs are flawed or contested. Who has the authority to interpret, override or adjust the results? Algorithmic governance draws attention to these shifting boundaries of agency and underscores the need for institutional reflexivity when addressing technical uncertainty and accountability.

2.1.3 *Automated Surveillance*

Finally, the theory of automated surveillance provides a framework for analysing NGOs' creation of automated systems of environmental monitoring in support of enforcement. Drawing on Andrejevic (2019, p. 7), this shift in surveillance practices is characterised by a fundamental reconfiguration of how control is exercised through operationalism, environmentality and framelessness. NGOs are increasingly deploying EO systems equipped with machine learning (ML) models to automatically detect deforestation, mining, illegal fishing and other forms of environmental harm. These systems are action-oriented (*operationalism*), often triggering alerts or interventions without direct human oversight. As Andrejevic (2019, pp. 10–11) argues, this marks a transition from symbolic deterrence to direct intervention where surveillance does not warn, it acts.

Environmentality refers to the embedding of sensors, satellites and data platforms such as Google Earth Engine (GEE) within the informational environment, enabling continuous observation of land, water and atmospheric changes. The result is a monitoring

regime that externalises control: actors may be unaware that they are being observed, yet their actions may still be shaped in advance by the presence and outcomes of automated monitoring (Andrejevic, 2019, p. 11). *Framelessness* is evident in the expanding spatial and temporal reach of these systems. NGOs can access both historical archives and near real-time data, erasing boundaries between monitored and unmonitored spaces. Moreover, EO data are increasingly integrated with other sources of data; there are no limits on what can be collected or from where (Andrejevic, 2019, p. 12).

Many technical studies advocate for automating the downloading, preprocessing and analysis of satellite imagery for environmental monitoring, with human actors relegated to oversight roles (Maslov & Tokareva, 2019, p. 1; Chien et al., 2005, pp. 16–17; Ehlers et al., 2006, p. 844). These studies reflect Andrejevic's hypothesis: automated workflows using EO data transform surveillance from a mode of watching into one of determining independently what matters within the overwhelming volume of observable data.

In the context of environmental crime detection, such systems may enhance responsiveness and scalability. However, they also raise concerns regarding visibility, accountability, decision-making and bias (Nazarov et al., 2024, pp. 3–4). Nevertheless, this shift does not entirely negate Foucault's concerns with internalised discipline. As automated surveillance becomes normalised, awareness of these systems may reintroduce forms of self-regulation. For example, corporations may adjust their behaviour in anticipation of algorithmic detection. Automated surveillance may thus represent only one element within a broader dynamic, in which disciplinary and post-disciplinary logics continue to interact and transform one another.

2.2 Satellite Imagery Used for the Production of Knowledge

Scholars from across disciplines have examined the democratic potential of open access to satellite data. However, discourses concerning the political, security, ethical and epistemological issues associated with the distribution of surveillance data (Witjes & Olbrich, 2017, p. 525) have challenged the framing of satellite imagery as objective, transparent or as offering a "god's eye" perspective that reveals the whole truth by being detached from a limited, ground-level view (Snyder, 2021, p. 377). This study draws on both perspectives to explore how civic- and justice-oriented institutions must critically engage with the limitations and risks of satellite technologies in order to harness their potential responsibly.

2.2.1 *Satellite Data as Democratised Oversight*

Satellite data enables civil society actors to challenge dominant narratives and shine a spotlight on powerful institutions. In the realm of human rights, NGOs have developed what two scholars term "human rights panopticism," a counter-surveillance strategy that makes state violence and neglect visible to the international community (Steele & Amoureux, 2006, p. 403). Groups such as *Médecins Sans Frontières*, Sea-Watch and WatchTheMed utilise satellite imagery, drones and GPS to document border enforcement practices and assist in migrant search and rescue operations (Topak, 2019, p. 383). WatchTheMed, for example, integrates georeferenced data with satellite imagery to reconstruct maritime incidents and assign accountability for migrant deaths and rights violations at Europe's borders (Topak, 2019, p. 396).

Similar dynamics are evident in the use of satellite imagery to monitor environmental criminal activity. EO platforms such as Sentinel-2 offer scalable and cost-effective methods for detecting deforestation and illegal land use (Patias et al., 2020, p. 1491). Projects like Copernicus for Environmental Law Enforcement Support (eLENS) demonstrate how NGOs and legal authorities can transform raw satellite data into admissible evidence for environmental law enforcement (Patias et al., 2020, p. 1492). Enhanced by unmanned aerial vehicles (UAVs) and GIS, these efforts enable real-time surveillance of remote or conflict-affected regions, supporting early interventions and informed investigations (Lega & Teta, 2016, pp. 710–12). In disaster response, satellite imagery fuels rapid crisis mapping through platforms such as OpenStreetMap, which relies on crowdsourced data to map infrastructure and hazards in affected areas (Shanley et al., 2014, p. 867). Open-source intelligence initiatives like Bellingcat also apply satellite analysis to track environmental harms, although the limitations of remote sensing often necessitate ground-truthing by local actors (Weir et al., 2019, p. 6). Across these domains, satellite data has helped promote transparency, effectively redistributing the power of oversight to actors beyond the state.

2.2.2 *Satellite Data as Distorted Transparency*

Several technical, political and epistemological issues challenge satellite imagery's claim to objectivity. The elevated, top-down view offered by satellite surveillance is compromised by cloud cover, resolution limits, algorithmic bias and interpretive uncertainty (Witjes & Olbrich, 2017, p. 525). Satellite data often lacks the granularity required to detect subtle or concealed activities, and analysts interpreting such data are themselves embedded within institutional priorities and subjective frameworks (Kochupillai et al., 2022, pp. 109–10).

Moreover, the availability and framing of satellite imagery are shaped by powerful political and economic actors. High-resolution data is largely controlled by states or corporations, whose access policies and geopolitical interests influence what is made visible (Rothe, 2017, pp. 342–4). As van Wyk (2022) argues, satellite observation reflects ideological constructs and determines what counts as "truth" through selective visibility. This constructed visibility has epistemological consequences, privileging certain truths while marginalising others (van Wyk, 2022, pp. 36–8). This generates hegemonies of satellite-based knowledge, especially evident in environmental monitoring. Platforms such as Global Forest Watch (GFW) ostensibly democratise access to remote sensing, yet they encode a Western-centric framework that abstracts local environments into quantifiable metrics, erasing their historical and socio-political complexity (Rothe & Shim, 2018, pp. 431–2). Critics warn of a growing "digital environmentalism" that privileges visually compelling satellite narratives over grounded, community-led engagement (Bennett, 2025, p. 3). In Arctic regions, for instance, NGOs increasingly rely on satellite-derived visualisations to influence policy but often do so without integrating local and Indigenous ecological knowledge, weakening the legitimacy of their advocacy (Bennett, 2025, p. 12).

Underlying these concerns is the notion that satellite data providers are not neutral observers but participants in a broader "visual assemblage" (Rothe, 2017, p. 338). Whether public or private, these providers are embedded within networks of scientific assumptions, legal norms and commercial incentives that shape how large-scale environmental risks are made visible (Rothe, 2017, p. 350). As scholars caution, the transparency promised by satellite data is often fragile, meaning contingent on geopolitical power relations and institutional control over imagery access and interpretation (Witjes & Olbrich, 2020, p. 524).

2.3 Ethics and AI4EO

AI is increasingly integrated into EO research, particularly in the field of environmental stewardship. This transformation presents both opportunities and significant ethical challenges. The automation of satellite imagery analysis enables large-scale, near real-time monitoring of ecosystems, biodiversity and climate change. However, this shift towards automation also raises important questions about accuracy, accountability, privacy and equity, which must be carefully considered (Nazarov et al., 2024, p. 2). The following ethical issues cover four areas, though this list is not exhaustive:

1. Reliability and bias in automated systems: Errors such as sensor drift, hardware malfunctions or data transmission failures may go unnoticed in highly automated workflows, undermining the integrity of EO data. Moreover, algorithmic models

trained on incomplete or skewed datasets may embed existing biases into environmental assessments, shaping conservation strategies in ways that do not reflect on-the-ground realities. This is particularly concerning in ecologically sensitive or politically contested regions, where flawed data could lead to harmful misinterpretations. To mitigate these risks, robust testing, validation and continuous oversight of automated systems are essential (Nazarov et al., 2024, p. 3).

2. Ethical and privacy concerns: While remote sensing is often perceived as non-invasive, the widespread deployment of sensors, drones and satellites introduces new forms of visibility that may encroach upon inhabited regions or Indigenous territories. The collection of environmental data from such spaces, particularly when carried out without consent, risks violating privacy rights or potentially disrupting traditional land-use practices. Ethical deployment therefore requires social and cultural sensitivity, guided by principles of environmental justice and informed consent (Nazarov et al., 2024, p. 3).
3. Socioeconomic implications: The cost of developing, operating and maintaining advanced AI systems may exclude under-resourced countries and communities from meaningful participation in global environmental governance. As a result, automation could reinforce existing inequalities, concentrating monitoring capabilities and decision-making power in the hands of a few technologically advanced actors. Ethical EO practices must therefore prioritise equitable access to AI tools and foster inclusive collaborations that bridge the global digital divide (Nazarov et al., 2024, pp. 3–4).
4. Human in the loop: While AI can enhance the scale and speed of analysis, it cannot replace the contextual knowledge, field experience and moral reasoning that human observers bring. Over-reliance on automation threatens to gradually diminish fieldwork, participatory research and local ecological expertise in environmental work and research. Rather than viewing automation as a replacement for human engagement, it should be seen as a tool that supports the work of scientists, Indigenous communities and environmental stewards from across disciplines (Nazarov et al., 2024, p. 4).

These considerations are especially relevant for environmental NGOs interested or already engaged in the automation of EO work and research. Explicit mechanisms for embedding ethical review into automated workflows will enable NGOs to clearly address questions related to accountability, contextual understanding, transparency, human judgement and

other ethical concerns. Doing so is essential for preserving the credibility and integrity of civil society actors working to protect people and the planet.

2.3.1 *The Ethical Opportunities Framework*

Kochupillai et al. (2022) offer a practically oriented intervention into the field of AI4EO, addressing a gap in the ethical literacy of scientists working at the intersection of AI and remote sensing. Recognising that generic AI ethics guidelines often fail to resonate with or influence the practices of technical researchers (Hagendorff, 2020, pp. 113–14), their study provides a domain-specific overview of emerging ethical issues in AI4EO, offering concrete examples drawn directly from EO contexts (Kochupillai et al., 2022, pp. 106–12). Central to their contribution is a user-friendly roadmap designed to help scientists identify and reflect on ethical concerns throughout the research process (Kochupillai et al., 2022, p. 96). The study highlights two main strands of AI4EO research: one focused on advancing algorithmic capabilities for automated information extraction and the other on applying EO data to socially and environmentally relevant fields. As researchers increasingly integrate EO data with other sources, the need for contextual, application-specific ethical scrutiny becomes critical (Kochupillai et al., 2022, p. 91).

Ethics, as a discipline, is concerned with navigating tensions between competing values in various domains of human life, including scientific research. It is not solely about identifying misconduct or harmful practices, but also about promoting values such as honesty, integrity and responsibility. In this broader sense, ethics helps to avoid harm while guiding researchers towards constructive and socially beneficial action. Within the context of AI4EO, ethics provides a framework for evaluating the impact of scientific decisions and technologies. This includes defining desirable duties and consequences, weighing competing interests and ensuring that research outcomes align with fundamental human values. For example, the use of AI for environmental monitoring should consider the potential social and ecological effects of such monitoring (Kochupillai et al., 2022, p. 92).

Ethical issues arise when actions or decisions raise questions about what is right or wrong and good or harmful. These issues often emerge in AI4EO when determining how to balance technical innovation with societal responsibility (Kochupillai et al., 2022, p. 92). Ethical dilemmas, by contrast, involve situations where two or more valuable outcomes are in direct conflict. For instance, in the case of illegal artisanal and small-scale mining (ASM), an ethical dilemma might ask whether governments should tolerate environmentally harmful mining practices to protect the livelihoods of marginalised communities or enforce bans that secure ecological integrity at the cost of social harm. Ethical dilemmas are distinct in that

there may be no clear “right” answer. Each option carries significant and often irreversible trade-offs. Alongside these concerns, researchers must also be attentive to ethical risks and ethical opportunities. Ethical risks refer to foreseeable negative consequences resulting from a decision or its absence. For example, relying solely on automated systems for environmental analysis may lead to the erosion of human responsibility and oversight, resulting in unintended or opaque outcomes. Ethical opportunities, on the other hand, are potential benefits or enhancements to human and societal well-being that arise from ethical decision-making. The integration of AI into EO research, for instance, presents an ethical opportunity when it enhances human agency, allowing for faster, more comprehensive environmental insights that can inform timely policy responses (Kochupillai et al., 2022, p. 93).

The study draws from five influential ethical guidelines and sources: the EU’s Ethics Guidelines for Trustworthy AI, AI4People’s framework, Germany’s Data Ethics Commission, Jobin et al. (2019) synthesis of 84 global AI ethics principles and Hagendorff (2020) critical analysis (Kochupillai et al., 2022, p. 91). The authors use these sources to categorise ethical concerns into six key areas. These categories correspond to three foundational ethical principles: honesty, integrity and fairness (Kochupillai et al., 2022, p. 95).

1. *Privacy* includes individual autonomy and data protection combined with broader values such as non-stigmatisation, national sovereignty and equitable data governance. This is particularly salient in EO contexts where sensitive spatial data could unintentionally expose or endanger communities (Kochupillai et al., 2022, pp. 96–9).
2. *Honesty* relates to transparency, explainability and the veracity of the data and models used. In AI4EO, this demands clarity in how EO data is processed and interpreted, ensuring that outputs can be understood and trusted by both scientists and stakeholders (Kochupillai et al., 2022, pp. 99–100).
3. *Integrity* emphasises the need for technical robustness, safety and security, including national and environmental security. Given the growing reliance on automated EO systems, ensuring model accuracy and anticipating unintended consequences are essential components of responsible design (Kochupillai et al., 2022, pp. 100–1).
4. *Fairness* centres on the mitigation of bias, especially in training data, and advocates nondiscrimination, cultural sensitivity and inclusive standard-setting. This is critical

in EO applications that affect marginalised or historically surveilled communities (Kochupillai et al., 2022, pp. 101–4).

5. *Responsibility* addresses the importance of human agency, oversight and accountability. It calls for scientists to recognise their duty of care and to actively consider the social cohesion and security implications of their work (Kochupillai et al., 2022, pp. 104–5).
6. *Sustainability* expands the ethical lens beyond immediate concerns, urging scientific, social and environmental foresight. It also includes investing in education and capacity-building to equip the next generation of AI scientists with the tools to make ethically informed decisions (Kochupillai et al., 2022, p. 105).

The Kochupillai et al. (2022) framework is adaptable in that it is not a fixed or exhaustive list of ethical considerations, but rather a living structure that acknowledges ethical challenges evolve alongside technological advancement and societal change. By organising core ethical issues into broad, interconnected categories, the framework helps bridge the gap between abstract ethical discourse and the practical day-to-day decisions made by scientists working at the intersection of AI and EO (Kochupillai et al., 2022, p. 91). A table organising the principles, defining them and providing examples relevant to this study is provided in Appendix 2.

As environmental NGOs continue to incorporate AI tools into their monitoring and enforcement activities, a pressing challenge emerges: how to maintain ethical credibility as automated systems begin to replace human judgment in key stages of analysis. The detachment of human oversight risks undermining the legitimacy of NGOs, especially when decisions made through AI have significant consequences for communities, ecosystems, or political systems. Without clear ethical governance, these organizations may face scrutiny from their users, partner communities, donors, and the broader public. In response, this paper argues that civic- and justice-oriented NGOs must adopt organization-wide ethical frameworks or governance structures that guide the use of AI4EO alongside AI-driven improvement in their technical capabilities. The ethical framework proposed by Kochupillai et al. (2022) serves as a starting point. Their categorization of ethical issues structured around honesty, integrity, fairness, privacy, responsibility, and sustainability provides a practical and adaptable approach with plenty of example applications. These examples illustrate how organisations can proactively identify and seize ethical opportunities that arise from the responsible use of AI and EO technologies, while simultaneously minimizing

potential ethical concerns. This practical approach also encourages organisations to actively promote values such as transparency, fairness and sustainability in their AI applications.

Interested readers can view these example cases for implementing the ethical opportunities framework on pp. 106–12 of the Kochupillai et al. (2022) paper titled *Earth Observation and Artificial Intelligence: Understanding emerging ethical issues and opportunities.*

This study applies the Kochupillai et al. (2022) novel ethical opportunities framework to two real-world case studies: illegal deforestation and ocean pollution by artisanal fisheries. These examples are used to explore how analysts at NGOs can operationalise ethical opportunities and anticipate risks in their AI4EO workflows.

3. Methods

This study adopts a qualitative research approach to explore how environmental NGOs operationalise ethical principles in their use of satellite imagery to combat environmental crime. Qualitative research examines social reality through diverse disciplinary lenses, drawing on scientific, humanistic and creative traditions (Leavy, 2020, p. 2). It is not only a scholarly endeavour but also a practical and creative process, "allowing researchers to experiment, adapt and learn along the way" (Leavy, 2020, p. 8). Given the limited empirical focus in current literature on the day-to-day ethical practices of NGOs using EO technologies, a qualitative approach is well suited to uncover the nuanced, context-dependent strategies these organisations employ. The research question (indicated in the introduction section) is: what practical strategies do NGOs employ to ensure responsible use of satellite imagery in the fight against environmental crime?

3.1 Methods and Data

The researcher conducted semi-structured interviews with subject matter experts from two environmental NGOs to gather contextual insights into how ethical principles are applied in practice. Semi-structured interviews involve a set of guiding questions or prompts that allow participants to respond freely while also enabling the researcher to pose probing or follow-up questions based on the conversation. This approach is especially useful when the researcher is familiar with the research domain but cannot fully anticipate expert responses or perspectives (Morse, 2014, p. 10).

To systematically examine this interview data, the study employs thematic analysis (TA). TA is a widely used method in qualitative research for identifying and interpreting patterns across a dataset (Morse, 2014, p. 10). It provides a structured yet flexible approach to analysing qualitative interviews, allowing the researcher to develop theoretical insights throughout the analytical process. Thus, this analysis followed an inductive approach, where themes were derived directly from the interview transcripts rather than imposed by pre-existing hypotheses or theories (Reichertz, 2013, p. 10). This method allowed participants' language and experiences to shape the research findings, supporting a nuanced understanding of how NGOs navigate ethical considerations in the use of satellite imagery.

Rather than ending the analysis at thematic description, this research advances a conceptual model (Olson, 2025, p. 12). Drawing from established theoretical frameworks in surveillance studies, the analysis culminated in a model of civic surveillance mediation which characterises how NGOs operate as mediators of surveillance: interpreting geospatial

data, translating findings for public and institutional audiences and negotiating the ethical tensions inherent to the use and dissemination of surveillance data and technology.

3.2 Justification

Interviews were selected to gather rich, contextual and reflective insights into the practices and informal strategies of environmental NGOs. Interviewing has traditionally been viewed as a relatively straightforward method of data collection, where interviewers pose questions and interviewees simply provide truthful responses. Under this view, gaining insight into others' thoughts, feelings and actions is seen as a matter of asking the right questions and receiving accurate answers (Gubrium et al., 2014, p. 4). However, this assumption overlooks the inherent complexity and potential limitations of the interview process as a research method (Gubrium et al., 2014, p. 3). One such limitation lies in the constructed nature of interview responses. The meanings expressed by participants are shaped by the specific context of the interview itself. Responses are often strategically assembled during the exchange, influenced by the participant's interpretation of the situation, their relationship with the interviewer and the broader social context. This means that responses about past experiences may reflect the ways participants choose to frame and communicate those experiences in the moment (Gubrium & Holstein, 2014, pp. 10–1). This presents a challenge for the study, as the researcher sought reliable insights into institutional strategies but may have received responses crafted to protect and promote each organisation's credibility.

However, this approach was necessary to achieve the study's goals, given the limited existing documentation on how environmental NGOs navigate ethical concerns in practice. Many of the challenges and strategies these actors encounter are not codified in policy or formally reported, making qualitative interviews ideal for uncovering tacit knowledge and institutional memory. The co-constructed nature of interviews could indeed be a methodological strength, allowing for the emergence of situated narratives that reflect how ethical principles are interpreted and implemented in real-world scenarios. In contrast to standardised surveys or document analysis, interviews enable participants to reflect on the everyday trade-offs and constraints that shape their work, offering insight into ethical reasoning integrated into ordinary work scenarios.

TA was selected as the most appropriate method for analysing these subject matter expert interviews, particularly due to its flexibility and inductive orientation. The interview questions were broad, covering topics ranging from technical tools and analytical methods to legal, ethical and organisational considerations. This breadth made TA especially suitable, as

it allowed for the identification and interpretation of patterns across diverse responses without requiring a rigid theoretical framework in advance. TA enabled the researcher to remain open to the emergence of unexpected themes and to capture the nuanced ways in which participants describe and make sense of their work. In the end, themes were reflected in participants' conceptualisations of ethics, their operational struggles and how these intersect with environmental enforcement efforts using EO data.

Some scholars have argued that TA is not a method in its own right but a process embedded in various qualitative approaches (Boyatzis, 1998 and Ryan & Bernard, 2000, as cited in Willig, 2013, p. 19). Thus, one's epistemological orientation can significantly influence the systematic processing of themes, meaning that the researcher must interpret what themes signify. For instance, does a theme reflect a participant's personal experience, a culturally shaped discourse, an emotional response or a deeper psychological or structural mechanism? Should the researcher take participants' words at face value or view them as constructed narratives requiring further interpretation? These interpretive decisions are shaped by the researcher's underlying epistemological and theoretical commitments. As such, TA is not a purely descriptive method but one that can support a range of interpretive stances, from empathetic understandings of participants' accounts to more critical or "suspicious" readings that question what lies beneath surface meanings (Willig, 2013, p. 19).

This study embraces an empathetic stance in that it seeks to understand participants' perspectives without imposing critical assumptions. The researcher readily acknowledges her own empathetic orientation for primarily two reasons. First, this stance is appropriate given the nature of the participants: environmental NGO workers who are engaged in efforts to address ecological harm and injustice. Second, given that these actors are often underrepresented in academic literature yet play critical roles in environmental governance, an empathic reading allows their practices and rationales to emerge on their own terms without imposing a critical lens that may obscure the practical and moral complexity of their work. Empathy, as applied here, does not preclude analytical rigour. Rather, it facilitates a form of engaged scholarship that honours the lived complexity and moral reasoning embedded in participants' day-to-day decision-making. This project demonstrates that empathy in academic research does not constitute naivety or lack of analytical rigour. Rather, it is a sign of respect, potentially bridging academic and practical realms that are both focused on bettering the use of EO for environmental stewardship.

3.3 Procedure

This investigation consisted of four main stages: sampling and recruitment, data collection, transcription and coding and theoretical positioning. See the full research design illustrated below:

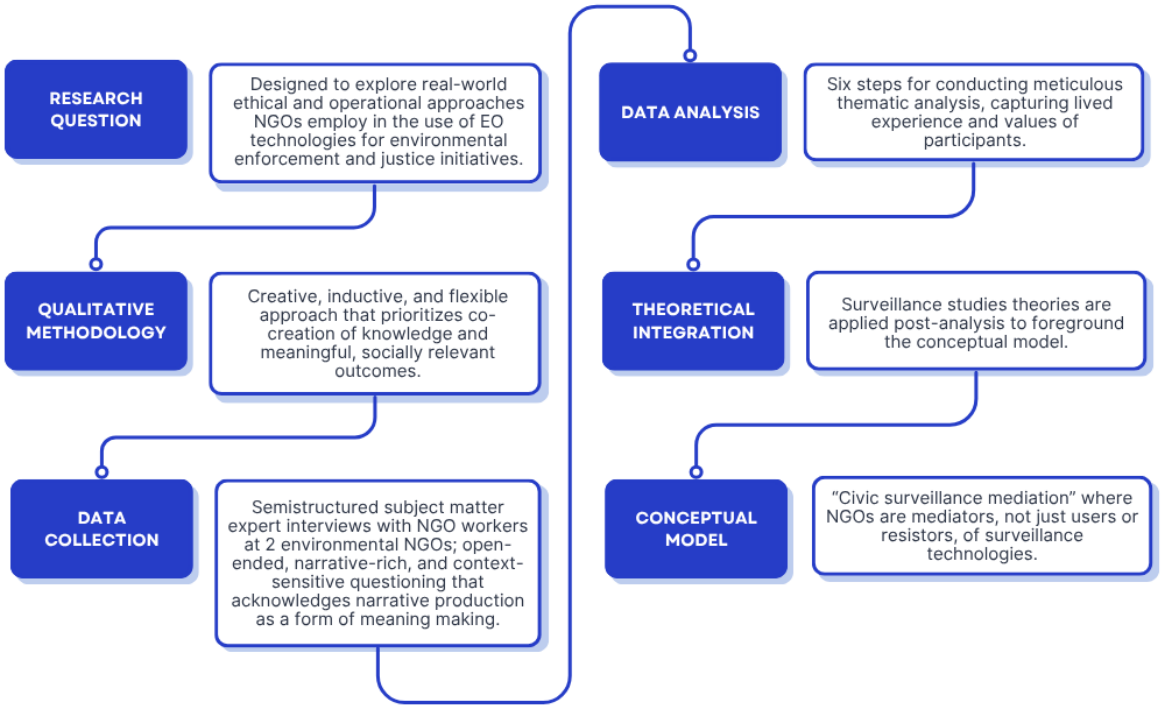

Figure 1. Research process from the formulation of a research question to the creation of a conceptual model.

3.3.1 *Sampling and Recruitment*

Purposive sampling was used to recruit participants with direct expertise in the use of satellite imagery in environmental enforcement. To capture a holistic picture of operational strategies, legal and ethical frameworks and practical challenges, interviews were conducted with two categories of NGO staff: (1) geospatial data analysts responsible for processing and interpreting satellite imagery and (2) advocacy or legal personnel who apply this analysis to promote transparency, accountability or justice. The participating NGOs, one based in Europe and the other in North America, are similar in size and operational capacity and both work globally to detect, investigate and support the prosecution of environmental crimes using satellite technologies.

3.3.2 *Data Collection*

All participants provided informed consent at the start of each interview. A formal consent form was distributed outlining the study's objectives, potential risks, data handling protocols, participant rights and researcher contact details. At the beginning of each interview, participants verbally confirmed their consent by stating, "I give consent to be recorded during this study." A copy of the consent form is provided in Appendix 1. To preserve confidentiality in a small and specialised field, no demographic data such as age,

gender or nationality is reported. Participants' anonymity is further protected by citing quotations by organisation rather than by individual.

Eight semi-structured subject matter expert interviews were conducted via either Microsoft Teams or Zoom and followed a consistent format, moving from general background and project experience to more focused discussions around practical challenges, legal compliance, ethical use of geospatial data and transparency. By asking each participant a consistent set of questions with the opportunity to branch off in new directions, this method ensures comparability across interviews while allowing enough flexibility to compare ethical decision-making across disciplines and focus areas. The full interview guide is provided in Appendix 1. Interviews were recorded using Teams' built-in recording and transcription feature, and one Zoom recording was transcribed directly by the researcher. Each transcript was reviewed and corrected by the researcher against the video recording to ensure accuracy. A total of 41,026 words of interview data were collected.

3.3.3 *Transcription and Coding*

The step-by-step process recommended by Naeem et al. (2023) was utilised to conduct TA. This began with the creation of interview transcripts followed by data familiarisation, during which keywords and patterns were noted. According to the principles of TA, patterns and emerging themes were derived from all participants collectively rather than on a case-by-case basis (Olson, 2025, p. 12). Keywords served as the foundation for the open coding phase, during which meaningful data segments were labelled to categorise and summarise their content (Charmaz, 2006, p. 43). Using the constant comparative method, open codes were refined through iterative comparison, leading to the clustering and merging of codes into broader categories, or axial codes (Thornberg & Charmaz, 2013, p. 10). The next phase involved theme development, or the distilling of axial codes into overarching themes that captured recurring and significant patterns in the data (Roulston, 2013, p. 12). These themes were developed to reveal the conceptual and ethical tensions faced by NGOs. In the selective coding phase, the most analytically meaningful codes were organised around a core category, representing a unifying concept that linked various themes and offered insight into the central dynamics of the phenomenon under study (Thornberg & Charmaz, 2013, p. 10).

The researcher first developed 57 open codes, which were then grouped into 9 axial codes and distilled into 3 selective codes. Some interviews were conducted in languages other than English; these were translated and edited for clarity without indicating language

fluency, to avoid distinguishing between native and non-native English speakers. See the researcher's code tree illustrated below:

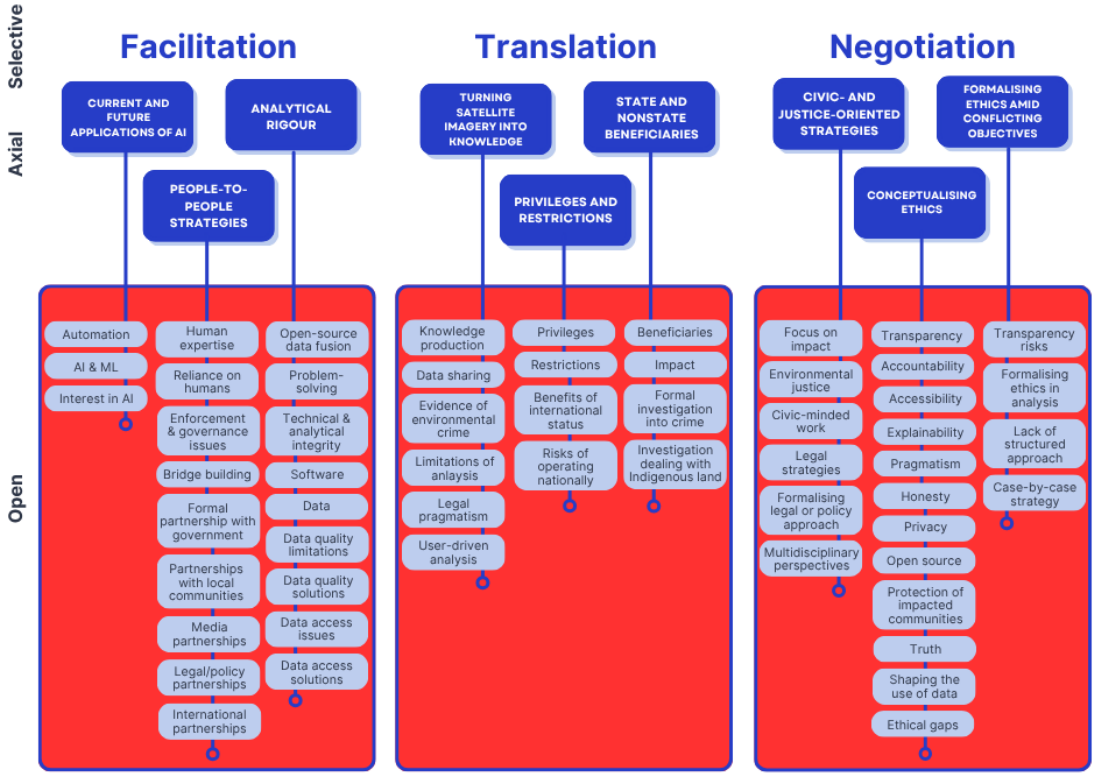

Figure 2. Breakdown of open, axial, and selective codes used to categorise fragments of subject matter expert interview transcripts.

3.3.4 *Theoretical Positioning*

Guided by the TA procedure proposed by Naeem et al. (2023), the results were interpreted using a theoretical lens that positions environmental NGOs within a spectrum of surveillance practices. At one end lies sousveillance, or bottom-up surveillance, where NGOs use satellite technology to hold powerful actors accountable. At the other end of the spectrum is traditional surveillance, or social sorting, characterised by data-driven abstraction, classification and control. In this model, satellite imagery and other digital tools are used by states or corporations to categorise environments, assign value and govern behaviour, often without transparency or public input. As their monitoring efforts become more reliant on algorithmic tools and automated analysis, environmental NGOs' work may increasingly resemble the logic of social sorting rather than resist it. The algorithmic governance and automated surveillance frameworks help to illustrate that risk and position formal ethical guidelines as a possible tool for responsibly shaping environmental surveillance for civic accountability and environmental justice purposes.

While not a narrative inquiry, the analysis incorporated narrative dimensions such as participants' personal experiences, values and moral reasoning to ensure that the conceptual

model reflected the lived realities and ethical deliberations shaping NGO practices (Naeem et al., 2023, p. 13). By bridging empirical insights with conceptual reasoning, this methodological process captured expert perspectives to produce a theoretically informed model that advances academia's understanding of ethical geospatial practices in environmental governance. The resulting model offers both an analytic contribution and a potential framework for guiding practice in similar civic and institutional contexts.

4. Results

The following results provide an answer to the original research question indicated in the introduction. It is important to note that these results are not comparative. While differences between the two organisations are acknowledged, participants are treated as expert representatives of a broader field rather than as representatives of their specific institutions. Identifying differences in operational approaches is not of value for this study. However, the two environmental NGOs are founded on different missions, which shape their approaches to ethics and the use of satellite imagery. Organisation 1 focuses on supporting environmental enforcement through the legal process, although it collaborates with a range of partners beyond justice-sector institutions to ensure its analysis can be effectively used in different contexts. Organisation 2 is primarily mission-driven towards providing public access to data on environmental crimes, often aiming to increase transparency and inform public discourse, but also works with both state and non-state partners. This distinction in institutional missions has several implications for interpreting the findings.

While both organisations rely on satellite data to identify and address environmental harm, their motivations influence how they operationalise ethical principles in practice. For instance, ethical reasoning may reflect the mission of the organisation. Organisation 2 may describe ethics in terms of transparency, public responsibility and data democratisation, while Organisation 1 may emphasise data privacy, evidentiary standards and legal integrity. Recognising this difference is crucial, as the themes identified in the analysis were developed across both organisations collectively, not separately. Thus, the reader should interpret the results as capturing shared patterns, but also as patterns shaped by distinct institutional logics. Where relevant, distinctions are highlighted to clarify how different organisational goals mediate the ethical considerations described by participants.

The researcher began each interview by framing the study as an exploration of how ethical principles such as privacy, transparency and fairness are put into practice, and how NGOs are innovating to promote accountability and justice through geospatial tools. The following results depict environmental NGOs as facilitators, translators and negotiators of EO technologies for the detection, investigation and prosecution of various environmental crimes.

4.1 Facilitation: Practices for Facilitating the Use and Analysis of EO Data

As providers of data, information and analytical insight, both organisations emphasise a sustained commitment to analytical rigour, people-to-people strategies and the use of AI and automation. These strategies have become a strategic imperative for

legitimacy and the long-term sustainability of their work in supporting partners' investigations and prosecutions of environmental crimes.

In the following examples, the practices of analytical rigour, people-to-people strategies and AI integration illustrate how environmental NGOs navigate contemporary surveillance dynamics. Their use of EO data to monitor powerful actors such as large Brazilian landowners exemplifies hierarchical sousveillance (Mann et al., 2003, p. 332; Newell, 2020, p. 259). However, as NGOs use their findings to collaborate with formal authorities and contribute to enforcement processes, they increasingly inhabit hybrid veillance roles, oscillating between grassroots monitoring and institutional partnership. Their growing interest in the use of AI brings up concerns associated with the theory of algorithmic governance, particularly the redistribution of agency between human experts and automated systems, as well as the ethical opacity of algorithmic decision-making (Katzenbach & Ulbricht, 2019, p. 3–4). By embedding AI within context-sensitive, human-centred practices, NGOs attempt to mitigate the risks associated with automation. At the same time, emerging automated workflows reflect a broader shift toward automated surveillance, where monitoring becomes continuous, frameless and action-oriented (Andrejevic, 2019, pp. 10–11). These theoretical perspectives highlight how environmental NGOs are working to shape surveillance norms and the preservation of accountability.

4.1.1 ***Analytical Rigour***

Both NGOs prioritise analytical rigour throughout their technological workflows. One example is the systematic integration of multiple open-source datasets. This cross-referencing serves to verify patterns detected in satellite imagery and to ensure transparency and reproducibility. One analyst described their work combining satellite imagery with other spatial datasets, such as Brazil's Rural Environmental Registry (CAR), which maps rural properties and cattle movement, "to detect illegal logging within Indigenous lands. All of this data was used by our partners to file 11 lawsuits" (Organisation 1). At both organisations, EO data is rarely used in isolation. Rather, it is embedded within a broader analytical framework built on publicly available administrative records, geospatial data and local knowledge. These data fusion practices reflect a deliberate effort to strengthen the analytical chain from detection to potential legal consequence.

Technical constraints often complicate this process. Satellite imagery may be cloud-obstructed, temporally limited or lack the resolution required for certain analyses. These inherent limitations require methodological adaptation and innovation. As one practitioner explained, the challenge in this field lies in the fundamental limitations of satellite data: "It's

infrequent, incomplete, there might be cloud cover, most of the data you can get shows you 10-metre pixels that allow you to see only large- or industrial-scale changes," which makes it difficult to tie an environmental crime to an actor. "So, we try to mitigate that issue [by combining other types of data] or ground-based information if we're partnered with somebody on the ground" (Organisation 2). This reflects a nuanced understanding of EO data's capabilities and constraints, and the importance of blending remote and in-situ data.

Technical effectiveness also relies on the capacity to process large volumes of raw data. This requires analytical skill and the technological infrastructure needed for intensive computation. One interviewee described the dual challenge of accessing and processing diverse datasets: "If we don't have access to all the data, we can't carry out the analyses. So we constantly need to develop more efficient ways of obtaining this data," which often entails navigating barriers to public information or building new tools for preparing raw data, such as altering the data type. "That requires a lot of processing power. So we've been buying servers, we've been paying for cloud computing budgets, we've been creating the necessary infrastructure conditions to carry out this kind of processing" (Organisation 1). Analytical rigour, then, is grounded in methodological decisions, infrastructure investments and the consistent ability to overcome challenges through innovation.

Credibility depends on the technical competence and reliability of these NGOs' data, tools and insights. One interviewee noted that the technical rigour shields the organisation from legal disputes and reputational harm: "We've never had a case where the entity we identified as being involved in a crime or fraud came forward and said, 'You're wrong. Your analysis is flawed.'" Although companies may deny the accusations, none has ever countered them with its own analysis. "This technical quality of our product, I believe, protects us and shields us from legal action, because I imagine that companies assess the situation and determine that legal action would not be viable, since we generally present accurate data" (Organisation 1). This sense of responsibility is heightened by the relatively informal regulatory environment in which NGOs operate. Without statutory mandates or formal accountability mechanisms, organisations are compelled to construct their own analytical frameworks and justifications for action. As one interviewee put it, "The lack of formal regulation governing NGOs' work is not necessarily a constraint on our effectiveness, given that credibility of the organisation is fundamental. We can't simply point to a regulation and say, 'Well, I prioritise this case because there's a formal case selection policy.' We've got to develop our own criteria," as well as standards for analysis and investigation. "And if we're persistently pursuing and trying to present cases that either

don’t have a solid factual basis or have such low significance that partners aren’t going to invest time in them, then we lose our credibility” (Organisation 1).

A focus on analytical rigour enables these NGOs to turn raw data into meaningful evidence and legitimate influence. This focus on technical accuracy and precision as a strategic imperative may be a unique characteristic of nonstate bodies practicing civic surveillance mediation. Unlike state actors with coercive power or private firms with proprietary interests, these organisations must earn their authority through the perceived integrity of their methods. Their credibility hinges on how well their data is produced, interpreted and mobilized, which determines how NGOs legitimise their mediating role between surveillance and justice.

4.1.2 *People-to-People Strategies*

While both organisations are driven by the technical promise of EO technologies, they consistently stress that human relationships are central to the success and relevance of their work. People-to-people strategies are vital for facilitating, interpreting and acting on EO data in complex and often under-resourced environmental governance systems. A core element of this strategy is building and maintaining partnerships across diverse sectors. Both organisations actively cultivate networks spanning legal, journalistic and scientific communities: “Building technical, legal and journalistic partnerships is a very important strategy that helps maximise the reach of our work” (Organisation 1). These partnerships expand the visibility and legitimacy of EO-based findings and enable downstream action through media exposure, legal processes or policy engagement.

Ongoing dialogue is critical to these relationship-building strategies. The NGOs stress that facilitating EO data use requires frequent, adaptive communication with partners. This ensures that EO-derived products, such as maps or satellite analyses, align with operational needs and legal thresholds. At times, they proactively approach institutions with detected environmental crimes. “We know what a case of importing illegally logged timber looks like,” said one analyst. “So we want to take it to the partner and say, ‘Here is what we’ve got. Here is why we think it’s legally relevant. Can you do something with this?’” (Organisation 1). This initiates a dialogue wherein partners assess the evidence and frequently respond with further queries, prompting refinement or expansion of the analysis. What emerges is a responsive, iterative collaboration based on trust and shared objectives.

However, these people-centred strategies encounter significant barriers in contexts with weak or absent environmental governance. As one practitioner observed, “There is this lack of governance within environmental bodies with respect to control and oversight of

environmental actions. It makes our work difficult" (Organisation 1). In such cases, even when EO data provides compelling evidence, institutions may be reluctant or unable to act without substantial proof and sustained support. NGOs must therefore invest more heavily in their analyses and pursue more strategic, long-term engagement with local authorities, where personal relationships and organisational credibility can help overcome institutional inertia.

This people-centred emphasis also applies internally. Both organisations prioritise human expertise within their teams. Although their missions are technical, they recognise that interpretation, ethical judgement and contextual sensitivity are inherently human capacities that cannot be outsourced to algorithms. One interviewee said their approach to ethics largely involves hiring "people we trust and telling them to use their best judgement." Especially when engaging with communities, this trust-based model depends on staff having experience and strong ethical awareness. "I work hard not to overpromise," said the same practitioner, "to help people understand up front what we can and cannot do, and to not speak too freely" (Organisation 2). Others emphasised hiring people with local knowledge. "When we're engaging with local communities, we've usually got people from those countries that have an understanding of the local context. We're very cautious when this is not the case" (Organisation 1). Human-centred strategies thus position human judgement as central to the responsible and effective use of EO data. Through partnership, dialogue and embedded contextual knowledge, NGOs ensure that EO technologies remain conscientious and actionable.

These strategies show how environmental NGOs counterbalance the impersonal logic of automated surveillance (Andrejevic, 2019, p. 7) with human relationships and contextual understanding. While algorithmic governance (Katzenbach & Ulbricht, 2019, pp. 3–4) often privileges abstraction and scale, the NGOs studied here deliberately foreground dialogue and responsiveness, which may more closely align with sousveillant values (Mann et al., 2003, p. 332). Their efforts to co-develop interpretations of EO data with legal, journalistic and local actors resist the top-down dynamics characteristic of traditional or institutional surveillance.

4.1.3 *Current and Future Applications of AI*

Both organisations have already integrated AI and ML into their workflows to enhance operational efficiency. These technologies allow NGOs to scale monitoring, automate repetitive tasks and identify patterns that might otherwise go unnoticed. At present, automation does not replace expert judgement.

At Organisation 1, AI has been used to process publicly available data and improve the identification of links between environmental crimes and property ownership. One practitioner described using AI to infer property boundaries based on known geographic points. “We’re using AI to try to infer property limits from these points, which would then allow us to analyse links between those properties and deforestation or other environmental crimes” (Organisation 1). This facilitates the strategic targeting of enforcement by revealing land tenure patterns that are unclear in Brazil’s CAR. However, this application of AI remains in development. While certain teams are using advanced tools, adoption is not yet uniform. One analyst explained, “I think we are really, in the last year, delving into artificial intelligence tools,” citing ML and deep learning used to “contextualise the data and to find meaningful connections that can create more impact.” Nonetheless, another team member admitted, “Right now, we’re not doing deep learning, not even machine learning yet. But we want to move in that direction” (Organisation 1). These initial steps reveal growing institutional interest in scaling EO oversight with AI, even as capacity remains uneven.

Organisation 2 has invested more heavily in automating EO analysis, especially through custom monitoring platforms. Their process begins with exploratory work in platforms like GEE, where analysts test scripts, visualise outcomes and refine algorithms. Once viable, they build custom pipelines for continuous monitoring. One practitioner explained, “It’s a lot of work in Google Earth Engine for exploration, and then once we know—assuming we want to automate something or make something more permanent, we’ll usually code it up somewhere else and create a whole custom data pipeline” (Organisation 2). This emphasis on sustained monitoring reflects Organisation 2’s aim to produce decision-ready outputs that are accessible and interpretable. Here, automation supports high-frequency assessments with minimal manual input.

Both organisations regard AI as a promising means of enhancing EO’s interpretive power. One emerging use is improving satellite image interpretation for investigations and early detection of environmental harm. One participant noted, “The use of AI to enhance the monitoring and interpretation of satellite imagery... that’s something we’re very interested in, but it has to be done responsibly” (Organisation 2). The emphasis remains on ethical deployment, especially where outputs may shape enforcement priorities or attribute culpability. Automated insights are validated through other sources before action is taken, acknowledging the limits of remote sensing. Both organisations share a cautious optimism about AI and ML’s role in strengthening EO-based environmental monitoring. AI is

increasingly seen as an enabler that supports the broader mission of holding perpetrators of environmental crime accountable through data-driven insights.

The integration of AI into EO workflows signals a deepening entanglement between environmental NGOs and the logics of algorithmic governance (Katzenbach & Ulbricht, 2019, p. 3–4) and automated surveillance (Andrejevic, 2019, p. 7). As civic surveillance mediators, these organisations navigate a dual imperative: to harness the efficiency and scale of automation while preserving the ethical, contextual and civic values that underpin their legitimacy. Their selective and cautious adoption of AI reflects this balancing act.

4.2 Translation: Serving as a Bridge Between Data, Knowledge, and Action

Environmental NGOs translate satellite imagery into knowledge through a multilayered set of practices. As the connective tissue between EO data and real-world environmental enforcement, these NGOs enjoy access to information and networks not available to ordinary civilians. Without their translation, satellite imagery remains detached from the decisions and actions it is meant to inform.

Through open-source dissemination, participatory design and capacity-building for non-state actors, such as Indigenous guards in Peru, environmental NGOs engage in a form of hierarchical sousveillance, leveraging EO data to hold powerful actors accountable while remaining formally outside state authority (Mann et al., 2003, p. 332; Newell, 2020, p. 259). However, their privileged access to high-resolution data and legal partnerships reveals an oscillation between grassroots oversight and institutional collaboration. As translators of complex, often opaque algorithmic outputs, they work to mitigate the risks introduced through the theory of algorithmic governance (Katzenbach & Ulbricht, 2019, p. 3–4). NGOs act as interpretive intermediaries, ensuring that automated EO systems do not obscure human judgement or ethical responsibility. By making algorithms legible and usable across different legal and cultural contexts, they help mitigate the opacity, rigidity and power imbalances embedded in digital infrastructures. Translation, therefore, can be an ethical act that reconfigures who can interpret, challenge and act upon surveillance data.

4.2.1 *Turning Satellite Imagery into Environmental Knowledge*

Data sharing and dissemination are central to translation. The capacity to transform satellite imagery into actionable knowledge depends first on ensuring that data is not locked away. This may involve a commitment to open-source practices. “As much as possible, we try to open source all of our work,” one NGO worker explained. “And if we don’t it’s probably because we just haven’t gotten to it yet. All of the code that we write, all of the data we produce—again, assuming there aren’t any specific privacy concerns—it is all open

to the public. We even open it up to commercial use" (Organisation 2). Here, open access is framed as an ethical commitment that lowers barriers and maximises the utility of environmental data across sectors. Through such practices, EO data is positioned as a shared tool for environmental problem-solving.

Application Programming Interfaces (APIs) are another key translational mechanism. These tools offer standardised and programmable access points to EO datasets, enabling users to interact with and combine multiple sources of environmental data without starting from scratch. As one practitioner noted, "The emergence of APIs is a standard end point for being able to access data and continues to be pretty transformative... particularly in the environmental space" (Organisation 2). APIs support interoperability and repeatability, reducing the need to "reinvent the wheel," as the same interviewee put it. While APIs assume a baseline of technical literacy, their existence lowers the long-term costs of environmental analysis by streamlining access and reducing redundancy.

Translation does not end with making data technically available. It also requires an active process of aligning EO tools with users' knowledge needs. This user-oriented design was consistently described as a strategy to avoid top-down dynamics in which EO technologies are developed without regard for the communities and institutions they aim to support. One interviewee described this approach as both practical and ethical: "We're really trying to be as user-driven as possible. We're identifying those needs and building something that we know people will use." Although this strategy is mainly driven by impact and strategy, the interviewee noted that it could also be seen as an informal ethical practice. This could mean engaging with beneficiaries: "if our users are on the ground and they probably have the best view of things vs. us just creating top-down pieces of tech and then saying, 'So, does anybody like this?' I think it gets at ethics a little bit" (Organisation 2). This recognition pushes EO translation beyond technical skill and towards participatory practice.

NGO staff emphasised that in order to make their products usable and comprehensible, they often need to undertake additional analytical and communicative work to contextualise the data. In one project related to chronic oil pollution, one participant's role was to support users in interpreting patterns, linking them to ground realities and exploring likely causes. "Sometimes a potential user or partner would like a little bit more analysis of the data, rather than just being able to use the data itself" (Organisation 2). In such cases, NGOs act as both analyst and interlocutor, constructing a narrative that connects EO-derived evidence to local environmental concerns.

Perhaps the most important translational work lies in ensuring that EO data is interpreted responsibly. One participant described this as a "translation function" essential for protecting both partners and the integrity of environmental enforcement. "There's a need to be really clear [...] about what the data does and does not show," they explained. "That clarity is critical for your partners to be able to use it responsibly." Misrepresentation becomes a risk when analysts fail to explain the limitations of satellite imagery analysis. This participant warned that simplification for legal or public presentation can obscure critical nuance. "That translation function [is so important] because you could expose both the case and the partner to risk" (Organisation 1). What is lost or distorted in the movement from imagery to enforcement can have real legal and environmental consequences.

By committing to open-source dissemination and the development of accessible tools like APIs, NGOs embrace sousveillant (Mann et al., 2003, p. 332) principles: they democratise surveillance infrastructures, lower technical barriers and invite participation from non-expert communities. At the same time, their practices reveal a deliberate resistance to the epistemic risks associated with algorithmic governance (Katzenbach & Ulbricht, 2019, pp. 3–4). Rather than allowing machine-generated outputs to circulate unchallenged, they insert themselves as human mediators available to interpret, contextualise and communicate the limits and meaning of EO data.

4.2.2 *Privileges and Restrictions*

NGOs benefit from access privileges that other state and civil society actors often do not. These may arise from financial capacity, technical expertise or relationships with data providers and institutional partners. For example, both organisations acknowledged occasional use of commercial satellite imagery when high-resolution data is needed. "We almost always use open data sources from ESA and NASA. Very occasionally, we'll use commercial imagery if there's a known location we want to look at with a very high resolution" (Organisation 2). While open data from Sentinel-2, Sentinel-1 and Landsat remains the norm, selective commercial access reveals a form of technical privilege. This access is often made possible by networks. As one practitioner explained, "We used high-resolution satellite imagery provided by MapBiomas, which acquires and shares the images with us through a partnership" (Organisation 1). MapBiomas, a regional network producing land cover data across Latin America, plays a vital role in redistributing commercial and high-resolution data to NGO partners. These organisations occupy a privileged role in the environmental data ecosystem due to their capacity to convert such resources into actionable environmental evidence.

International status can also serve as a form of institutional privilege. Several participants noted that being an internationally recognised NGO offers some protection, especially in politically sensitive environments. As one member remarked, “The fact that we are also an international institution, I think, is also a protective factor. I see many Brazilian NGOs suffering more from this kind of harassment and threats of legal action than international organisations” (Organisation 1). In such cases, jurisdictional complexity and the diplomatic or reputational risks involved may shield international NGOs from interference. These geopolitical privileges enable NGOs to operate in settings where environmental harm intersects with political and economic interests.

Nevertheless, NGOs remain outside formal state authority and are often limited in their access to sensitive information. In Brazil, for example, data privacy laws restrict NGOs from accessing personal data. A practitioner explained how this limitation shapes their methods: “If I need to investigate a farm in Brazil, I can’t access the owner’s name or ID. So what I do instead is imagine how that data might be organised, create the algorithm and send it to the MPF,” or Brazil’s Federal Public Ministry. “And they run the algorithm with their own data. So I don’t have access to the personal data myself—only the government does” (Organisation 1). In this case, the NGO translates technical capacity into a collaborative, legally compliant process. This workaround reflects the creativity NGOs require to operate within national data protection laws such as Brazil’s *Lei Geral de Proteção de Dados* (LGPD). Cross-border variations in data regimes add complexity. NGOs working internationally encounter different degrees of transparency and data accessibility. “In most countries across Latin America, there is a right to access to information which is better implemented than in other countries,” said one interviewee. “But in other jurisdictions... it’s very hard to get a response on anything that is related to trade or the market.” For example, Colombia and Peru allow data access via public request, while stricter privacy laws in Europe can hinder investigative work. NGOs’ ability to translate EO data into environmental knowledge is therefore shaped by the political and legal frameworks in which they operate.

The privileges and restrictions of environmental NGOs reveal the complex position they occupy as civic surveillance mediators. They possess certain technical and institutional privileges that set them apart from grassroots actors. Yet, unlike state entities, they lack coercive power and direct access to sensitive personal data, which situates them outside formal authority. This boundary compels NGOs to translate their technical capabilities into lawful, collaborative workarounds. In doing so, they remain entangled with state

surveillance infrastructures, while simultaneously seeking to reorient those systems toward civic- and justice-oriented ends.

4.2.3 *State and Nonstate Beneficiaries*

Each organisation structures its partnerships to align with its mission and strategic priorities. Organisation 1 described its model as deliberately plural: "The goal is to generate information and data to support decision-makers, especially the justice system and also local communities." Its work spans four categories of partners: "investigative journalists, local communities (in particular Indigenous communities and their representative organisations) and civil society groups, usually either environmental, climate or litigation NGOs, and public authorities" (Organisation 1). Organisation 2 expressed a similar partnership ethos: "More often, we're usually looking for partners in the space. So that could be journalists, other environmental NGOs who don't have technology and Earth Observation capacity. So, we'll create tools, datasets and analysis that serve them" (Organisation 2).

While both prioritise broad coalitions, they serve these beneficiaries in distinct ways. Organisation 1 focuses on generating outputs with legal and institutional weight. "We try to aggregate, analyse and produce information that is helpful to either public authorities or civil society in a legal sense," one team member explained. "We don't typically do any legal actions ourselves, but we are very much looking at what range of information is available to support a legal case" (Organisation 1). Legal specialists ask analysts, 'How can we make that information legally relevant and then present it in ways that partners can deploy most easily?' This reflects a pragmatic approach in which EO analysis forms the basis for further action. Organisation 2 instead sees itself as a catalyst within broader environmental movements. "We're not running campaigns ourselves," one member explained, "but instead trying to identify those leverage points where a small organisation like ours can have a meaningful impact in somebody else's campaign." This includes providing data to groups campaigning against offshore drilling, deforestation or pollution. "Our mission is really to be of service and to catalyse and unlock the work that other people are doing on the ground." The aim here is less about institutional enforcement and more about empowering grassroots campaigns with credible evidence.

Both organisations place strong emphasis on working with Indigenous groups, recognising them as key actors in environmental protection. Satellite imagery becomes a tool to support Indigenous sovereignty, territorial monitoring and resistance to illegal incursions such as logging or mining. Organisation 2 described this work as both technical and relational: "We do work with law enforcement agencies, but we also work with Indigenous

guards of community reserves, and they do similar work trying to prevent illegal gold mining and logging in territories that they're able to monitor." In this project, Indigenous partners collaborated with law enforcement in a hybrid governance model shaped by Organisation 2's training and technical support. "We definitely have worked with Indigenous groups and have trained Indigenous groups to use satellite imagery" (Organisation 2). Such training reflects a broader commitment to democratising access to EO technologies. By supporting both state and non-state actors, NGOs use their translational capacity to redistribute power in environmental monitoring.

Provision of data and analysis to both state and non-state actors illustrates how environmental NGOs practice civic surveillance mediation by redistributing surveillance capacity beyond traditional institutional boundaries. By serving legal authorities, investigative journalists, Indigenous communities and grassroots organisations, these NGOs find balance between formal surveillance regimes and sousveillant (Mann et al., 2003, p. 332) modes of environmental oversight. However, they remain connected with public authorities, reflecting an entanglement with institutional surveillance, where EO data is utilized to support environmental enforcement actions.

4.3 Negotiation: Shaping Data and Analysis for a Civic Mission

The work of environmental NGOs reveals that surveillance in service of justice is a negotiated process shaped by civic missions, legal constraints, ethical considerations and the anticipated consequences for affected communities. This section explores how environmental NGOs engage in negotiation across every phase of their workflows, from shaping initial analyses to deciding how and when to release findings. These decisions are often made collaboratively, drawing input from multidisciplinary teams that include lawyers, analysts, programme managers and field partners.

The practices described in this section reveal how environmental NGOs occupy a dynamic position within contemporary surveillance ecosystems. Through their civic- and justice-oriented strategies, these organisations demonstrate hierarchical sousveillance when leveraging EO technologies to monitor and hold powerful actors accountable (Mann et al., 2003, p. 332; Newell, 2020, p. 259). At the same time, the integration of AI tools into their workflows suggests algorithmic governance may risk this civic mission, where decisions are shaped by digital systems that mediate human agency (Katzenbach & Ulbricht, 2019, p. 8). Presently, NGOs negotiate their systems' design and use through deliberative processes involving multidisciplinary teams, reflecting an ongoing tension between ethical commitment and operational efficiency. These tools, especially when used for enforcement,

also suggest a possible movement toward automated surveillance, where EO systems pre-emptively act and reshape field responses without requiring human initiation (Andrejevic, 2019, p. 7). Together, these theories help to explain how surveillance, when aligned with civic values, can be mobilised for justice, while increasing automation puts at risk these context-sensitive, ethically grounded, and human-centred surveillance practices.

4.3.1 *Civic- and Justice-Oriented Strategies*

At the core of both organisations' practices is an engagement with the consequences of their work. These workers acknowledge that the analysis of EO data is not simply a technical exercise. Their outputs are embedded in multi-stage deliberative processes in which the legal, political and social implications of each project are debated. As one participant described, their workflow deliberately spans departments, with an emphasis on reflection and accountability: "The analysis is first done by the technical team, then passed on to the legal departments, then to programme directors and then to international directors." Throughout this process, members of the organisation discuss whether a finding or case is "appropriate or not, whether it will have a legal or political impact, and whether that impact is positive or not" (Organisation 1). This reflects an ethos of deliberation, where choices around data production and use are shaped by potential consequences for affected people and policy. One analyst affirmed this, saying, "I get a lot of direction from—and my work is sometimes shaped by—the legal side" (Organisation 1).

In practice, EO analysis often serves as the entry point for investigations and enforcement efforts. An interviewee described how one of their satellite-based models, which identifies likely gold mining activity, is used to prioritise patrols in rainforest regions. This geospatial intelligence enables small field teams to intervene more efficiently, leading to direct enforcement actions such as the seizure of illegal equipment. That interviewee remarked, "I'm not sure they actually use our satellite images in prosecution because by that point it's almost irrelevant [since] the police have found the actual equipment and caught people in the act" (Organisation 2). The value of EO lies in its catalytic function: it enables timely, grounded interventions in remote landscapes where environmental degradation might otherwise go undetected. EO data can also support legal advocacy through a collaborative approach in which NGOs regularly reach out to environmental law partners to ask, "What's on your mind? What are you working on? How can we help?" (Organisation 2). Rather than pursuing a fixed advocacy model, the organisation remains flexible, adapting its tools to meet the shifting needs and capacities of legal actors in the field. This practice underscores a

civic commitment to listening, responsiveness and relationship-building, and positions EO as one tool among many in the broader pursuit of environmental justice.

A civic orientation is also evident in how both organisations approach data governance and ethical use. Organisation 1, for example, insists on creating memoranda of understanding (MOUs) with partners to ensure that shared data is used solely for environmental analysis. These agreements represent a negotiation of trust and purpose, safeguarding against the misuse of sensitive geospatial intelligence. Similarly, Organisation 2 engages in internal debates over the risks and benefits of open data. "We've gone back and forth about whether [...] the industry could misuse it," one member noted, "but we think ultimately it's worth it" (Organisation 2). Their commitment to openness is grounded in the belief that transparency supports public oversight and civic empowerment, which are foundational principles for a justice-oriented approach to technology.

This justice ethic also extends into organisational culture and working practices. Speed and responsiveness are framed as ethical imperatives. "Especially with environmental issues, speed is a critical part of the equation. So if we can move fast, I think we have an obligation to" (Organisation 2). More broadly, both organisations situate their technological efforts within a wider commitment to public good, prioritising inclusion, access and the avoidance of harm. "We're trying to serve our mission," one worker explained. "So we don't want to do anything in conflict with that, meaning anything that would actually harm people rather than help people" (Organisation 2). This sense of mission serves as an informal moral compass, guiding decisions around design, data access and public engagement. Open-access models, while risky, are seen as necessary to ensure that grassroots actors and those most affected by environmental injustice can access and use EO data for their own advocacy. As another interviewee noted, "We don't welcome uses outside of [environmental conservation], but it's worth it to ensure that anyone who wants to use our tools is able to" (Organisation 2). However, this commitment to accessibility is sometimes limited by institutional capacity. One interviewee noted that "a lot of data doesn't even become public," not due to secrecy, but because of gaps in technical and organisational infrastructure (Organisation 1). They went on to express an interest in creating public platforms for improved transparency, reflecting a civic belief that environmental data should, when possible, be a public good.

Across both NGOs, civic and justice-oriented strategies are not the product of technical expertise alone. They arise from diverse, multidisciplinary teams who bring different forms of knowledge to the negotiation of EO technologies. As one interviewee put

it, “We are also multidisciplinary in the sense that I’m a lawyer, but there are also economists and social scientists and anthropologists. So we have very different profiles” (Organisation 1). This diversity fosters more inclusive conversations about the consequences and future potential of EO. It enables the organisation to consider environmental, legal, political and social dimensions, resulting in more just and context-sensitive analyses.

These organisations reorient surveillance practices from the top-down gaze of the state or industry to a bottom-up, participatory model that privileges affected communities. The NGOs use EO as a civic tool, enabling responsiveness, transparency and grassroots empowerment. The multi-stage processes of review, reflection and collaboration across technical and non-technical teams signal a governance approach aligned with careful accountability.

4.3.2 *Conceptualising Ethics*

Negotiating the use of EO technologies involves an ongoing, uneven and often informal process of grappling with the ethical dimensions of surveillance data and its mobilisation. Across the organisations studied, a shared commitment to civic accountability and environmental justice was evident. However, the ways in which ethics were conceptualised and operationalised remained fragmented, situational and deeply shaped by the organisational context and the personal dispositions of practitioners. There was a marked uncertainty around how ethics should be framed and enacted in day-to-day work. No formal ethics protocols or review procedures existed in either organisation to systematically assess the ethical implications of EO data use. Rather than being treated as a structured or codified element of operational practice, ethical considerations emerged informally throughout the lifecycle of a project but were rarely addressed in a formalised, strategic manner. This ambiguity is noted by a technical staff member from Organisation 1: “Yeah, about the ethical part. I think we do a lot of ethical work in simply obeying the LGPD, like not exposing data unlawfully. So I’m not sure if there is something I…As someone in tech, it’s hard to think about this ethical part because you are just trying to get your work done. Yeah, I’m not sure if I have something deeper to add about this kind of ethical topic. I don’t know” (Organization 1). Here, ethical responsibility is reduced to legal compliance, specifically with Brazil’s LGPD. The absence of a deeper ethical framework illustrates how, for many working in technical or operational roles, ethics is viewed as a checklist aligned with legal and regulatory obligations. For both organisations, operationalising ethical principles through compliance with the law reveals that ethics is externalised, or shaped by the existence of formal constraints.

At the same time, interviewees noted various ethical principles that guide their work informally. Chief among these was a commitment to honesty and truth in environmental reporting and data presentation. Practitioners emphasised the need for methodological rigour, cross-validation of evidence and transparent communication of uncertainty. One participant said that data and information reflecting truth and reality was their "main ethical principle." They added, "So I'm always very concerned with whether information has been confirmed, that it has been cross-referenced with a lot of different databases, and that we have a deep belief that this information is valid" (Organisation 1). Similarly, diligence with respect to the scientific method was cited as a form of formalised ethics: "Scientific integrity is one of our core organisational values. [...] We try to be very clear and open about all the caveats associated with the data and analysis" (Organisation 2). This emphasis on truth serves to reinforce the credibility of the organisations' outputs.

Practitioners also expressed concern over the risks of premature or inaccurate public claims, particularly in contentious cases involving land use or environmental crime. One interviewee recalled a case where a journalist wanted to publish information that was technically inaccurate, prompting the NGO to intervene. "It's not that they meant to do anything wrong. So we always make sure that what we say is illegal because it is illegal—not because of some technical error or weak evidence" (Organisation 1). This gatekeeping role reflects an ethic of responsibility, whereby these NGOs protect individuals and communities from the downstream consequences of misrepresentation.

Ethics also appeared in the form of democratic accessibility. Practitioners expressed a commitment to lowering barriers to environmental data through open-source tools, fee-free platforms and publicly accessible datasets. One interviewee explained that their organisation's tools enable "anyone who's a little more tech savvy to actually incorporate our findings into their own systems. [...] The idea is that a person with an Internet connection and with minimal technical skills can view all of our stuff for free" (Organisation 2). This ethic of accessibility often took an oppositional stance, aiming to counterbalance power asymmetries between states, industry and civil society. Acknowledging that EO surveillance often privileges powerful actors, these organisations use their resources to redistribute its potential, enabling grassroots monitoring by Indigenous communities or local NGOs. One participant remarked, "Industry, governments, at least a lot of them, already have access to very powerful tools and data. So we're trying to level the playing field as much as we can and really focus on democratising some of that access" (Organisation 2).

Yet even this democratising impulse has limits. The same data that can empower communities could also expose them to harm. Practitioners expressed a strong awareness of the safety risks associated with local involvement in environmental enforcement. One participant described a situation in which their organisation took measures to protect those involved in a criminal case:

> "This has created a lot of risk for the people trying to fight for the land because, one, they've been threatened several times, and two, there is some division within the community on this issue. What we did was to move the case somewhere outside of Peru to choose an environment for the proceeding to take place that would not bring on so much publicity. This strategy intended to avoid putting at risk the people involved with the case who still live in Peru with the supplier" (Organisation 1).

In such cases, ethical practice took on a protective character. Practitioners emphasised the importance of anonymisation, case relocation and delayed publication to mitigate privacy risks and protect sources.

These strategies were often guided by international privacy norms such as the General Data Protection Regulation (GDPR), which provided a kind of default ethical standard in the absence of formal organisational protocols. One analyst explained their use of the GDPR: "Even when [data] is publicly accessible, it is still technically private data in this weirdly blended way. So we pay considerable attention to ensuring compliance with data protection regulations" (Organisation 1). Treating data protection seriously was described as standard practice in this field. One participant used whistleblower protection as an example: "We take data and information privacy very seriously. [...] If a whistleblower comes to us with evidence about something that we can pass on, we keep their identity anonymous. We're very clear with them about how we will and will not use their information" (Organisation 2). Although this example does not relate directly to satellite imagery analysis, it suggests a preference for protecting the privacy of affected individuals rather than perpetrators of environmental harm. As one participant explained, "We think almost in the opposite terms. If we find some kind of environmental infraction out at sea or in a remote area, that's often a sign of a red flag or it's correlated with additional types of illegality" (Organisation 2). This tension points to potential operational conflicts between privacy norms and the desire to ensure accountability and impact.

Lastly, ethics was conceptualised relationally, in terms of accountability to local partners and affected communities. One participant discussed their organisation's recognition of NGO positionality, often removed from the material realities of those they seek to support. "We stay behind a computer. So it's pretty safe for us, but not always for the partners. So I think that is probably the most important issue" (Organisation 1). Taken together, these accounts suggest that ethics in EO-enabled environmental monitoring is not a

singular or standardised construct but a negotiated domain. Rather than being guided by overarching principles or institutional review boards, ethical practice is deeply contingent on the personal ethics of practitioners, the sociopolitical context of data use and the balancing of multiple, sometimes competing imperatives: truth, protection, accessibility and impact. The absence of formal ethical frameworks may create gaps, but it also allows for an adaptive and situational ethics that evolves in response to specific cases or political and environmental landscapes. However informally, these interviewees emphasised that EO data is shaped, interpreted and made to serve a civic mission.

Ethics are thus mediated through the personal values of practitioners, local contexts and civic commitments. This decentralised and relational approach to ethics highlights potential problems of ambiguity and accountability gaps. The interviewees' emphasis on transparency, truth and public access reveals a civic orientation that resists the opacity of automated surveillance systems (Andrejevic, 2019, p. 9), where algorithmic outputs often evade human scrutiny. However, the reliance on legal standards like the GDPR or Brazil's LGPD as default ethical anchors demonstrates how, in the absence of formal structures, legal compliance can substitute for deeper ethical reflection.

4.3.3 *Formalising Ethical Practices amid Conflicting Objectives*

While informal values and implicit norms shape much of the decision-making around EO data use, both organisations studied have begun to express a clear desire for more formalised ethical frameworks. This desire may stem from a recognition that codifying ethical practices could enhance internal coherence, provide safeguards for technical staff and strengthen relationships with partners and the wider civic field. However, formalising ethics is complex due to the diverse contexts, actors and goals involved in environmental enforcement. A rigid, one-size-fits-all ethical protocol would be ill-suited to the nuanced realities of this work.

One of the primary motivations for formalisation is to protect the work of analysts. Practitioners acknowledged that having clearer ethical guidelines could shield technical teams from potential liability or external critique and bolster confidence in their decision-making. A staff member at Organisation 1 emphasised this point, saying, "It would give us—even internally, for the technicians working in this area—more security in our work. I think we already have a lot of material, based on our experience, that could help in creating this kind of protocol" (Organisation 1). Here, formalisation is envisioned as a protective infrastructure or a set of clearly articulated principles that would offer consistency, accountability and legitimacy to both internal and external stakeholders. This participant

believes such a protocol could build on accumulated institutional experience and lessons learned.

In addition to internal protection, formal ethical guidelines are seen as a way to streamline workflows across diverse teams and units. Within the same organisation, staff noted that methodologies and standards often vary between teams, leading to fragmented practices. Ethical guidance could serve as a harmonising mechanism: “So we don’t necessarily use the same methodology or the same criteria to conduct analysis, and I feel like having ethical guidelines or policies in general would help close this gap and help create a streamlined approach across the organisation” (Organisation 1). As EO data is leveraged for litigation, media campaigns and community-based monitoring, consistency in ethical practice may improve effectiveness and diligence across all projects.

Still, efforts to codify ethical norms remain largely in development. Some practitioners acknowledged the importance of formalising partner engagement protocols but admitted that current efforts were nascent: “Those ethical concerns are definitely really important to us, but I don’t think we have a written set of policies on partner engagement. It’s something that I’ve sort of worked on a little bit over the course of my time here, but definitely still a work in progress” (Organisation 2). The discussion about formalising ethics was described as “a good flag” for something to work towards more actively. However, this state of partial development is telling. It reflects the fact that even where ethical concerns are widely acknowledged, developing generalised policies for diverse, high-stakes and often unpredictable work remains a major challenge.

Practitioners frequently emphasised that different partners and projects require tailored ethical approaches. One proposal was what an interviewee termed a “soft standardised” model, or an ethical structure flexible enough to accommodate contextual variation while still grounded in organisational precedent:

> “I think that the most helpful is what I’d call a soft standardised approach where you’ve got [...] a checklist or a set of basic steps that you go through. And you might have two or three of those depending on which scenario you’re in. If you’re dealing with a domestic law enforcement body, here’s the general approach one should take, with room to adjust as needed. If you’re dealing with a local community, helping them develop a strategy, it’s going to be a very different approach, but you should be taking a broadly standard approach each time you’re engaging with a local community. If you’re engaging with an NGO bringing an action in a foreign jurisdiction, here’s the basic approach in terms of the type, how you engage with the analysts, how you engage with the partner, the steps that you take” (Organisation 1).

This pragmatic model allows for ethical guidance that is responsive rather than prescriptive. It recognises that the needs of Indigenous land rights groups differ from those of public prosecutors, and that ethical practice must be negotiated dynamically, with attention to power, purpose and risk. The need for case-specific ethical consideration was further

underscored through examples of specific partnerships. For instance, in working with Indigenous communities seeking land recognition, practitioners acknowledged the ethical stakes involved, especially in the absence of a formal protocol: “So our purpose is to support their fight for land rights. And we don’t have a written protocol for that—for managing community relations” (Organisation 1). In this case, the absence of a formal protocol does not signal a lack of ethical concern. Rather, it reflects the challenges of applying standardised approaches in contexts shaped by historical injustices, political sensitivities and complex social dynamics.

One ethical principle that illustrates the tension between formalisation and contextual sensitivity is transparency. While often considered a straightforward good, transparency in the context of EO data and environmental monitoring is fraught with competing demands between public accountability, investigative effectiveness and the protection of vulnerable groups. Practitioners highlighted the role of transparency in sustaining trust: “Our NGO depends a lot on trust. If you do something wrong, you risk losing the trust of public organisations and communities. So sometimes, you have to be cautious. You need that trust to keep working with them” (Organisation 1). Yet full transparency could, in other situations, undermine legal or operational goals. One staff member noted the risk of compromising investigations by disclosing too much too early: “There are limits on how transparent one can be publicly about the information you’re providing [...] It could compromise an investigation or it could compromise your relationship with that enforcement authority” (Organisation 1). Transparency also had to be weighed against privacy concerns and community safety. Strategic decisions to delay or anonymise data publication depended not only on legal constraints but also on ethical obligations to partners at risk: “Sometimes the more strategic thing to do [...] is to retain the data until the campaign is launched or until the judicial proceedings start.” The greatest risk, they noted, was in revealing sources central to the investigation: “If a civilian is identified, we would anonymise the data. Sometimes even if it is a company. [...] It also depends on the security risk of the communities [...] And if it is about judicial proceedings, it depends on the procedural rules” (Organisation 1). These examples illustrate the multidimensional nature of ethical judgement in EO work. Transparency, while a general principle, cannot be applied uniformly. Instead, it must be negotiated in relation to strategic timing, legal procedure and, above all, the risks faced by partners on the ground.

Civic surveillance mediation evolves through consideration of the complexities and contextual demands of environmental monitoring. The interviewees’ emphasis on the

drawbacks of transparency demonstrates negotiation between the democratic ideals of openness and the risks of exposure, loss of trust and investigative compromise. Unlike sousveillance (Mann et al., 2003, p. 332), which often implies a direct counter-surveillance stance, this approach demonstrates a more institutionalised form of civic engagement. NGOs thus seek to harmonise justice-oriented ethics with the strategic and legal realities of environmental enforcement. Through this lens, the organisations' attempts to formalise ethics reflect a reconfiguration of surveillance practices toward ethical adaptability.

4.4 Environmental NGOs Practice Civic Surveillance Mediation

These findings provide compelling evidence that environmental NGOs occupy a unique and increasingly complex role within the contemporary surveillance ecosystem of EO. Through their facilitation, translation and negotiation of EO technologies for environmental enforcement, these organisations neither fully resist nor wholly reproduce traditional surveillance logics. Instead, they act as civic surveillance mediators: intermediaries operating between the poles of sousveillance and state or corporate surveillance, shaping the direction and ethical use of monitoring technologies in pursuit of civic- and justice-oriented goals.

This model positions NGOs as neither passive users of satellite data nor outright challengers of state or industrial surveillance. Rather, they are mediators that enable, interpret and redirect surveillance flows to serve people and the planet. Their work involves translating complex datasets into actionable evidence, enabling legal interventions, empowering communities and holding environmental violators accountable. Below is a conceptual illustration of this model:

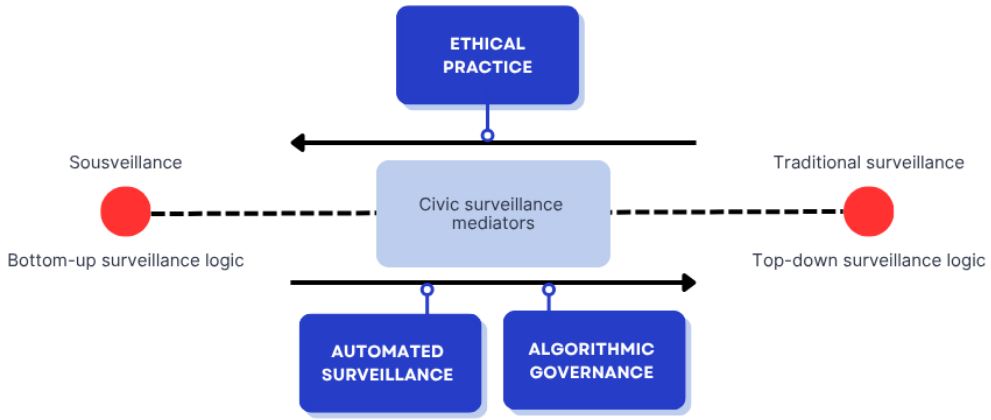

Figure 3. Conceptual model of civic surveillance mediation, whereby civic surveillance mediators employ surveillance technologies such that their work exists on a sliding scale between bottom-up and top-down surveillance logics, shaped by ethical practices and the risks of technological oversight, as explored through the frameworks of automated surveillance (Andrejevic, 2019, p. 7) and algorithmic governance (Katzenbach & Ulbricht, 2019, pp. 1–4).

This conceptual model is supported by three core thematic nodes that emerged from the study. These themes were not predetermined but surfaced through empirical analysis of how environmental NGOs engage with EO technologies in practice:

1. *Sousveillance* (Mann et al., 2003, p. 332): Environmental NGOs in this study demonstrated clear sousveillant tendencies. First, they prioritised open access and data sharing, promoting transparency in their tools and outputs. These practices support citizen science, grassroots activism and other forms of civic engagement by making technical tools accessible beyond institutional elites. Second, their mission and outputs often aimed to hold industry and government actors to account. Both organisations worked to uncover environmental violations, expose regulatory failures and support legal action. These are targeted interventions designed to shift power and mobilise oversight. Third, the beneficiaries of their monitoring activities included local communities, Indigenous groups and the general public. Even when working with enforcement agencies, their stated goals were often aligned with protecting environmental defenders and improving environmental justice outcomes. Finally, the stated objectives of their work reflected civic- and justice-oriented commitments, not commercial surveillance or behavioural control. Their concern with avoiding false accusations and protecting whistleblowers reflected a strong civic ethic.
2. *Algorithmic Governance* (Katzenbach & Ulbricht, 2019, pp. 3–4) and *Automated Surveillance* (Andrejevic, 2019, pp. 7–11): The study also revealed how these organisations are entangled in the logic of algorithmic governance. Both have adopted and are expanding their use of ML and AI to automate environmental monitoring. While automation enhances efficiency, it mirrors the rationalities of state and corporate surveillance: algorithmic detection, real-time alerts and data-driven decision-making. Under such configurations, NGOs may resemble the analytical arms of institutional surveillance rather than its counterweight. Moreover, the reliance on remote sensing and automation risks sidelining the lived experiences of frontline communities. Several participants acknowledged the limitations of remote analysis and the need to remain sensitive to on-the-ground impacts, including risks of public exposure or legal retaliation. While NGOs are cautious, this tension suggests that as they scale their methods, their work may begin to resemble traditional surveillance frameworks that have historically excluded public input.
3. *Unique Features of Mediators*: What makes environmental NGOs distinct in this ecosystem is how they negotiate their role within it. First, NGOs serve as bridges

across institutional levels: connecting grassroots actors with legal systems, public audiences with technical data and local concerns with international platforms. This connective role demands ethical sensitivity and interpretive work not often found in state surveillance settings. Second, both organisations emphasised an ethic of scientific honesty and transparency about limitations. Rather than presenting data as infallible, they foregrounded uncertainty, clarified that outputs were inferential and insisted on human validation of algorithmic results. This epistemic humility contrasts with the assertive finality that often characterises bureaucratic or commercial surveillance outputs. Third, environmental NGOs operate in a hybrid legal-political space. They enjoy certain privileges, such as data access not available to individuals, yet lack the authority, funding or coercive power of state bodies. This in-betweenness allows them to question dominant practices, but also demands careful navigation of institutional expectations and civic obligations. Finally, they practise a pluralistic and evolving ethics. This study reveals that no standardised ethical framework governs EO work across these organisations. Yet informal norms, lived experiences and partner feedback generate adaptive ethical practices that are more responsive to local complexity than state or corporate ethics regimes.

Between the poles of resistance and control lies the actual work of environmental NGOs. Their use of EO data cannot be neatly categorised as either counter-balancing or disciplinary. Instead, they actively mediate the civic potential of surveillance technologies. This means translating these tools for justice while simultaneously navigating their risks and contradictions. However, this mediating role is not fixed. Environmental NGOs may shift between veillance positions depending on who funds the work, who receives the analysis and what the legal stakes are. They are not neutral facilitators but strategic actors whose relationships to power, data and justice are dynamic and negotiated. As EO tools continue to evolve and surveillance becomes increasingly automated, NGOs will likely face growing pressure to clarify their ethical commitments and formalise their protocols. The model of civic surveillance mediation helps name and situate this role, foregrounding the need for intentional design, participatory engagement and ethical consideration in shaping future surveillance practices.

4.5 Future Challenge and Proposed Solution

As environmental NGOs expand their use of AI and automated tools in EO workflows, maintaining ethical credibility may become a challenge. As human oversight diminishes and reliance on algorithmic models grows, the risk of unexamined assumptions,

opaque decision-making and unintended harm also increases (Katzenbach & Ulbricht, 2019, pp. 3–4; Andrejevic, 2019, pp. 7). This creates an urgent need for civic- and justice-oriented NGOs to formalise their ethical approach to AI.

To address this challenge, this study draws on the AI4EO ethical research framework proposed by Kochupillai et al. (2022), which offers practical guidance for integrating ethical thinking into EO research and application. The framework focuses on identifying and acting on ethical opportunities, or potential benefits and enhancements to human and societal well-being that arise from ethical decision-making throughout the research process.

Using the ethical opportunities model, this project adapts their structure to create actionable recommendations for environmental NGOs. Readers are encouraged to consult the full paper, particularly pages 106–112, where Kochupillai et al. (2022) provide detailed examples including slum and urban mapping, mining surveillance and biodiversity monitoring. Building on this, two exercises apply the ethical opportunities framework to cases of illegal deforestation and illicit ocean pollution, provided in Appendix 3.

5. Conclusion

This study has examined how environmental NGOs facilitate, translate and negotiate the use of satellite imagery in the fight against environmental crime. It has focused particularly on the practical and ethical strategies NGOs employ to ensure the responsible application of geospatial technologies in real-world enforcement contexts. Through qualitative insights from practitioners across two prominent NGOs, the research contributes to a deeper understanding of the operational dynamics that underlie the use of EO data for environmental justice.

The categories that structure the results of this study help to illuminate the diverse and sometimes contradictory logics NGOs must navigate as they work across technological, institutional and social spaces. First, facilitation strategies fall into three main camps: analytical rigour, people-centred engagement and the adoption of advanced technologies. NGOs demonstrate analytical rigour by drawing on publicly available data, creatively merging different data streams to validate findings and tackling complex technical hurdles to produce outputs that are scientifically credible. Equally important is their people-to-people strategy, involving the interpersonal, coalition-building work that makes technical outputs actionable. NGOs form partnerships with government agencies, civil society, academia and local communities. Even in cases where institutional capacity is weak or political will is lacking, NGOs continue to deliver results by relying on human expertise, contextual knowledge and dialogue. Their responsiveness reinforces their civic mission and ensures that EO-derived insights are grounded in social realities. Current and future uses of AI represent another facilitating domain. Both NGOs already use ML to automate detection tasks and extract patterns from large datasets of imagery. There is clear interest in scaling AI capabilities to enhance monitoring and reduce human labour across workflows. Nonetheless, the organisations also recognise the risks of ‘dehumanising’ the process and stress the importance of maintaining a role for human oversight and ethical judgement.

Second, translation strategies concern the transformation of technical imagery into useful and actionable knowledge. NGOs carefully manage how EO-derived data is shared, disseminated and framed. Their communication efforts are designed to avoid overclaiming and to clearly explain methodological limitations and contextual uncertainties. This cautious approach helps minimise the risk that satellite images will be misused, misinterpreted or co-opted by bad-faith actors. The ability of NGOs to serve as trusted intermediaries is partly shaped by their privileges and constraints. On the one hand, their international standing, technical capacity and networked position afford them privileged access to high-resolution

imagery and information networks. On the other hand, they face constraints around licensing, data delays and legal restrictions that can inhibit fast-paced work. These privileges and restrictions shape how NGOs choose to serve a diverse range of state and non-state beneficiaries, including prosecutors, journalists, regulatory agencies and local communities. Their work cuts across scales and sectors, underscoring the flexible role they play in knowledge translation.

Third, negotiation strategies reveal how NGOs shape their EO work to support civic- and justice-oriented ends. Without a formal mandate, NGOs make discretionary and informal decisions that reflect civic values: supporting environmental defenders, amplifying underrepresented voices and working towards equitable enforcement. Ethical consideration is where negotiation most obviously takes place. There is no unified or formal ethical policy at either organisation. Instead, there exists a patchwork of informal ethical practices: truth-telling, transparency about limitations, guarding against false claims, protection of people and communities, and adherence to privacy laws. This ad hoc approach is flexible and adaptive but reveals an important limitation in institutional readiness for a future of more automated and expansive surveillance. There is a growing awareness among staff that ethical standards must be formalised to keep pace with technical advances. Yet this formalisation effort must reckon with tensions: transparency versus privacy, protection of witnesses versus legal liability, and democratisation of access versus risk of abuse.

To interpret these findings, the study employed a post-analysis theoretical framework drawing on concepts of sousveillance, algorithmic governance and automated surveillance. These theories helped locate environmental NGOs within a hybrid position on the surveillance spectrum as civic surveillance mediators that navigate and sometimes reconfigure power from within the surveillance ecosystem. This theoretical positioning proved suitable, especially given the empirical ambiguity of the NGOs' role. The concept of civic surveillance mediation offers insight into how NGOs can both legitimise and resist surveillance logics, depending on the context. It captures the simultaneous promise and risk of using satellite data for civic ends and highlights NGOs' crucial role in negotiating this terrain.

5.1 Limitations and Directions for Future Research

The goal of this study was not to test a predefined hypothesis but rather to uncover patterns in practice and ethical reasoning. TA enabled the flexible coding of diverse responses, allowing themes to emerge inductively from the data. The decision to pair TA with post-analysis theoretical development was essential, as many of the ethical nuances

only became apparent through sustained interpretation of the interview data. Without a clear literature or typology on NGO-led civic surveillance using EO, the theory had to be developed in response to the empirical findings, not in advance of them.

Nevertheless, the study is subject to important limitations. First, the small number of interviews means that findings may not be generalisable across the broader NGO sector. The sampled NGOs were also relatively well-resourced and internationally connected, which may not reflect the experiences of smaller or more grassroots organisations. Second, TA lacks the ability to measure frequency, scale or comparative effectiveness of strategies. This limits the study's ability to claim how common or widespread certain practices are. The lack of observational or document-based data also restricts the ability to cross-validate statements made by interviewees, especially when discussing informal practices or ethical decision-making. Lastly, the researcher's positionality and the reflexive choices made in interpreting complex ethical narratives undoubtedly influenced the final themes. While reflexivity was embraced throughout the research, it is possible that alternative interpretations might emerge from a different analytical lens.

Further research is necessary to determine whether the concept of civic surveillance mediation can apply beyond environmental NGOs to other actors involved in monitoring, enforcement and governance, such as human rights groups monitoring national border crossings. It would also be valuable to examine how these roles evolve over time, particularly in relation to increasing automation and AI integration. As NGOs scale up their technological capacities, will the human-centred, civic ethos remain intact or will reliance on automated detection risk alienating the very communities civic NGOs seek to serve? Moreover, future studies should explore how ethical standards for satellite data use are being developed across sectors and whether shared norms can be established to balance civic accountability with technological innovation. As EO becomes more embedded in public decision-making, the ethical and governance frameworks NGOs adopt may significantly influence the sustainability of civic surveillance mediation in the future.

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Appendix 1. Interview Guide and Consent Form

Introduction

2–3 minutes

Initial welcome.

Explain confidentiality, ask for them to obtain the consent form I emailed him, and then ask for permission to record.

Start recording.

Introduce myself and the project.

Thank you so much for taking the time to speak with me. My name is Cora, and I'm currently conducting research on how NGOs are using satellite imagery and remote sensing to detect, investigate, and prosecute environmental crimes such as illegal deforestation, mining, and fishing.

This project explores how ethical principles like privacy, transparency, and fairness are put into practice, and how NGOs are innovating to promote accountability and justice through geospatial tools.

The goal is to understand not only the technical side but also the practical and ethical strategies NGOs use to ensure responsible data use in their work.

Ask for them to read the second to last line of the consent form:

"I give consent to be recorded during this study."

Background

2–3 minutes

Could you briefly introduce yourself and your organization?

How long have you been working with your organization, and what positions have you held?

Project Experience with Geospatial Tools

8–10 minutes

Can you describe some of the projects where your organization has used satellite imagery or remote sensing to address environmental crime?

What kinds of technologies, data sources, or analytical methods have you used for these projects?

Ex: landcover classification, object detection, LiDAR, SAR, AI/ML, time-series analysis…

Are there any particular tools or platforms you regularly rely on for these projects?

Ex: Google Earth Engine, QGIS, PlanetScope…

Potential follow-up question:

What do you think are the potential advantages and disadvantages of reliance on these tools?

Practical and Operational Challenges

8–10 minutes

What are some of the main challenges your organization faces in applying geospatial analysis for environmental crime detection or documentation?

Ex: data availability, resolution, cloud cover, funding, tech access, government pushback…

What strategies does your organization try to employ to effectively operate globally, especially when working across local, national, or transboundary jurisdictions? And if you have specific examples in mind, feel free to share.

Legal and Regulatory Considerations

8–10 minutes

Does your organization follow any legal or procedural guidelines to ensure your analysis is admissible or useful in legal or policy contexts? And if so, can you give some examples of how these guidelines are operationalized in your work?

Has your organization encountered legal or regulatory restrictions (at the local, national, or international level) that impact your ability to publish or act on geospatial findings? And if you have an example of a barrier you faced and how you dealt with that barrier, that would be great to hear more about.

Ethical Use of Geospatial Data

8–10 minutes

Does your organization have internal policies or protocols around the ethical use of satellite imagery or remote sensing? If so, can you describe those? How were they developed and what influenced the development of them? Were their conflicting influences?

Ex: data privacy, minimization, masking of sensitive areas or people, consent for data use…

Probe: If not, do you think there should be?

How do you ensure that your organization is protecting local populations or communities that are visible in your analysis?

Prepared example: for example, using high-resolution satellite imagery to document illegal deforestation or mining activity. If your analysis displays forest loss in a protected area, and a community happens to live nearby without formal land rights, authorities might move to evict them under the assumption that they are contributing to the degradation. In reality, they may be sustainably managing the land or simply residing there due to displacement or economic need. The public visibility of their presence can lead to consequences like displacement or criminalization.

Transparency and Accountability

8–10 minutes

Note from Daniel: You would want to get a sense of how the participant is defining / measuring transparency here, as it may highlight some aspects, while obscuring other less transparent practices.

How transparent is your organization about data collection, use, processing, and analysis?

Potential follow up question:

Have there been any times when transparency has not been possible?

Has your organization ever engaged with local or Indigenous communities in relation to satellite-based mapping or monitoring efforts? If so, would you feel comfortable sharing 1 or 2 examples?

Ex: co-creation of data, informing communities about remote sensing activities, joint validation of findings…

Potential follow up:

Does your organization offer any cultural sensitivity training?

Final Thoughts

10–12 minutes

In your view, what are the most important principles or practices that help ensure satellite imagery is used responsibly in the field of environmental crime detection?

Are there examples of particularly innovative or effective uses of remote sensing in your work that you think others could learn from?

Do you think there is anything your organization could be doing better to make ethical and effective use of geospatial analysis?

Is there anything else you'd like to add about your organization's approach or lessons learned in using geospatial tools ethically and effectively?

Conclusion

End the interview.

Thank you again for sharing your insights. This has been incredibly valuable for my research. If you think of anything else that you want to add or you think could be valuable for me to know, please reach out anytime.

CONSENT REQUEST FOR PARTICIPATING IN RESEARCH

FOR QUESTIONS ABOUT THE STUDY, CONTACT:

Cora Martin,

DESCRIPTION

You are invited to participate in research about the use of geospatial analysis for the detection, investigation, or prosecution of environmental crimes. The purpose of the study is to collect practical perspectives on the ethical and effective use of satellite imagery and remote sensing for combating environmental crime.

Your acceptance to participate in this study means that you accept to be interviewed. In general terms, my questions will be related to:

- challenges facing your organization when making effective use of geospatial analysis for combating environmental crime;
- the use of advanced technologies for geospatial analysis, including but not limited to high-precision landcover classification models;
- regulatory compliance and legal hurdles associated with the use of geospatial analysis and remotely sensed data in legal settings;
- ethical guidelines or frameworks your organization uses for processing and analyzing geospatial data;
- privacy and transparency with respect to the use of remotely sensed data; and
- social impacts and human rights considerations associated with the use of remotely sensed data for monitoring environmental crime.

I will make an audio and a video recording of the interview.

I will use the material from the interviews exclusively for academic work, namely publications.

RISKS AND BENEFITS

I am aware that the possibility of identifying the people who participate in this study may involve risks for the potential exposure of sensitive or privileged information unique to your work and your organization. For that reason, I will not keep any information that may lead to the identification of those involved in the study. I will only pseudonyms to identify participants.

You are always free not to answer any particular question, and/or stop participating at any point.

TIME INVOLVEMENT

Your participation in this study will take 60 minutes. You may interrupt your participation at any time.

PAYMENTS

There will be no monetary compensation for your participation.

DATA COLLECTION AND RETENTION

During the interview, the following personal data will be collected from you: Name, gender, professional title, occupational organization, audio or visual recordings, native language, and experiences related to and expert opinions about your organization’s use of satellite imagery and remote sensing data and analysis.

Your data will be retained for a maximum of 6 months. I retain the data so that I have the opportunity to verify the research data in the case of future revisions during the publication period.

PARTICIPANTS' RIGHTS

If you have decided to accept to participate in this project, please understand your participation is voluntary and you have the right to withdraw your consent or discontinue participation at any time without penalty. You have the right to refuse to answer particular questions. If you prefer, your identity will be made known in all written data resulting from the study. Otherwise, your individual privacy will be maintained in all published and written data resulting from the study.

CONTACTS AND QUESTIONS

SIGNING THE CONSENT FORM

If you sign this consent form, your signature will be the only documentation of your identity. Thus, you DO NOT NEED to sign this form. In order to minimize risks and protect your identity, you may prefer to consent orally. Your oral consent is sufficient.

I give consent to be recorded during this study.

Appendix 2. Ethical Principles and Examples

PRINCIPLE	DEFINITION	EXAMPLE
Privacy	Protecting individuals from being identified without their consent	When monitoring illegal deforestation near settlements using high-resolution satellite imagery, analysts might inadvertently capture private residences or human activity. Even if the aim is environmental enforcement, publishing or sharing such images without redaction or consent could violate privacy by revealing who was where, when, and doing what. To respect privacy, researchers should limit image resolution when unnecessary, anonymize sensitive areas, or redesign the analysis to avoid capturing identifiable features.
Non-stigmatization	Avoiding the labeling of individuals or communities in ways that could cause harm, reinforce sterotypes or contribute to social exclusion	When using EO data to detect illegal mining, researchers may label certain areas as "informal" or "illegal" based on visible activity patterns. If such labels are publicly shared or mapped over specific communities, they risk stigmatizing entire populations as lawbreakers or environmentally irresponsible. This can harm reputations, fuel discrimination, or invite punitive action without due process. To avoid this, analysts should use neutral, non-judgmental terms, such as "areas of unregulated extraction activity," and consider involving local stakeholders to contextualize findings responsibly.
Autonomy, freedom, and self-determination	Emphasizes the ethical obligation to respect individuals' and nations' rights to make decisions about their own lives, land, and governance.	Suppose international organizations use satellite data to identify and pressure a country to shut down informal gold mining operations in Indigenous territories. While well-intentioned, this action could disrupt local livelihoods and disregard the community's autonomy and historical land rights. Ethical EO practice would require engaging local stakeholders, respecting Indigenous governance structures, and ensuring that enforcement actions support the community's right to self-determination.

PRINCIPLE	DEFINITION	EXAMPLE
Data governance, ownership, and licensing	Considers the ethical and legal responsibility to manage data in ways that respect ownership rights, privacy, and consent.	Researchers using satellite imagery to detect illegal logging in a remote region and to publish results identifying specific land parcels may inadvertently expose private landowners or Indigenous groups to legal scrutiny or reputational harm without their consent or knowledge. If the imagery used includes commercially licensed data or if geotagged social media posts are integrated, failing to secure proper data rights or permissions could breach legal or ethical boundaries. To uphold ethical standards, researchers should ensure data licensing terms are followed, anonymize outputs, and engage communities when their land or livelihoods are implicated.
Honesty	Being transparent about data, methods, and model limitations.	In remote sensing applications to detect illegal logging, honesty requires scientists to clearly state the confidence levels of deforestation maps and avoid overstating the precision of their models. If researchers use training and test data from the same region without proper separation, they may report inflated accuracy. This could mislead enforcement agencies into acting on faulty predictions, potentially harming innocent communities or missing actual illegal activity. Being honest about such limitations ensures better decision-making and public trust.
Transparency	Clearly communicating how data are chosen, processed, and interpreted, and openly acknowledging the limitations and ambiguities of methods, models, and results.	In using satellite imagery to detect illegal mining, transparency requires researchers to explain how they define and identify mining activity, including the criteria used, the resolution of imagery, and the limitations of detection. For instance, if artisanal mining sites are small and often obscured by canopy cover, researchers must clarify this constraint so that authorities do not overestimate the accuracy of the findings or wrongly target communities based on incomplete evidence.

PRINCIPLE	DEFINITION	EXAMPLE
Explainability	Refers to the ability to make AI-driven decisions and outputs understandable, including how and why certain conclusions are reached, so that users and stakeholders can assess, trust, and challenge them when needed.	When satellite imagery is used to detect illegal, unreported, and unregulated (IUU) fishing, explainability is crucial to justify enforcement actions. For example, if an AI system flags a vessel as engaging in illegal fishing based on its movement patterns and absence from a registered fleet database, authorities must be able to explain how that conclusion was reached, such as the vessel's speed near marine protected areas or lack of an Automatic Identification System (AIS) signal.
Data veracity	Refers to the accuracy, reliability, and contextual appropriateness of data used in AI and remote sensing analyses.	In designing algorithms to detect illegal fishing, data veracity is essential. If a model is trained on vessel movement patterns from one region and applied to another with very different fishing practices, the results may misidentify legal activity as illegal. Poor-quality or misinterpreted training data, such as inaccurate vessel labels or missing AIS signals, can lead to false positives, risking unjust enforcement actions against innocent fishers and undermining trust in the monitoring system.
Integrity	Means ensuring that AI and remote sensing systems perform as promised, delivering reliable, accurate, and robust results.	Tracking animal movements or human activity near protected areas using satellite imagery and remote sensing data can help detect illegal poaching. To ground this work in the principle of integrity, the system's developers must disclose any limitations, like reduced accuracy during dense vegetation cover or at night. This honesty helps prevent false alarms that could lead to wrongful enforcement actions and ensures that anti-poaching efforts are based on trustworthy and responsible data use.

PRINCIPLE	DEFINITION	EXAMPLE
Technical robustness and uncertainty	Emphasizes that systems using satellite or remote sensing data must reliably perform as claimed while openly acknowledging their limitations and uncertainties.	In detecting illegal logging, technical robustness means the system accurately identifies deforestation without frequent false positives from seasonal changes or cloud cover. Acknowledging uncertainty, researchers must inform authorities about possible errors, such as misclassification during heavy cloud seasons, so that enforcement actions are based on realistic confidence levels rather than absolute certainty.
Safety and security, including national security	Stresses that AI and satellite systems must operate safely and securely to prevent harm to people, wildlife, and the environment.	When using satellite imagery to track illegal maritime pollution, ensuring safety and security means protecting the location data of patrol boats and vulnerable marine areas to prevent sabotage or targeted attacks. Additionally, sensitive data about naval patrol routes should be carefully controlled to avoid exposing national security risks while enabling effective enforcement against environmental crimes.
Fairness	Means treating similar cases alike and recognizing when different treatment is justified.	When using satellite imagery to monitor illegal deforestation, fairness requires that surveillance and enforcement efforts cover both wealthy and poorer regions equitably. It also means supporting developing countries by providing access to relevant satellite data and tools to detect and combat environmental crimes, rather than concentrating resources only where countries can afford costly technologies. This ensures that environmental protections are just and inclusive globally.

PRINCIPLE	DEFINITION	EXAMPLE
Nonbias	Bias arises when training data lack diversity or reflect unfair stereotypes, leading to discriminatory or inaccurate results.	In monitoring illegal mining via satellite imagery, biased training data that mostly represent certain regions or socioeconomic groups might cause the AI system to misclassify similar activities in underrepresented areas, overlooking crimes or unfairly flagging innocent communities. To prevent this, training datasets must include diverse examples from different locations and social contexts, ensuring fair and accurate detection everywhere.
Non-discrimination and diversity	Biased data can also arise from cultural assumptions, selective data sources, and the uneven availability of data across different geographic and social contexts.	Satellite imagery and remote sensing can be used to detect and monitor illegal methane emissions from oil and gas infrastructure. However, if the training data and models primarily come from regions with well-documented, large-scale industrial facilities, often located in wealthier or more regulated countries, these models may underperform or misclassify emissions in less-studied regions such as rural areas in developing countries or informal extraction sites. This geographic bias can lead to discrimination by making pollution from certain regions or communities less visible or inaccurately assessed, potentially allowing illegal activities to go undetected in marginalized areas. Without transparent disclosure of dataset limitations and efforts to diversify data sources, enforcement efforts may unfairly address areas with better data representation, exacerbating injustice.
Sociocultural sensitivities	Require that satellite and remote sensing analyses account for local cultural and social contexts during data labeling and interpretation.	In detecting illegal deforestation, satellite imagery might misclassify community-managed forests in indigenous territories as degraded or illegally cleared if the model is trained without understanding local land use practices. Recognizing sociocultural contexts ensures that crime detection respects community rights and avoids false accusations based on cultural misunderstandings.

PRINCIPLE	DEFINITION	EXAMPLE
Democratic creation of standards	Developing data labels and analysis criteria through inclusive, multi-stakeholder collaboration.	When using satellite imagery to identify illegal mining sites, involving local communities, environmental experts, and government agencies in defining what constitutes illegal activity helps create fairer, more accurate labeling standards. This collaborative approach reduces the risk of mislabeling legitimate small-scale mining as illegal, preventing unfair targeting.
Responsibility	Developers and analysts must remain accountable for their actions and decisions, especially when using technology like AI and satellite data.	In monitoring illegal dumping sites using satellite imagery and AI, those responsible for the analysis must ensure that detection results are thoroughly validated before any legal or regulatory steps are taken. Automated alerts should be reviewed carefully to avoid falsely accusing landowners or communities, thus upholding accountability and respecting individuals' rights throughout the investigation process.
Human agency, oversight, and accountability	Help ensure AI and remote sensing systems are responsibly designed, interpreted, and applied.	In using satellite imagery to detect illegal dumping, human oversight is crucial to interpret AI-generated alerts within the local social and regulatory context. This helps avoid mislabeling sites or unfairly blaming landowners, ensuring that responses are fair, legally sound, and sensitive to community realities.
Human rights and the duty of care	Consideration for the human rights implications of analytical and investigative work.	When satellite imagery is used to detect illegal logging near Indigenous lands, researchers must be careful that their findings do not unintentionally expose these communities to surveillance or displacement. A duty of care means working transparently, protecting identities, and ensuring that the data is used to support and protect human rights.

PRINCIPLE	DEFINITION	EXAMPLE
Scientific, social, cultural, and environmental sustainability	Minimizing ecological harm from data practices, and ensuring that no aspect of sustainability, such as cultural diversity or community well-being, is sacrificed for another.	In detecting illegal sand mining using satellite imagery, researchers must ensure their models track environmental degradation while also considering the livelihoods of local communities who may depend on the land. Over-prioritizing environmental metrics without accounting for social and economic realities could lead to unjust crackdowns or displacement, undermining sustainability goals.

Appendix 3. Exercises Using the Ethical Opportunities Framework

STEP	ILLEGAL DEFORESTATION	ILLEGAL OCEAN POLLUTION
Step 1 Identify the research goal and application.	Leverage EO technologies to detect, monitor, and analyze illegal forest clearing for cattle ranching in tropical forests. Support interventions aligned with SDG 3 (climate action), SDG 15 (life on land), and SDG 16 (peace, justice, and strong institutions).	Use EO and AI to detect and monitor illegal ocean pollution by artisanal fisheries (e.g., dumping waste, fuel leakage, plastic disposal, use of banned gear causing ecosystem damage). Support interventions aligned with SDG 9 (industry, innovation, and infrastructure), SDG 14 (life below water), and SDG 16 (peace, justice, and strong institutions).
Step 2 Recognize ethical issues, risks, and dilemmas.	**Non-stigmatization**: Publicly flagging certain areas as illegal ranching hotspots could stigmatize entire communities, some of whom may be unwitting participants or economically dependent. **Transparency**: Are the models and thresholds used to classify "deforestation" versus "natural clearing" disclosed and justified. Models may misclassify cleared areas due to fire, drought, or other natural causes as illegal clearing. **Sociocultural sensitivities**: Forests often overlap with Indigenous territories or lands used by smallholders with traditional rights.	**Sustainability**: Monitoring illegal activities (pollution) vs. protecting the rights, dignity, and livelihood of artisanal fishers. **Responsibility and duty of care**: Risk of criminalizing communities dependent on fishing for survival; risk of enforcement policies rooted in top-down surveillance, lacking socio-ecological context. **Fairness**: Targeting small vessels could disproportionately impact the vulnerable while ignoring large industrial polluters. **Transparency**: Lack of transparency in labeling "illegal pollution" vs. natural oceanic features (e.g., algal blooms). Models might misclassify oil slicks, organic debris, or silt as pollution.

STEP	ILLEGAL DEFORESTATION	ILLEGAL OCEAN POLLUTION
Step 3 Acknowledge limitations of EO proxies and learn about ground realities.	NDVI change or loss of forest cover does not distinguish between legal vs illegal clearing, or between clearing by large agribusinesses vs subsistence users. Shadows, seasonal variation, and regrowth can mislead classification models. EO proxies lack contextual knowledge, such as land tenure status, enforcement gaps, local livelihoods.	Many artisanal fishers lack access to waste disposal infrastructure or knowledge about environmental risks. Pollution might stem from necessity rather than intent to harm. Local knowledge about sustainable practices may exist but be ignored in policy or AI system design. Some illegal practices may be culturally sanctioned or historically tolerated.
Step 4 Reframe the research question.	From "How can we detect illegal clearing?" to "How can AI4EO help promote forest protection while supporting equitable, lawful, and sustainable land use?"	From "How can we detect illegal ocean pollution by artisanal fishers?" to "How can AI4EO support pollution reduction while protecting artisanal fishers' livelihoods and promoting sustainable ocean governance?"
Step 5 Propose alternative, purpose-driven approaches.	Multi-tier classification: Distinguish between industrial-scale clearing, smallholder activities, and natural forest loss. Probabilistic alerts with human review: Prioritize interpretability and look for opportunities for local validation. Community-based ground truthing: Involve Indigenous and forest-dwelling peoples to validate model assumptions and outputs. License-aware mapping: Integrate known legal land tenure data to distinguish legal from illegal land-use change.	Multi-source fusion models: Combine EO data with vessel tracking, meteorological data, and fisher interviews to differentiate pollution sources. Capacity-building tools: Use AI4EO outputs to inform local training programs on pollution prevention, such as safe gear disposal or spill prevention. Create simple dashboards showing pollution hotspots, causes, and advice. Incentivize sustainable practices: Blockchain-based reward systems for clean fishing behavior or community-led monitoring initiatives.

STEP	ILLEGAL DEFORESTATION	ILLEGAL OCEAN POLLUTION
Step 6 Advocate for ethical data practices and inclusive validation.	Design participatory data governance mechanisms: Involve forest communities in setting thresholds, labels, and use cases; ensure informed consent when monitoring Indigenous lands. Licensing and data ownership: Work with national space and forestry agencies to determine who has access and rights to interpret EO data. Integrate citizen science and local data sources, such as deforestation alerts from community monitors or NGOs.	Short-term: Identify marine areas under greatest ecological pressure and prioritize educational outreach; develop low-bandwidth tools for coastal communities to engage with EO data. Long-term: Integrate fisher knowledge into model design and validation; develop co-monitoring platforms with participatory data labeling by fishers; collaborate with marine conservation NGOs to co-design training, data sharing protocols, and early-warning systems.
Step 7 Link insights to broader social justice and environmental governance.	Identify corporate supply chain actors linked to illegal clearing, not just proximate land users. Expose land tenure inequalities: Who gets criminalized for land use and who benefits from land clearance? Highlight enforcement gaps and policy contradictions, such as subsidies for cattle farming vs climate commitments.	Partner with marine biologists, coastal law experts, sociologists or anthropologists with expertise in artisanal fisheries, and local fisher associations and cooperatives. Conduct co-design workshops to understand traditional knowledge of ocean health, community perceptions of pollution and accountability, and what constitutes “fair” monitoring to them.

STEP	ILLEGAL DEFORESTATION	ILLEGAL OCEAN POLLUTION
Step 8 Design ethical data governance and oversight.	Support local land rights formalization: Help identify areas where smallholders can be granted legal tenure. Inform restoration and reforestation priorities. Enable environmental justice mapping: Where are the burdens of forest loss falling, and where are the benefits flowing? Encourage adaptive, democratic policymaking using AI4EO outputs as a tool, not a verdict.	Informed consent protocols when tracking or using data from artisanal vessels. Data ownership agreements between coastal nations and international research entities. Ethics oversight boards involving local NGOs, scientists, and fishers to approve model use and intervention deployment.
Step 9 Ensure explainability and transparency.	Develop educational programs and participatory AI design labs in tropical forest countries. Promote AI ethics exchanges between forest-rich countries and AI research hubs.	Make models explainable: Why was a pollution event flagged? What data contributed to the judgment? Train local actors to interpret model outputs and provide feedback. Publish methodologies openly to promote trust and enable peer review.
Step 10 Engage multi-disciplinary and local perspectives throughout, monitoring social and environmental outcomes.	Collaborate with environmental scientists and ecologists, forest governance and land tenure experts, legal scholars on environmental and Indigenous rights, local NGOs, forest communities, and affected land users. Treat them not just as informants but co-researchers and co-designers of AI systems.	Track whether EO-driven monitoring improves environmental health, whether fishers' incomes or access to fishing grounds are affected, and if community trust in monitoring improves. Develop indicators of social educational uptake and participation in sustainable practices.

Erasmus School of History, Culture and Communication

Declaration Page: Use of Generative AI Tools in Thesis

Student Information
Name: Cora Martin
Student ID: 720023
Course Name: Master Thesis CM5000
Supervisor Name: Daniel Trottier
Date: 26/6/2025

Declaration:

Acknowledgment of Generative AI Tools
I acknowledge that I am aware of the existence and functionality of generative artificial intelligence (AI) tools, which are capable of producing content such as text, images, and other creative works autonomously.

GenAI use would include, but not limited to:

- Generated content (e.g., ChatGPT, Quillbot) limited strictly to content that is not assessed (e.g., thesis title).
- ~~Writing improvements, including~~ grammar and spelling corrections (e.g., Grammarly)
- Language translation (e.g., DeepL), without generative AI alterations/improvements.
- Research task assistance (e.g., finding survey scales, qualitative coding verification, debugging code)
- Using GenAI as a search engine tool to find academic articles or books (e.g.,

☐ I declare that I have used generative AI tools, specifically [Microsoft Teams automatic transcription service during interview recording] in the process of creating parts or components of my thesis. The purpose of using these tools was to aid in generating content or assisting with specific aspects of thesis work.

Extent of AI Usage
☐ I confirm that while I utilized generative AI tools to aid in content creation, the majority of the intellectual effort, creative input, and decision-making involved in completing the thesis were undertaken by me. I have enclosed the prompts/logging of the GenAI tool use in an appendix.

Ethical and Academic Integrity
☐ I understand the ethical implications and academic integrity concerns related to the use of AI tools in coursework. I assure that the AI-generated content

☒ I declare that I have NOT used any generative AI tools and that the assignment concerned is my original work.

Signature: Cora Martin
Date of Signature: 26/6/2025

was used responsibly, and any content derived from these tools has been appropriately cited and attributed according to the guidelines provided by the instructor and the course. I have taken necessary steps to distinguish between my original work and the AI-generated contributions. Any direct quotations, paraphrased content, or other forms of AI-generated material have been properly referenced in accordance with academic conventions.

By signing this declaration, I affirm that this declaration is accurate and truthful. I take full responsibility for the integrity of my assignment and am prepared to discuss and explain the role of generative AI tools in my creative process if required by the instructor or the Examination Board. I further affirm that I have used generative AI tools in accordance with ethical standards and academic integrity expectations.

Signature: Cora Martin
Date of Signature: 26/6/2025