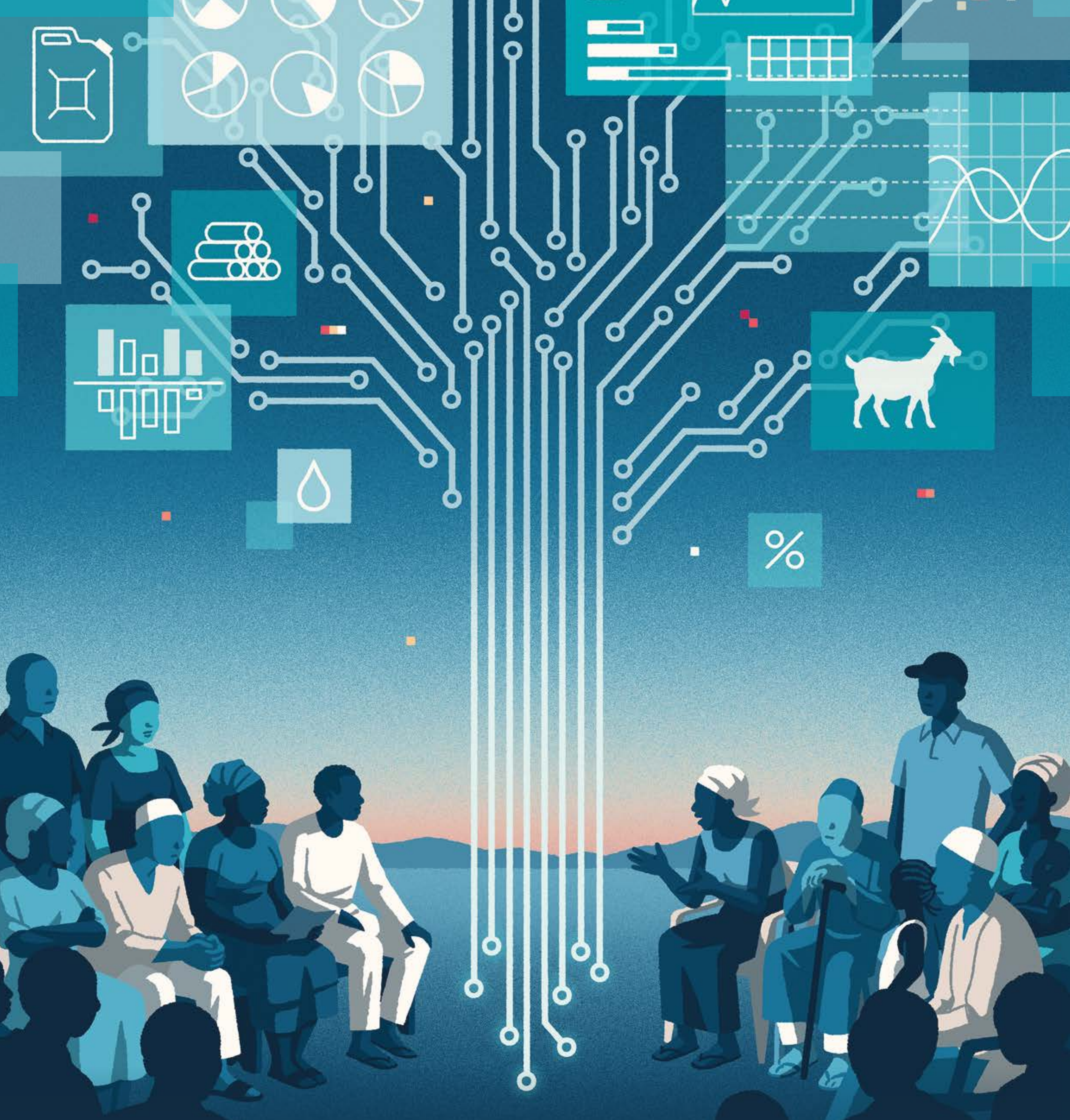

Digital Technologies for Environmental Peacebuilding

HORIZON SCANNING OF OPPORTUNITIES & RISKS

UN environment programme | environmental PEACEBUILDING

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LIST OF ACRONYMS

ACLED	Armed Conflict Location and Event Data
AI	Artificial Intelligence
AU	African Union
CEOBS	Conflict and Environment Observatory
CC	Cloud Computing
DL	Deep Learning
DPKO	United Nations Department of Peacekeeping Operations (now DPO)
DPO	United Nations Department of Peace Operations
DPPA	United Nations Department of Political and Peacebuilding Affairs
DRC	Danish Refugee Council
EC	European Commission
EEAS	European External Action Service
EWEAS	Early Warning Early Action System
FIG	International Federation of Surveyors
GCRI	Global Conflict Risk Index
GIS	Geographic Information System
GPS	Global Positioning System
HD	Centre for Humanitarian Dialogue
IBM	International Business Machines Corporation
ICT	Information and Communication Technology
IOT	Internet of Things
ML	Machine Learning
MSF	Médecins Sans Frontières
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
OECD	Organization for Economic Co-operation and Development
OHCHR	Office of the High Commissioner for Human Rights
OSCE	Organization for Security and Co-operation in Europe
PAX	PAX for Peace
PES	Payment for Ecosystem Services
SDI	Spatial Data Infrastructure
SIWI	Stockholm International Water Institute
UCDP	Uppsala Conflict Data Program
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children’s Emergency Fund
UNVMC	United Nations Verification Mission in Colombia
WFP	World Food Programme
WHO	World Health Organization
WPS	Water, Peace, and Security (partnership)

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FOREWORD

GOLESTAN (SALLY) RADWAN,
Chief Digital Officer of the United Nations Environment Programme

The accelerating deployment of digital technologies, much like previous revolutions in human history, holds the potential to fundamentally transform our world. Frontier technologies such as the Internet of Things (IoT), big data, and artificial intelligence (AI) offer groundbreaking capabilities to address the triple planetary crises of climate change, biodiversity loss, and pollution. However, it is crucial to acknowledge that the irresponsible use of these technologies could paradoxically hasten consumption, compromise environmental security, and potentially give rise to new, unforeseen crises and conflicts.

In response to this critical juncture, the United Nations Environment Programme (UNEP) and the Environmental Peacebuilding Association (EnPAx) have collaborated to conduct a survey of digital technology applications within the field of environmental peacebuilding. This initiative aims to comprehensively scan both the opportunities and risks that these technologies present across the peace and security continuum.

This review aligns with broader efforts by the UN system to understand and harness digital technologies in support of the Sustainable Development Goals (SDGs), including the protection of human rights and the maintenance of international peace and security. The numerous integral connections between digital technologies and the various pillars of the UN's work were underscored in the Declaration commemorating the seventy-fifth anniversary of the United Nations, which highlights both the transformative impact and the challenges posed by these technologies:

Digital technologies have profoundly transformed society. They offer unprecedented opportunities and new challenges. When improperly or maliciously used, they can fuel divisions within and between countries, increase insecurity, undermine human rights, and exacerbate inequality. Shaping a shared vision on digital cooperation and a digital future that show the full potential for beneficial technology usage, and addressing digital trust and security, must continue to be a priority as our world is now more than ever relying on digital tools for connectivity and social-economic prosperity. Digital technologies have a potential to accelerate the realization of the 2030 Agenda. We must ensure safe and affordable digital access for all. The United Nations can provide a platform for all stakeholders to participate in such deliberations." [1]

Against this policy background, this report specifically delves into how digital technologies can be harnessed to manage environmental and natural resource risks that contribute to insecurity and social conflict, as well as the opportunities they present for peacebuilding, cooperation, and social cohesion. We examine relevant use cases spanning the peace and security continuum and conclude with a set of important policy and governance recommendations. The report is designed to inform and contribute to significant upcoming frameworks addressing digital technologies, including the Summit of the Future and the Global Digital Compact, among others.

Our aspiration is that this report will serve as a catalyst for the establishment of a dedicated framework for the responsible and ethical use of digital technologies in environmental peacebuilding. The goal is to ensure that these technologies are deployed in a manner that respects, protects, and advances our collective environmental and peacebuilding objectives.

G. Radwan

EXECUTIVE SUMMARY

Peaceful and healthy environments are prerequisites for sustainable development, but in many regions of the world, the devastating impacts of armed conflict, unsustainable resource exploitation and climate change are intensifying the degradation of our environments and contributing to fragility, instability, and insecurity.

In response to these challenges, the field of environmental peacebuilding has evolved as a holistic and multidisciplinary approach, addressing the crucial role of the environment and natural resources in preventing, mitigating, resolving, and recovering from conflicts. This field promotes social cohesion, healthy ecosystems, and resilient environments through sustainable management of natural resources, effective environmental governance, and proactive climate change adaptation measures.

A key objective of environmental peacebuilding is to manage the environment and natural resources in a manner that fosters peace and trust among individuals and groups. This is achieved by creating inclusive platforms for engagement, facilitating dialogue, encouraging collaboration, and fostering mutual benefits. Through these efforts, environmental peacebuilding seeks to transform environmental risks into opportunities for cooperation and peace, thereby contributing to a more stable and sustainable future.

While digital technologies are increasingly used in environmental peacebuilding a comprehensive analysis exploring both the opportunities and risks these technologies present across the peace and security continuum has yet to be conducted. Prior research has delved into the application of digital technologies within humanitarian operations,[2] mediation,[3] and broader peace and security.[4] However, there is a notable gap in understanding how these technologies specifically intersect with conflict risks and peacebuilding opportunities related to environment, natural resources, and climate change.

In light of this gap, the primary objective of this report is to explore a pivotal question: **What are the potential opportunities and risks for communities, governments, international actors, and other stakeholders in harnessing digital technologies for environmental peacebuilding?**

To answer this question, this report uses a **horizon-scanning approach that compiles 17 case studies of digital technologies already in use** by environmental peacebuilding practitioners at different stages of the peace and security continuum, with the aim of providing a nuanced understanding and guiding strategic decision making in this increasingly important intersection of digital technology and environmental peacebuilding.

Five key overarching findings emerge from the report's efforts to identify and examine the core outcomes that digital technologies can enable in the field of environmental peacebuilding:

FINDING 1

BENEFIT-SHARING TRANSPARENCY

The use of digital technologies in tracking, displaying, and communicating the benefits from natural resources significantly enhances transparency and equity in resource-sharing provisions connected to peace agreements. Blockchain and other digital ledger technologies are particularly effective, providing a secure and immutable record of transactions and agreements that is crucial in contexts where power imbalances might otherwise lead to mistrust in the execution of these arrangements, and offering an unprecedented level of traceability to conflict resources such as diamonds, oil, gas, cocoa, and timber. This level of transparency ensures that all parties have access to the same information, reducing the likelihood of disputes and fostering a sense of fairness and collaboration. Additionally, these technologies can be used to create accessible and user-friendly dashboards, offering real-time insights into resource extraction, production, and revenue generation and use. By ensuring that all stakeholders have a clear and shared understanding of how benefits are being distributed, digital technologies can play a crucial role in building and maintaining trust across divided groups, an essential component of any successful environmental peacebuilding effort.

FINDING 2

ENHANCED RESOURCE MANAGEMENT AND ENVIRONMENTAL MONITORING

Digital tools, including blockchain and digital product passports, provide sophisticated means to track and trace commodities, which can be particularly beneficial in situations where illegal and illicit resource exploitation has fueled conflict or served to finance armed groups. Earth observation and remote sensing enable automated monitoring of resources, aiding in the detection of illegal extraction, pollution, or degradation. Blockchain offer an unprecedented level of traceability to conflict resources such as timber, cocoa, gold, and diamonds, reducing their environmental impact, breaking the link with illicit operations, and increasing consumer awareness of the ecological and social impact of purchases. Mobile technologies can support local economies by providing access to market information, facilitating financial transactions with fewer middlemen, and enabling micro-entrepreneurship related to natural resources or payment for ecosystem services. Digital technologies such as drones, AI-driven image analysis, and sensor networks can play a crucial role in tracking environmental degradation, increasing pollution, biodiversity loss, and climate impact assessments, providing key information to prioritize action to strengthen implementation of standards, enhance environmental governance, and begin adaptation projects. This is crucial in fragile and conflict-affected situations where less resilient communities and governments may be more vulnerable to conflict and instability linked to environmental degradation. Overall, digital technologies can also support spatial data infrastructures (SDIs) that can help digitally document and manage natural resource and land tenure rights, empowering communities to make informed decisions about natural resource management. This can particularly benefit marginalized groups, including women.

FINDING 3

INCLUSIVE DECISION MAKING AND COLLABORATION

Digital technologies can help include additional stakeholders within decision making, mediation, and dispute resolution processes about natural resources and the environment, thereby addressing historic marginalization and exclusion and making agreements more resilient to future climate realities. They can also help improve the transparency of the processes and underpin collaboration around key outcomes, such as the joint monitoring and implementation of environmental provisions of peace agreements. Digital tools can also facilitate more transparent and equitable participation by offering various channels for input and feedback, accommodating different communication preferences and capabilities, allowing easy access to and understanding of environmental and climate data reducing the need for technical skills. That said, digital environments cannot fully replace face-to-face contact; contacts and relationships must often first happen in an in-person manner before they can be transferred into a digital realm. Process design is fundamental. Tools such as community mapping and participatory GIS enable communities to contribute to and benefit from resource mapping and planning, fostering a sense of ownership and empowerment. This is particularly important in fragile and conflict-affected situations, where local involvement is key to sustainable management and conflict resolution.

FINDING 4
CAPACITY BUILDING

Digital technologies significantly enhance capacity building for environmental peacebuilding by providing access to a wealth of training materials, good practices, and knowledge-sharing platforms. Utilization of e-learning tools and online courses enables various parties—including local communities, government officials, and NGO staff—to gain crucial skills and knowledge in resource management, conflict resolution, and environmental governance. Mobile technologies, in particular, can be instrumental in reaching broader audiences, making educational resources accessible even in remote or underserved areas. This approach helps bridge the gap created by a lack of traditional educational resources and ensures that all stakeholders, regardless of their location or background, can contribute effectively to peacebuilding efforts, especially regarding the natural resources upon which their livelihoods and food security depend. Furthermore, digital platforms facilitate the sharing of experiences and lessons learned from various contexts, fostering a global community of practice, and encouraging the informed adoption of innovative and effective strategies in environmental peacebuilding, particularly among women and youth, enabling them to actively participate in environmental peacebuilding initiatives.

FINDING 5
OBJECTIVE INFORMATION AND ANALYSIS

Digital technologies, using Earth observation systems and other remote sensing technologies, offer broad access to objective environmental data, helping to level the playing field among various stakeholders. This inclusiveness in information access is crucial for informed decision making, counteracting misinformation, and distrust regarding natural resource data. Integrating multiple data types such as armed conflict events, availability of natural resources and climate projections enhances complex analysis, modeling, and forecasting of natural resource-related conflicts also facilitates a more comprehensive and data-driven understanding of potential scenarios, shared risks, and potential solutions, including prioritization for preventive diplomacy and climate security programming. Data analytics and simulation models can help shape policy decisions related to natural resource governance; for example, hydrological modeling of rivers shared by countries in conflict can help find entry points for mediation and cooperation. Moreover, these technologies are key in generating early warnings about escalating risks related to natural resources or impending hazards and disasters that could incite tensions. Blending these digital insights with traditional knowledge is important, ensuring that technology complements, rather than replaces, local expertise and ownership.

At the same time, **five risks** are identified in the review that need to be addressed in the application of digital technologies for environmental peacebuilding:

RISK 1
TOP-DOWN IMPLEMENTATION

The application of digital technologies in environmental peacebuilding often follows a top-down approach, neglecting user needs and lacking human-centered design. Such an approach, without involving local stakeholders and end-users in the co-design process, can lead to unintended negative consequences, reduced ownership, and unsustainable adoption by local communities. Practitioners must remember that digital technologies are tools to facilitate broader outcomes and should not be seen as goals or ends in themselves. Emphasizing a participatory and conflict-sensitive approach that engages local communities in technology design and implementation is crucial for sustainable and effective use of these tools.

RISK 2
OVERRELIANCE ON DIGITAL TECHNOLOGIES

Excessive dependence on digital technology in natural resource management and peacebuilding can sideline local capacities, traditional knowledge systems, and trust-building processes that are critical for sustainable resource management in fragile and conflict-affected situations. Overreliance on digital technologies can result in technology dependency, marginalizing and overshadowing local dispute resolution mechanisms and traditional knowledge, particularly from women, who often hold valuable knowledge about natural resource management, and who may be sidelined in decision making processes dominated by technology-driven solutions. In areas with underdeveloped or unreliable technological infrastructure, this dependency risks significant disruptions if these systems fail. Additionally, focusing too heavily on digital solutions can shift attention away from underlying sociopolitical issues integral to resource conflicts. Integrating digital and traditional (often, in-person) approaches and acknowledging the value of local knowledge and practices are essential for holistic and sustainable resource management.

RISK 3
DATA SECURITY, PRIVACY, AND BIAS CHALLENGES

The integration of digital technologies in natural resource management, environmental mediation, and climate adaptation introduces significant data security, privacy, and bias risks, especially in fragile and conflict-affected states with weak or absent regulatory frameworks. Technologies such as remote sensing and big data analytics necessitate handling sensitive data from geological information to community resource ownership and usage. Inadequately protected, this data is prone to breaches and misuse, endangering community privacy and security. The unauthorized access or manipulation of data in areas with existing resource conflicts and sociopolitical tensions can aggravate conflicts, encourage resource capture and illegal exploitation, or lead to targeted violence. Women and other marginalized groups may be at greater risk of exploitation or misuse of their personal information, exacerbating existing vulnerabilities. Therefore, implementing robust data protection measures and respecting community privacy rights are paramount. Considering potential sources of bias in the collection, processing, and interpretation of data is also fundamental.

RISK 4
AMPLIFICATION OF MISINFORMATION

Digital technologies can inadvertently amplify misinformation about natural resources, conflict, and peace, potentially driving new tensions and conflicts. In fragile situations with volatile information ecosystems, misinformation can distort public perception of resource management, environmental damages of war or disasters, potentially increasing tensions and instability. Examples include baseless rumors about resource scarcity or exploitation, which can trigger competition or violence, and misinterpretation of complex algorithms used for conflict forecasting, which could lead to faulty interventions. Weak governance and low public trust in institutions compound the issue, challenging effective and equitable resource management, joint environmental protection action, and peaceful climate adaptation which require trust between actors. Strategies to combat misinformation and enhance information literacy are essential in these contexts, and especially so at the national level, where coordination between groups is essential to peacefully address environmental and climate crises.

RISK 5
DIGITAL DIVIDE AND LITERACY GAPS

In fragile and conflict-affected situations, the digital divide and a lack of digital literacy often hinder the widespread use of digital technologies in environmental peacebuilding. With only about 32 percent of the population in these countries having Internet access, compared to 70 percent in stable states, the gap in basic technological infrastructure and Internet accessibility limits the use of digital technologies. Additionally, digital literacy often mirrors the rural-urban, gender, and socio-economic divides, potentially exacerbating existing inequalities. Women, in particular, may face barriers such as limited internet access, digital literacy, and control over digital assets, hindering their meaningful participation in environmental peacebuilding efforts. Environmental peacebuilding initiatives should incorporate non-digital alternatives to prevent the exclusion or marginalization of disconnected groups. Capacity building efforts need to prioritize reducing this digital divide, ensuring that digital literacy is an integral part of program design.

Based on these findings of the core opportunities and risks, the report presents **five recommendations** to better prepare the environmental peacebuilding community to access and deploy these technologies in a safer and more responsible manner. These recommendations have been conceptualized for all stakeholders, from local communities to governments, international practitioners and technology developers working in peace and security.

RECOMMENDATION 1
ADOPT A HUMAN-CENTERED, PARTICIPATORY, CONFLICT-SENSITIVE APPROACH

The deployment of digital technologies in environmental peacebuilding must be guided by a human-centered design philosophy, which actively involves local communities and stakeholders at every step, from the initial design phase to final implementation. This approach necessitates facilitating co-design and collaborative decision making processes, ensuring that the development and application of digital solutions are informed by local knowledge and needs, ensuring technically, culturally, and contextually relevant technologies. This should go hand in hand with the implementation of gender- and conflict-sensitive approaches to avoid unintended consequences such as potentially creating or exacerbating existing tensions and biases. These approaches involve thorough analysis of the conflict landscape and gender dynamics, continuous monitoring of the impact of technological interventions, and adaptive strategies that respond to evolving conflict dynamics. By integrating conflict sensitivity, practitioners can more effectively navigate the complexities of natural resource disputes, harnessing technology as a tool for peace rather than a catalyst for further conflict.

RECOMMENDATION 2

INTEGRATE DIGITAL AND TRADITIONAL KNOWLEDGE SYSTEMS

Effective environmental peacebuilding requires the integration of traditional knowledge systems and processes (often focused on in-person approaches) with digital technologies for a comprehensive strategy of managing natural resources, the environment, and the climate. This integration involves enabling policies that encourage mutual learning and knowledge exchange between digital technology experts and local community members. This integration can also help to reduce the impact of false positives associated with digital technologies. Ensuring that digital solutions complement rather than replace traditional practices is critical for achieving sustainable and culturally sensitive resource management strategies. This integration of modern technological advancements and traditional wisdom is essential for the long-term success and acceptance of environmental initiatives in fragile and conflict-affected situations.

RECOMMENDATION 3

ESTABLISH ROBUST DATA PROTECTION AND PRIVACY STANDARDS TOGETHER WITH SPATIAL DATA INFRASTRUCTURES

In fragile and conflict-affected situations, where data sensitivity is heightened due to potential conflicts and violence, establishing and enforcing effective data protection regulations is essential. Policies should focus on safeguarding sensitive environment and natural resource information gathered through digital technologies. Privacy-preserving measures, including data anonymization and secure data storage, must be implemented to protect the identities and data of local communities, especially in politically sensitive environments. This will not only ensure data security but also build trust among stakeholders about the use of digital technologies in resource management. Moreover, the development of spatial data infrastructures (SDIs) should be a parallel priority. These infrastructures are pivotal for the digital documentation and management of natural resource and land tenure rights, offering a structured approach to organizing and accessing spatial data. By supporting national and local authorities in establishing comprehensive SDIs, the accurate and transparent management of land and resource data can be greatly enhanced. This not only aids in conflict resolution and informed decision making but also contributes to long-term stability and sustainable resource management.

RECOMMENDATION 4

COMBAT MISINFORMATION AND ENHANCE INFORMATION INTEGRITY

With the risk of misinformation being amplified through digital means, it is imperative to develop initiatives aimed at combating misinformation and promoting digital information literacy linked to natural resources. This includes establishing fact-checking services and conducting public awareness campaigns. Collaboration with local media, civil society, and educational institutions is vital to disseminate accurate and reliable information about natural resources and environmental concerns. Such efforts are key to maintaining a well-informed public discourse and making responsible decisions based on credible information.

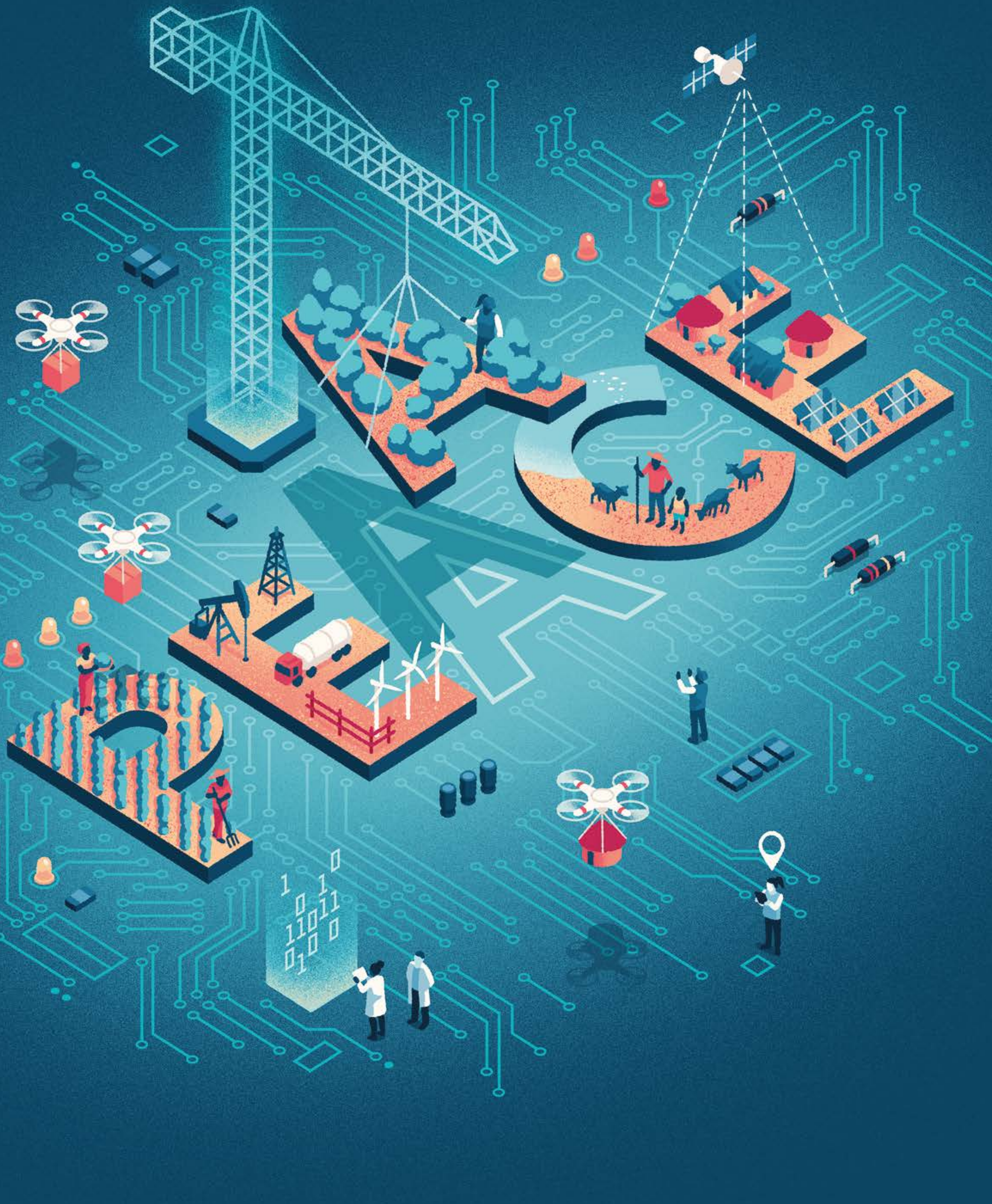
RECOMMENDATION 5

PROMOTE DIGITAL INCLUSION AND LITERACY OF NATURAL RESOURCE AND ENVIRONMENTAL MANAGEMENT STAKEHOLDERS

To effectively implement digital technologies in fragile and conflict-affected situations for natural resource and environmental management, it is crucial to prioritize policies that bridge the digital divide. This involves expanding access to technology and Internet connectivity, particularly in rural and underserved communities. Alongside improving access, digital literacy programs should be established, tailored to cater to diverse demographic groups with an appropriate gender lens. These programs should not only impart the technical skills needed to utilize digital technologies but also emphasize critical thinking skills essential for understanding and evaluating digital information. This approach ensures a more equitable and informed engagement with digital resources across all segments of society. In addition, it is necessary to develop digital infrastructure strategies that ensure resilience against technological disruptions and minimize their environmental footprint. Until the necessary capacities and infrastructure are in place, programs should use a mix of digital and non-digital implementation strategies on a case-by-case basis.

These policy recommendations are designed to guide environmental peacebuilding practitioners toward a responsible, inclusive, and effective deployment of digital technologies in the complex and sensitive context of natural resource and environmental management in fragile and conflict-affected situations.

A more structured process is essential, one that brings together environmental peacebuilding practitioners from various levels—from the local to the global—to actively shape future policies and direct research efforts. This collaborative process should facilitate open discussions about values, principles, best practices, and the risks associated with digital technology in environmental peacebuilding. It is also critical to catalyze the creation of robust safeguards, detailed guidance, and comprehensive training programs for the application of these technologies in the field. Such coordinated and intentional action is crucial for ensuring that digital technologies are applied judiciously and effectively in fragile and conflict-affected contexts, thereby preventing potential misuse and unforeseen negative impacts. The success of digital technologies in environmental peacebuilding hinges on collectively navigating the complexities and harnessing the transformative potential they offer for environmental peacebuilding.



CHAPTER 1

Introduction

Crises and conflicts that are driven (in whole or in part) by environmental security issues affect millions of people across the world and further degrade the environments and natural resources that we depend on. In addition, climate change is steadily threatening the capacity of people to manage ecosystems and sustain peace. The combination of extreme weather events, the decline in biodiversity, and increased pollution is affecting every dimension of our societies and exacerbating the sense of urgency to act for a more sustainable and peaceful future.

In response, environmental peacebuilding emerged as an integrated multi-disciplinary practice that addresses the role of natural resources and the environment in conflict prevention, mitigation, resolution, and recovery. It promotes healthy and resilient environments through sustainable natural resource management, inclusive environmental governance, and climate change adaptation practices. One of the overarching aims is to manage the environment and natural resources in ways that create opportunities to build peace and trust by creating spaces for engagement, dialogue, collaboration, and mutual benefits across political divides.

Environmental peacebuilding is going through a transformative moment as emerging digital technologies are now part of the response toolkit across all stages of the peace and security continuum. While the excitement for these technologies grows, many concerns are also being raised about their inherent risks and potential misuses.

1.1 REPORT OBJECTIVES AND METHOD

This report is an early attempt to identify, examine and systematize the applications of digital technologies in environmental peacebuilding. The core goal of the report is to better understand the opportunities and risks related to the application of digital technologies in building resilient societies and healthy environments in fragile and conflict-affected settings.

This report uses a horizon-scanning approach that compiles 17 case studies of digital technologies already in use by environmental peacebuilding practitioners at different stages of the peace and security continuum. These practical examples were submitted by communities, practitioners, researchers, and civil society organizations through an open call for contributions. These case studies were supplemented by a review of academic and gray literature to identify which other potential applications and use cases are envisaged and the risks associated with applying them.

Taking the peace and security continuum as its framework, the report focuses on how digital technologies can help address the risks and opportunities from natural resources and the environment at each stage of a conflict (FIGURE 1.1). Following this introduction, chapter 2 investigates opportunities to use digital technologies in early warning and early action systems for conflict prevention linked to natural resources and climate change. Chapter 3 assesses the use of digital technologies in preventive diplomacy to address rising tensions over shared natural resources. Chapter 4 reviews different applications for digital technologies in addressing benefit sharing provisions for natural resources as part of peacemaking, mediation, and other in-conflict processes. Chapter 5 analyzes the use of digital technologies in managing natural resource risks as part of peacekeeping, stabilization and humanitarian operations. Chapter 6 looks at how digital technologies can enable natural resources to contribute to post-conflict peacebuilding and sustainable development. Finally, chapter 7 examines the cross-cutting risks of data and digital technologies in conflict settings, while chapter 8 provides concluding remarks and policy recommendations.

While the report was conceptualized as a collaborative horizon-scanning process with a range of practitioners, two limitations should be pointed out.

First, the decision to structure digital technology applications using the peace and security continuum was beneficial for this report since authors could explore the ways technologies are used at precise stages of peace and security interventions. However, in many cases, digital technology applications are not restricted to a specific stage and are often used across the peace and security continuum.

A second limitation arises from the fact that the case studies outlined in the report may not represent an exhaustive list of digital technologies in use today. Many of the cases were collected through an open call for submissions in 2021-2022 and then updated in 2024. The goal of the open call was to compile case studies of digital technologies already in use with environmental peacebuilding objectives. This call was meant to be the first step in building an evidence base to better understand associated opportunities and risks. However, since 2023, new applications such as generative AI, including applications such as ChatGPT, have emerged and are not included in the report. This is a clear indication of how rapidly digital technologies are evolving and new applications are emerging in the field.

The speed of technological evolution shows no signs of slowing. The manifold digital technologies showcased in the report are yet to be robustly understood and applied to their full potential. Nonetheless, their application across the peace and security continuum has thus far been nothing short of ground-breaking. As digital technologies continue to evolve and provide a foundation from which future innovation will grow, communities, governments and practitioners should remain cognizant of their roles and impacts.

1.2 ENVIRONMENTAL PEACEBUILDING ACROSS THE PEACE AND SECURITY CONTINUUM

While there is no one-size-fits-all approach to environmental peacebuilding, the practice generally addresses how natural resources, environmental degradation and climate change interact with peace and security dynamics between divided groups. This complex interplay necessitates multifaceted programs and interventions that encompass seven key dimensions:

RESILIENT LIVELIHOODS AND NATURAL RESOURCE MANAGEMENT	This involves developing strategies that ensure sustainable use and management of natural resources, fostering livelihoods that are both resilient and environmentally sustainable.
SUSTAINABLE AND EQUITABLE BENEFIT SHARING OF NATURAL RESOURCES	It is crucial to establish frameworks that guarantee fair distribution of the benefits derived from natural resources, promoting transparency, equity, and sustainability.
COLLABORATIVE AND PARTICIPATORY ENVIRONMENTAL GOVERNANCE	Effective environmental governance requires inclusive and cooperative approaches, ensuring that all stakeholders have a say in how natural resources are managed and conserved. This includes a strong emphasis on enabling community-based natural resource management (CBNRM).
PREPAREDNESS AND RESPONSE FOR ENVIRONMENTAL SECURITY RISKS	This dimension focuses on anticipating and mitigating risks associated with environmental degradation, resource scarcity, or climate change which can trigger or exacerbate conflicts.
ENVIRONMENTAL COOPERATION FOR DIALOGUE, TRUST BUILDING, AND SOCIAL COHESION	Facilitating cooperative efforts around environmental issues can serve as a platform for dialogue, helping to build trust and foster social cohesion among conflicting groups.
CLIMATE CHANGE ADAPTATION FOR CONFLICT PREVENTION AND RESOLUTION	Recognizing the role of climate change in exacerbating conflict, this aspect involves developing strategies to adapt to climate impacts in ways that also contribute to conflict prevention and resolution.
EQUALIZING AND DEMOCRATIZING ENVIRONMENTAL INFORMATION	This aspect focuses on making objective and impartial environmental information accessible to all stakeholders to support data-driven decision making and to dispel misinformation or misperceptions that are driving grievances and disputes.

In addressing these dimensions, environmental peacebuilding seeks to create integrated solutions that not only preserve and enhance the natural environment but also foster peace and security in areas affected by conflict.

Across the peace and security continuum, the roles of natural resources, the environment, and climate change are multifaceted and can vary greatly depending on the context (FIGURE 1.1). While the six dimensions of environmental peacebuilding are adaptable to different stages of the continuum, specific issues tend to be prioritized at each stage:

EARLY WARNING

This stage involves the identification of escalating resource scarcity, emerging disputes over the sharing of resource benefits, or increasing disaster risks that hold the potential to provoke violence. It is critical to recognize and address these signs early to prevent the escalation of tensions.

PREVENTIVE DIPLOMACY

At this juncture, the focus is on proactively de-escalating tensions related to natural resources that could ignite violence between divided groups. Preventive diplomacy aims to intervene before these tensions transform into open conflict, seeking diplomatic solutions to diffuse potential disputes.

PEACEMAKING AND MEDIATION

This stage is centered on addressing the trust deficits that prevent agreements on resource exploitation and benefit sharing. It involves resolving contested information about natural resources and highlighting the mutual benefits that peace can bring, including the equitable sharing of these resources. In addition, natural resource management and climate change adaptation interventions may be included in peacemaking as a confidence building measure. This stage is crucial in transforming conflicting viewpoints into collaborative agreements.

PEACEKEEPING

Here, the emphasis is on identifying and addressing illegal resource exploitation by armed groups, which might finance ongoing conflicts. Additionally, this stage addresses maladaptive livelihoods that lead to resource degradation and focuses on the reintegration of ex-combatants through resource-based livelihood opportunities. Peacekeeping efforts are essential to stabilize regions and prevent the resurgence of conflict linked to natural resources.

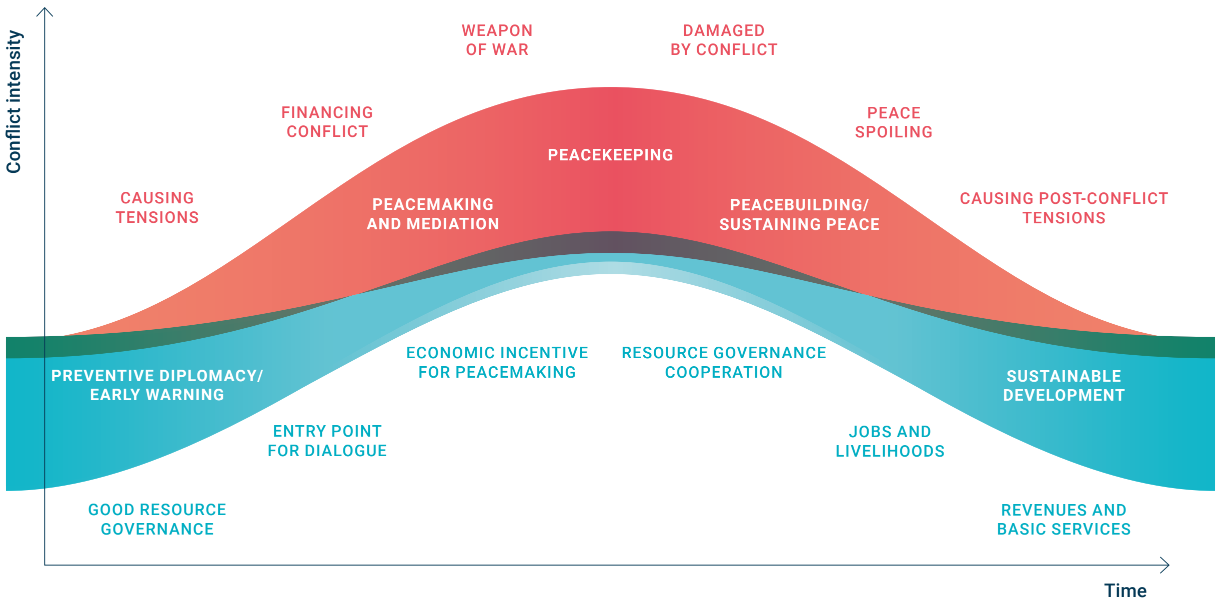
POST-CONFLICT PEACEBUILDING / SUSTAINING PEACE

This phase utilizes shared natural resources as a platform for confidence-building and cooperation between divided groups. It involves addressing environmental damage and health risks as measures to build trust and foster lasting peace. Sustainable peacebuilding efforts are vital in creating a stable and cooperative environment post-conflict.

SUSTAINABLE DEVELOPMENT

The goal at this stage is to ensure the sustainable management of natural resources and associated livelihoods, coupled with effective conflict management and dispute resolution mechanisms. This approach is integral to maintaining long-term peace and security, ensuring that development efforts do not reignite tensions but rather contribute to a lasting peace.

FIGURE 1.1: CONCEPTUALIZATION OF THE PEACE AND SECURITY CONTINUUM, ACCORDING TO CONFLICT INTENSITY AND TIME.



The figure showcases a simplified version of the role that the environment can have in conflict (IN RED TEXT) and contributing to peace (IN BLUE TEXT).

Source: UNEP and EnPAx 2016.

1.3 DIGITAL TECHNOLOGIES IN ENVIRONMENTAL PEACEBUILDING

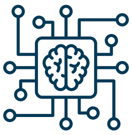
Among communities, governments, and practitioners applying environmental peacebuilding approaches across the peace and security continuum, **there is a growing recognition of the transformative potential of digital technologies in helping to achieve environmental peacebuilding goals.** These technologies present unprecedented opportunities to enhance environmental and resource management efforts in a manner that also fosters trust building and peaceful relationships. Digital tools such as remote sensing, GIS mapping, and blockchain offer new ways to monitor environmental changes, manage natural resources more effectively, and ensure transparent and equitable resource distribution. The use of big data and analytics can provide deeper insights into environmental trends and conflict dynamics, enabling more informed decision making and proactive conflict prevention strategies. Furthermore, digital platforms facilitate broader engagement and collaboration, allowing diverse stakeholders to participate in dialogue, share information, and build consensus.

By harnessing these technological advancements, environmental peacebuilding initiatives can not only address the immediate challenges of resource management in conflict-affected and fragile contexts but also lay the groundwork for long-term stability and sustainable resource management. The integration of digital technologies in this field is not just an innovation; it is a vital component in adapting to the changing nature of conflict and environmental governance, ensuring that peacebuilding efforts are as effective and inclusive as possible.

However, their application is not without risks and can, in some cases, inadvertently cause harm. A critical concern is the failure to integrate a conflict-sensitive approach when implementing these technologies in environments marked by fragility, mistrust and insecurity. Such oversight can significantly impede meaningful engagement and diminish the sense of ownership among local communities directly affected by conflict. Additionally, there is a risk that digital technologies might exacerbate the exclusion of already marginalized groups, further entrenching disparities and fostering mistrust between individuals, communities, and local governments.

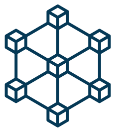
It is essential to recognize that digital technologies are tools to facilitate environmental peacebuilding outcomes, not goals in themselves. Their deployment should be strategically focused on addressing political challenges by breaking them down into manageable, technical components. In the optimal scenario, digital technologies can provide effective solutions to some of the underlying political tensions and surrounding natural resources and environmental issues, which fuel conflicts among divided groups. However, they are not a universal remedy. Prudent and context-sensitive application is key to ensuring that these technologies contribute positively to environmental peacebuilding efforts without unintentionally exacerbating existing tensions or creating new ones.

"Digital technologies" are used in this report as an umbrella term for hardware, software, data, approaches, and systems that harness the advances of digitalization, connectivity, and processing power. Since a vast number of digital technologies fall within this categorization, the list below presents commonly used digital technologies and related terms in environmental peacebuilding.



ARTIFICIAL INTELLIGENCE

The theory behind and the development of computer systems that can perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision making, translation, and interpretation.[5] Advanced artificial intelligence algorithms comprise many approaches, such as machine learning, deep learning, and natural-language processing. They are used in unsupervised and supervised learning, guided by data from existing information.[6]

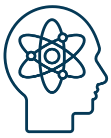


BLOCKCHAIN

Blockchain is software made up of records of digital transactions that are grouped together into "blocks" of information and shared securely across computers on a shared network. When a new block is added, it is connected or "chained" to the previous block, making it difficult to change past information. Digital currencies (e.g., bitcoin) are famous applications of blockchain technologies, but these technologies have promises that go beyond currencies or financial transactions.[7]

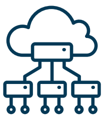
BIG DATA

High-volume, high-velocity, and/or high-variety information assets that demand cost-effective, innovative forms of information processing to enable enhanced insight, decision making, and automation. Deriving value from big data in predictive or user behavior analytics requires using digital technologies such as machine learning, cloud-based computing, high-volume spatial analysis, and decision-support systems or visualization tools such as dashboards.[8]



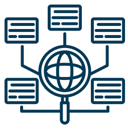
CITIZEN SCIENCE

Formulation of questions or hypotheses, generally associated with social or environmental challenges, which allows us to build knowledge outside traditional academic environments. What differentiates it is the participation of individuals and civil society organizations at some point in the scientific process. It is characterized by a rigorous methodology that people without formal scientific training may utilize.[9]



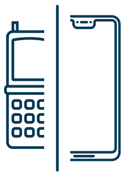
CLOUD COMPUTING

The practice of using a network of remote servers hosted on the Internet to store, manage, and process data, rather than a local server or a personal computer.[10]



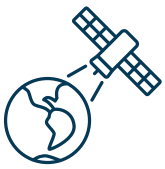
DECISION-SUPPORT SYSTEMS

A system that collects, organizes, and visualizes information to support decision making. It consists of data, a model, and a graphic user interface. Digital dashboards allow users to monitor different indicators over time and space, visualizing trends, measuring efficiencies, and producing reports. Geographic information systems (GIS) further allow advanced analyzes, which, for instance, are used in conflict analysis and environmental risk assessments. These outputs enable more informed decision making and provide contextual analysis of hazards, risks, vulnerability, and socio-economic information to support informed decision making.[11]



DIGITAL DIVIDE

The gap experienced by people who have access to digital technologies and possess digital literacy skills, and people who do not. Connectivity and literacy gaps persist along gender and rural/urban lines, especially in least developed countries.[12]

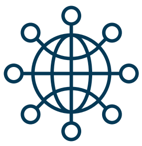


EARTH OBSERVATION

The collection of data and information about our planet, whether atmospheric, oceanic, or terrestrial. This includes space-based, remotely sensed data, unmanned aerial vehicles (UAVs), and drones, as well as ground-based sensors and in-situ data. Coordinated and open Earth observation enables decision makers worldwide to better understand the issues they face and shape more effective policies.[13]

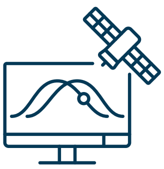
GEOSPATIAL DATA AND ANALYSIS

Geospatial data is data about objects, events, or phenomena that are located on the Earth's surface. Geospatial analysis describes the process of gathering, processing, and displaying geospatial data.[14]



INTERNET OF THINGS

The global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies.[15]



REMOTE SENSING

Remote sensing is the science of gathering data about objects or areas from a distance. It is a tool frequently used to obtain details about the Earth's surface from space, as data is gathered by detecting and measuring electromagnetic waves emitted, reflected or diffracted by the sensed object.[16]

As will be showcased in following chapters, these technologies can enable several environmental peacebuilding outcomes. However, it is essential to understand the context where these technologies are being deployed to mitigate potential risks.

CHAPTER 2

Early warning and early action

ASIM ZIA AND PANAGIOTIS D. OIKONOMOU • University of Vermont (UVM)

2.1 INTRODUCTION

Early warning and early action systems (EWEAS) provide critical information to anticipate and prevent crises before they occur. Effectively designed EWEAS are integrated with institutional mechanisms at multiple levels of governance to mitigate the impacts of hazards and build resilience against disasters and conflicts.[17]

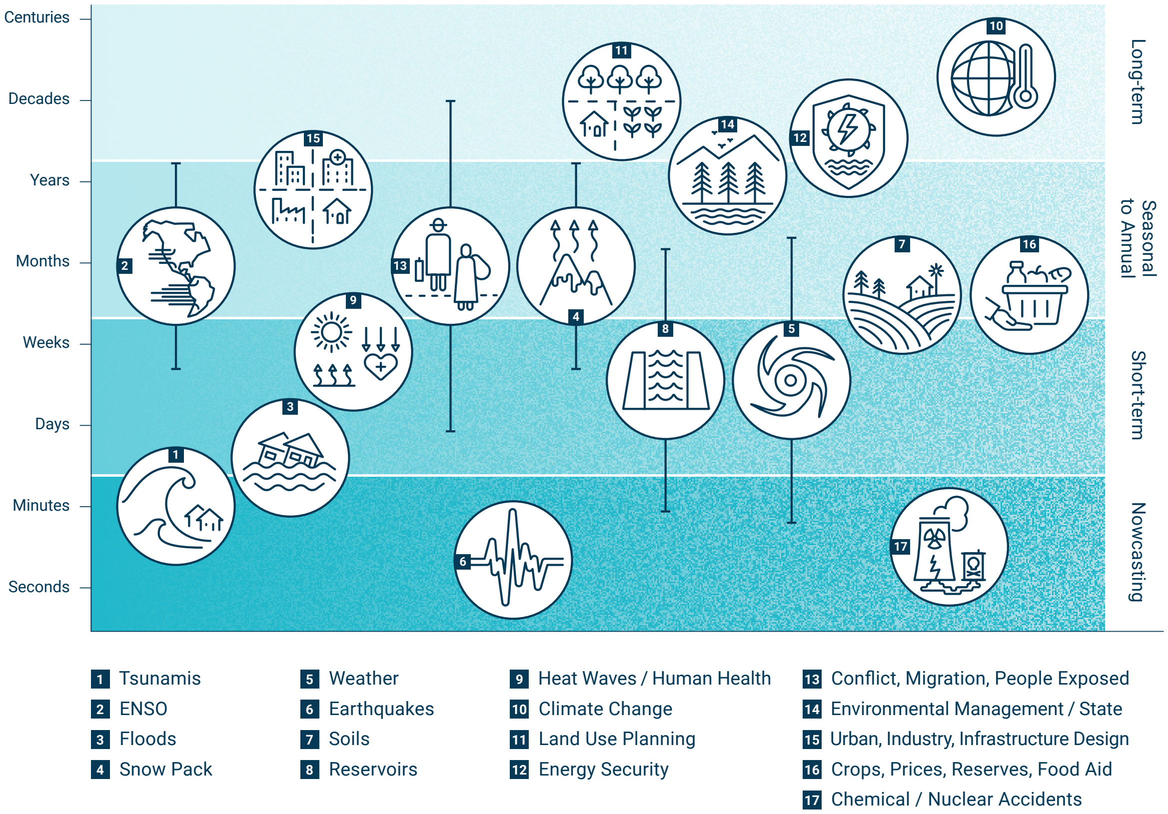
The development and deployment of EWEAS are intrinsically related to the advances in digital technologies, a link recognized by the Sendai Framework for Disaster Risk Reduction 2015–2030, the global policy guiding disaster risk reduction. It advocates harnessing digital technologies and data to design and establish the next-generation EWEAS with a people- and community-centric approach.[18] Recognizing the potential benefits, in 2022 the UN Secretary-General also called for every person on Earth to be protected by early warning systems within five years by 2027 (known as the Early Warnings for All Initiative).[19]

The first-generation EWEAS focused primarily on communicating early warnings, with varying levels of forecast accuracy. They have been deployed for a variety of natural hazards, including sudden-onset disasters such as earthquakes[20] and tsunamis in the South China Sea[21] and the Indian Ocean,[22] landslides,[23] and flooding from rivers and tsunamis,[24] as well as for more gradual processes like drought,[25] famine,[26] and even malaria transmission driven by climate variability.[27] First-generation systems often focused on natural hazards, which are easier to predict compared to violent conflict.

Second-generation EWEAS aim to identify and mitigate the impacts of hazards and conflicts on a multitude of temporal and spatial scales using a variety of heterogeneous datasets. The temporal scales, or early warning lead times, may range from minutes in the case of earthquakes and tsunamis, to days in the case of conflicts and human migrations, and at times months or even years in the case of famine and drought (FIGURE 2.1). The spatial scales may range from a few communities to entire countries and continents and vary significantly depending on the coarseness of the early warning spatial resolution.[28]

It is worth mentioning that there is value in using EWEAS across the entire peace and security continuum. The use of EWEAS can serve as a joint platform for disaster and conflict management[29] and, if embedded in planning and development processes, it can enhance sustainable development.[30]

FIGURE 2.1: ILLUSTRATION OF DIFFERENT LEAD TIMES IN DIFFERENT TYPES OF EARLY WARNING AND EARLY ACTION SYSTEMS.



Source: Design based on Basher 2006: 2171; McGregor et al. 2015; Lowe et al. 2016; Wang et al. 2018.[31]

2.2 USE CASES

The transformative power of digital technologies in shaping next-generation EWEAS is becoming increasingly evident. These advanced systems play a crucial role in enabling stakeholders, decision makers, and institutions to rapidly gather and interpret data, facilitating timely and effective responses to both natural and human-induced disasters, as well as conflicts over natural resources. The advent of near real-time or real-time operational applications significantly bolsters the capacity for swift decision making, a critical factor in mitigating the impacts of disasters and conflicts.

Particularly noteworthy is the integration of artificial intelligence (AI) technologies in the design of EWEAS. These systems, characterized by high spatial and temporal resolution, are not only automated but also capable of self-learning and enhancing forecast accuracy through the continual cross-validation of forecast data against actual hazard or conflict monitoring data. This evolution marks a significant leap in predictive capabilities, providing more accurate, reliable, and actionable insights.

Furthermore, the ability of digital technologies to design EWEAS for multiple hazards and conflict types is instrumental in addressing systemic risks to socio-ecological systems. These risks are omnipresent, affecting both developed and developing countries, albeit with varying degrees of impact. For vulnerable communities, especially in regions plagued by poverty and economic challenges, natural hazards like prolonged drought and desertification can have devastating consequences, especially among women, children and the elderly, often escalating into humanitarian crises or conflicts over scarce resources. The identification and management of such multi-hazard systemic risks through next-generation EWEAS, underpinned by AI and other digital innovations, offer a promising pathway to mitigate these challenges in the short to medium term.

Our horizon scanning process revealed four use cases where EWEAS are being used across the peace and security continuum, focusing on drivers of migration, displacement, or conflict linked to the environment, natural resources, or climate change.

The first is the Groundswell Project, an initiative that exemplifies the power of big data and complex modeling in forecasting long-term migration trends. This CASE STUDY 2.1, illustrates how integrating development and climate data can provide insightful predictions on migration patterns. The Groundswell Project stands as a testament to the ability of digital technologies to analyze and predict large-scale societal shifts resulting from environmental and climate dynamics.

CASE STUDY 2.2 explores the Foresight System. This innovative system demonstrates the integration and modeling of heterogeneous data sets to produce vital short-term forecasts on forced displacement. The Foresight System's approach highlights the adaptability and precision of digital technologies in responding to immediate humanitarian crises, showcasing their critical role in rapid response scenarios.

CASE STUDY 2.3 introduces the Global Conflict Risk Index. This comprehensive tool calculates the risk of violent conflict in countries by analyzing 22 variables across diverse sectors including politics, security, society, economy, geography/environment, and demographics. The index provides a nuanced understanding of the structural conditions that can lead to conflict, emphasizing the multifaceted nature of conflict risk assessment.

Lastly, CASE STUDY 2.4 focuses on the Strata Platform, which supports users to identify and visualize climate-security hotspots by analyzing the convergence of climatic and environmental stresses with social-economic vulnerability and instability. Strata's methodology underscores the importance of multi-dimensional data analysis in understanding the complex interplay between climate change, environmental degradation, and peace and security issues.

Each of these case studies not only demonstrates the diverse capabilities of digital technologies in EWEAS but also underlines their significant impact across various stages of environmental peacebuilding.

Other chapters in this report also present tools that can be considered an EWEAS, in particular CASE STUDY 3.1 on the Water, Peace, and Security Partnership, which showcases how an EWEAS can be used as the basis for triggering preventive diplomacy interventions.

2.2.1 Forecasting migration and forced displacement

Modeling and anticipating migration and forced displacement represents a major use case for the design of EWEAS, especially since population flows are generally a result of conflict.[32] Early warning can be on the order of seconds, days, or weeks; in some instances, though, it can be years or decades. Forecasting migration and drivers of migration can provide long-term—sometimes, up to decades in advance—warning that can provide sufficient time to act.

Many initiatives have emerged to help anticipate migration and displacement drivers in an effort to better prepare and respond to these phenomena. While our horizon scan highlights the Groundswell Platform (CASE STUDY 2.1) and the Foresight System (CASE STUDY 2.2), additional use cases warrant attention:

→ **The MM4SIGHT model** which uses machine-learning to predict cross-border movements of people prompted by a multiplicity of factors, ranging from refugees fleeing persecution and conflict to victims of trafficking and people seeking better lives and opportunities.[33]

→ **The Africa Media Monitor (AMM).** The system was co-developed by the African Union (AU) and the Joint Research Centre of the European Commission to support the AU's Continental Early Warning System. It is an operational, automated information monitoring and analysis tool, which is able to scan online news sources, blogs, news wires, and social media.[34] AMM can read more than 40,000 articles per day and is used to produce the Africa News Brief and the Daily News Highlights, two news materials with a continental reach.[35] The information is used not only in the AU Situation Room to track live news, but also by AU decision makers and stakeholders, including regional economic communities.

→ **The interagency Famine Early Warning System Network (FEWS NET),** which is among the earliest programs dedicated to developing an EWEAS to support governments and humanitarian organizations in anticipating and preventing food security crises.[36]

CASE STUDY 2.1

GROUNDSWELL: PREPARING & ACTING FOR INTERNAL CLIMATE MIGRATION

KANTA KUMARI RIGAUD, VIVIANE CLEMENT • World Bank
BRYAN JONES • City University of New York (CUNY)
ALEX DE SHERBININ • Columbia University

In the face of escalating climate impacts and growing levels of distress-driven mobility, there is an urgent need to assess how climate change could affect large-scale migration in the coming decades in order to steer informed and evidence-based policy and planning.

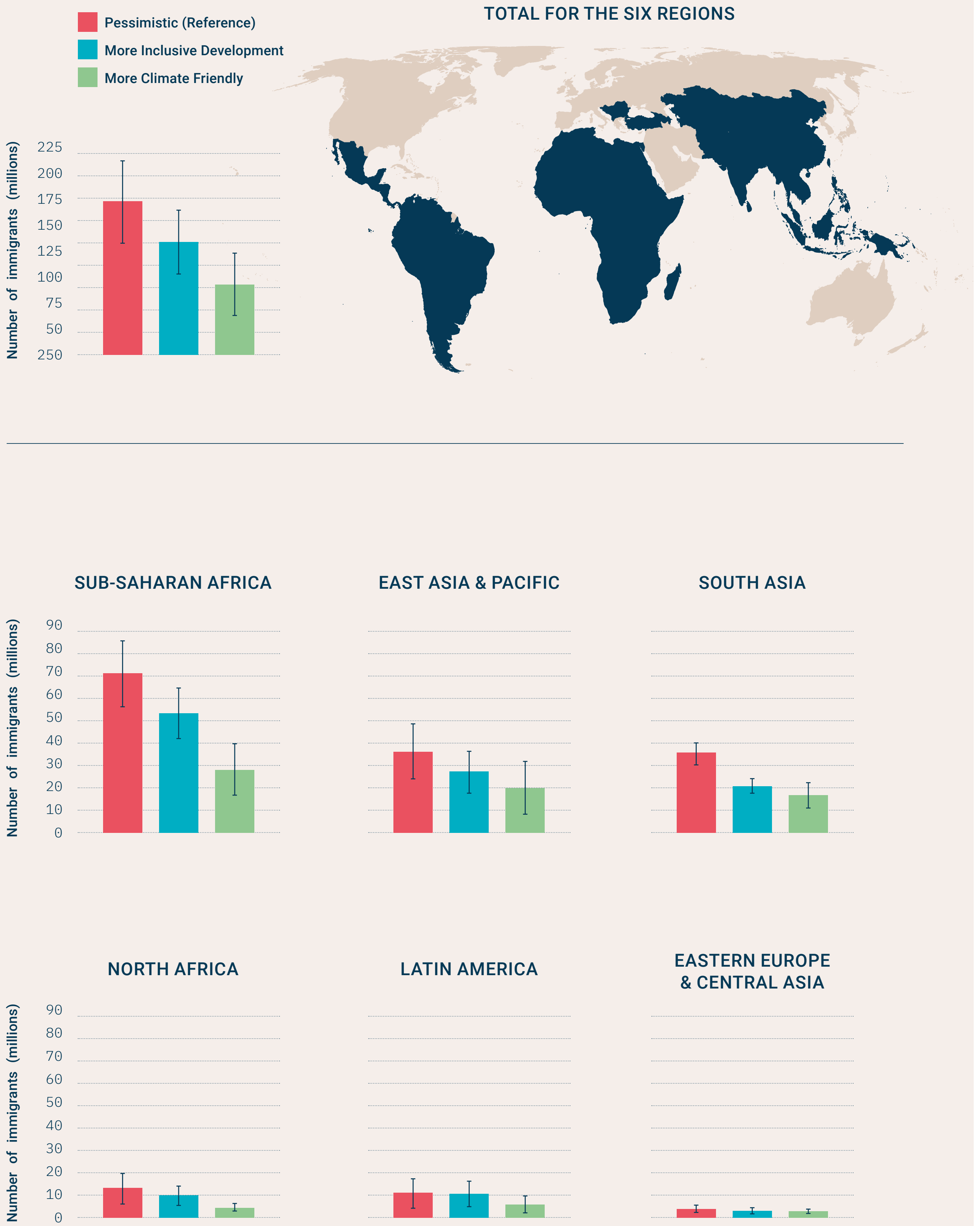
Governments and development actors can no longer assume that the evolution of population distribution and development activities targeting rural livelihoods and urban areas will remain linear in the face of climate change. Using a novel modeling approach, combining big data with tailored assessments, the World Bank developed a tool to help better respond to climate-driven migration through solutions that engender peace, stability, and security.

The World Bank's flagship report, *Groundswell: Preparing for Internal Climate Migration,* used a big data platform to set out for the first time the potency of climate change as a driver of internal migration in Sub-Saharan Africa, South Asia, and Latin America.[37] Climate in- and out-migration for the Middle East and North Africa, East Asia and the Pacific, and Eastern Europe and Central Asia was projected in a follow-up study that applied the same approach.[38] The Groundswell reports found that as many as 216 million people could be pushed to migrate within their own country by 2050 (FIGURE 2.2).

The analysis in the report found that the poorest and most climate-vulnerable areas will be the hardest hit. People will migrate more from areas with lower water availability and crop productivity and from areas affected by rising sea levels and storm surges. These trends, alongside the emergence of "hotspots" for climate migration, will have major implications for the poorest groups engaged in climate-sensitive sectors and will affect the adequacy of infrastructure and social support systems. While these trends are plausible outcomes, the scale of climate migration can be significantly reduced by pursuing global action on mitigation and inclusive, climate-resilient pathways within countries.

The Groundswell reports adopted a scenario-based approach and implemented a modified form of the gravity model to isolate the projected portion of future changes in the spatial population distribution that could be attributed to slow-onset climate factors up to 2050 (FIGURE 2.3). The gravity model used in Groundswell has the advantage of modeling at scale, over larger geographies, to illuminate the relative importance of push factors such as environmental or economic factors at the point of origin which influence the decision to migrate, versus pull factors. The full methodology is available in the appendices of the two Groundswell reports.

FIGURE 2.2: PROJECTED NUMBER OF CLIMATE MIGRANTS IN SIX REGIONS BY 2050, IN THREE DIFFERENT SCENARIOS.



Source: Adapted from World Bank 2021.

FIGURE 2.3: MODELING APPROACH TO ESTIMATE CLIMATE CHANGE-INDUCED INTERNAL MIGRATION.

MODELING INPUTS

Development pathways
Shared Socioeconomic Pathways (SSPs)—SSP2 (moderate development) and SSP4 (unequal development).

GHG emission pathways drive climate change impacts using ISIMIP water and crop model results, and sea level rise augmented by storm surge. Two Representative Concentration Pathways (RCPs) are used: RCP2.6 (low emissions) and RCP8.5 (high emissions).

PLAUSIBLE INTERNAL CLIMATE MIGRATION SCENARIOS UP TO 2050

PESSIMISTIC REFERENCE (RCP8.5/SSP4)

MORE INCLUSIVE DEVELOPMENT (RCP8.5/SSP4)

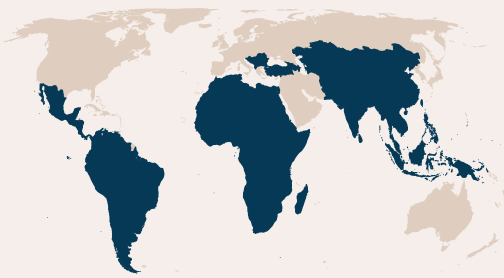
MORE CLIMATE-FRIENDLY (RCP8.5/SSP4)

GRAVITY MODEL

Accounts for demographic and socioeconomic (or development) trends, geographic factors and climate impacts applied at grid cell level for modeling shifts in population distribution at country level

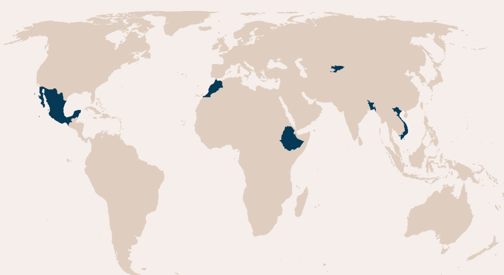
ESTIMATES OF INTERNAL CLIMATE MIGRANTS PRESENTED FOR SELECT REGIONS

Estimates of climate migrants derived by comparing grid-cell level population for each of the three "climate impact" scenarios with that of the "no climate impact" scenario (derived from the development only pathway i.e. SSP2, SSP4). The positive difference across all grid cells is aggregated to the national level (and then regional) to produce the estimated number of climate migrants under each of the three scenarios.



SIX REGIONS WITH SUBREGIONAL FOCUS FOR DEEPER ANALYSIS:

→ **East Africa** (Sub-Saharan Africa)
→ **Lower Mekong** (East and Asia and the Pacific)
→ **South Asia**
→ **North Africa** (Middle East and North Africa)
→ **Mexico** and **Central America** (Latin America)
→ **Central Asia** (Eastern Europe and Central Asia)



SIX ILLUSTRATIVE COUNTRY EXAMPLES FOR DEEPER NARRATIVE:

→ **Ethiopia** (Sub-Saharan Africa)
→ **Vietnam** (East and Asia and the Pacific)
→ **Bangladesh** (South Asia)
→ **Morocco** (Middle East and North Africa)
→ **Mexico** (Latin America)
→ **Kyrgyz Republic** (Eastern Europe and Central Asia)

Source: Adapted from World Bank 2021.

CASE STUDY 2.2

FORESIGHT — AN AI SYSTEM FOR FORECASTING THE FUTURE OF DISPLACEMENT

RANA NOVACK • IBM
BO SCHWARTZ MADSEN AND ALEXANDER KJÆRUM • Danish Refugee Council (DRC)

The United Nations High Commissioner for Refugees (UNHCR) reported in 2023 that at least 108.44 million people had been forced to flee their homes due to persecution, conflict, violence, human rights violations, or events significantly impacting public order.[39]

Effectively responding to growing displacement and humanitarian needs is made more complicated by limited humanitarian funding. As such, innovative solutions are needed to ensure a more efficient response based on prioritization of potential risks and impacts. With more accurate predictions and better evidence for scenario-building, humanitarian action can be improved, resulting in enhanced outcomes for people affected by displacement.

While displacement is known to be an inherently complex phenomenon, signals, metrics, and indicators can be monitored and analyzed to better understand the various drivers of a displacement crisis and the relations between them.

The Foresight System is an artificial intelligence application that provides long-term forecasts on forced displacement volumes as well as a causal analysis of displacement drivers. The system is cloud-based and open source, leveraging machine learning and advanced predictive analytics to forecast displacement. It facilitates data-driven decision making to improve the operational efficiency and impact of international humanitarian and development actors by providing a deeper understanding of displacement dynamics through:

- **The integration of digital technology with displacement knowledge:** causal models blend expert opinion and reliable, trusted data, and provide deeper insights into the drivers, trends, and signals that lead to a displacement crisis. It informs the operational, resource, and policy decisions of practitioners.

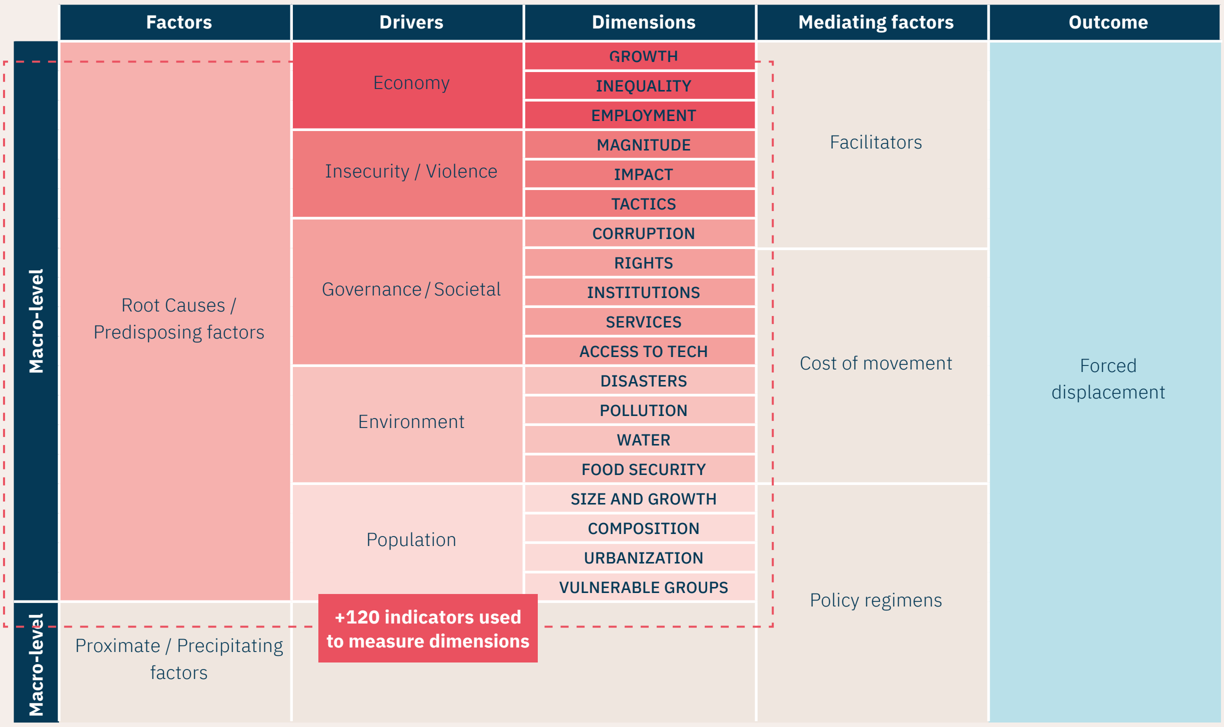
- **Accurate and valid displacement volumes and timing forecasts** based on correlates of historic indicators with displacement volumes. More accurate displacement predictions contribute to improved operations, as actors can respond early to cover humanitarian needs and support actions on displacement.

- **Custom scenario analysis and visualization** assess the impact of evolving conditions, evaluate alternative courses of action, and determine potential events and the outcomes of policy decisions. In turn, this enhances the situational awareness and decision making competency of practitioners.

Developed in partnership by IBM and the Danish Refugee Council, the Foresight System uses open data from 18 sources to predict the forced displacement of internally displaced persons and refugees, covering 26 countries and accounting for 87 percent of all global displacement. With a high degree of accuracy, the model can estimate the cumulative number of forcibly displaced people between one and three years into the future.

The Foresight model is based on a theoretical framework that focuses on the root causes or macro-level drivers of displacement and aggregates over 120 indicators from 18 open-source data sets (FIGURE 2.4). The different dimensions and associated indicators have been grouped into five categories: economy, security, governance, environment, and population.[40] The environmental indicators include disasters, pollution, water, and food security.

FIGURE 2.4: OVER 120 INDICATORS OF DIFFERENT DRIVERS ARE COMBINED TO GENERATE DISPLACEMENT FORECASTS IN TERMS OF VOLUME AND TIMELINE.

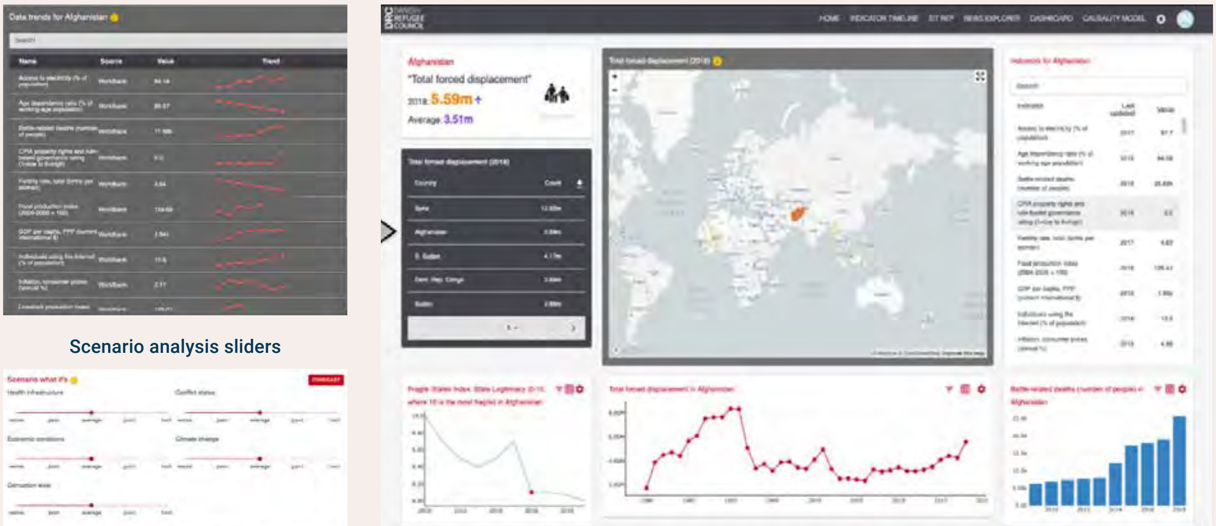


Source: IBM and DRC 2022.

The technology behind the Foresight System combines machine-learning models that leverage several constituent models to generate independent forecasts, which are then aggregated. Ensemble modeling detects changes when any combination of indicators changes, and the resulting displacement forecast is generated. The system also employs a "what if" scenario analysis capability, which allows practitioners to manipulate indicators to assess the impact of evolving conditions and determine the outcome of events and policy decisions before their implementation (FIGURE 2.5).

Implementing advanced predictive analytics and AI-driven forecasting solutions combined with integrated, quality data is critical in providing access to actionable intelligence and enhanced outcomes for the world's most vulnerable populations. The Foresight System demonstrates the value in applications of machine learning across the peace and security continuum. It confirms that adopting a forward-thinking and proactive approach should be a first step in supporting displaced populations globally in the digital age. Using the scenario analysis feature, peacebuilding practitioners working in high-displacement contexts can incorporate this technology to get a better understanding of the potential consequences of their interventions.

FIGURE 2.5: THE CUSTOM SCENARIO ANALYSIS ALLOWS USERS TO MODIFY INDICATORS AND PREVIEW THE POTENTIAL OUTCOMES OF A CRISIS AND DETERMINE ALTERNATIVE COURSES OF ACTION.



Source: IBM and DRC 2022.

2.2.2 Forecasting conflicts and security hotspots

Environmental degradation, climate change, and competition for natural resources, such as land and water, have historically played a significant role in contributing to violence and armed conflict.[41, 42] A combination of different variables and interactions can be used to identify potential conflict drivers. Exclusion from services and economic opportunities also represent a central driver of conflict that can also be monitored through EWEAS.[43] Forecasting economic dependency on natural resources and predicting the impact of natural resource degradation or scarcity on livelihoods provides another mechanism to predict drivers of conflict.

Traditional conflict forecasting models have recently been overtaken by AI and big data models, which show improvements in overall accuracy. Yet, there are still outstanding challenges to reduce the false positive and false negative rates of conflict forecasts. In addition to the utilization of conditional logistic regression models,[44] traditional models have also deployed pattern classification algorithms such as Fuzzy Analysis of Statistical Evidence,[45] Bayesian Aggregation of multiple models,[46] ensembles of quantitative forecasting models,[47] and thresholds-based correlation algorithms.[48]

Our horizon scanning identified two important EWEAS use cases that are using new data science techniques and digital tools for policy support on conflict prevention linked to natural resources and climate change. These are the Global Conflict Risk Index (2.3) and the Strata platform (2.4).

An additional use case warranting attention is the Violence Early-Warning System (VIEWS)[49] project led by Uppsala University, which uses an ensemble of thematic models as well as statistical and machine-learning approaches to predict conflict at the national and sub-national levels with a monthly temporal resolution. Input data sets cover a range of environmental variables capturing climate extremes and societal vulnerability to climate hazards and other external shocks, including climate extreme indices, reliance on agriculture, crop yields, precipitation, freshwater withdrawal, water management efficiency, and access to renewable resources.

CASE STUDY 2.3
THE GLOBAL CONFLICT RISK INDEX

European Commission's Joint Research Centre (JRC)

The Global Conflict Risk Index (GCRI)[50] is the quantitative starting point of the European Union's conflict Early Warning System (EWS),[51] first developed in 2014 by the European Commission's Joint Research Centre (JRC).[52] It has been updated and revised yearly, in line with the latest developments in the scientific literature. The GCRI is part of the JRC Disaster Risk Management Knowledge Centre,[53] launched in 2015, to respond to the emerging need for evidence-based decision making in disaster risk management and to develop and maintain tools for addressing risks related to human-made and natural hazards.

The current version of the GCRI model covers 22 variables that represent structural conditions associated with conflict risk in six areas: politics, security, society, economy, geography/environment, and demographics. The variables were selected following an extensive review of the scientific literature and consultations with experts and practitioners from the European External Action Service (EEAS) and the Service for Foreign Policy Instruments (FPI). The criteria used for variable selection are based on theoretical literature, empirical evidence, data availability, and predictive performance.

The GCRI uses historical data from 1991 to the present to train a statistical model that can estimate the average probability of a conflict and the likely intensity of violence over the next one to four years. The model distinguishes between the following three types of conflict: state-based conflict, non-state conflict, and one-sided violence.

The GCRI assesses each country's overall risk likelihood based on historical patterns and structural conditions and contributes to the EU's conflict EWS by providing systematic conflict risk estimates comparable over time and between countries. Monitoring structural causes helps the EEAS identify trends in violence and conflict onset and, consequently, be better prepared to swiftly mobilize its political, development, and crisis response tools.

These conflict risk assessments per country are probabilistic. Accordingly, countries with a high conflict risk do not inevitably face conflict, while some low-risk countries may still experience violence in the near future.

To provide the EU's conflict early warning system with greater risk accuracy, frequent updates, and finer spatial resolution, the JRC is developing the Dynamic Conflict Risk Model. This new model estimates conflict risk at the sub-national level for the continent of Africa over the next one to six months, focusing primarily on dynamic variables that reflect recent ground-level developments. For example, the model uses data on incidents such as riots and protests as well as geospatial data on droughts and other extreme weather events to understand the local impacts and security implications of climate change. In addition, the model tests various data sources and variables, together with advanced machine-learning methods, to improve its accuracy and predictive performance. Once the model performs reasonably well, the goal of the JRC is to expand it on a global scale and provide updated conflict risk forecasts on a monthly basis.

Intervening early in high-risk probability countries remains challenging when most of the attention is focused on responding to acute crises. However, data-driven insights allow policy makers to prioritize political engagement around important issues and not only urgent ones.

GCRI CONFLICT TYPES

The GCRI distinguishes between three types of conflict, as defined by the Uppsala Conflict Data Program (UCDP):

→ **State-based conflict:** Armed conflict between two or more organized groups, one of which represents a state government.
→ **Non-state conflict:** Armed conflict between two or more groups, neither of which is a state.
→ **One-sided violence:** Direct and deliberate killing of civilians, perpetrated by a government or armed group.

In addition, the GCRI estimates the risk of all three categories combined. Note that the GCRI focuses exclusively on **internal conflict** and therefore does not assess the risk of armed conflict between states, i.e. interstate conflict.

CASE STUDY 2.4
STRATA

SILJA HALLE AND CAMILLE RAHIER • United Nations Environment Programme (UNEP)
YHASMIN MENDES DE MOURA • Food and Agriculture Organization (FAO)

Across the globe, the impacts of climate change, environmental degradation, and the mismanagement of natural resources are undermining livelihoods and damaging essential infrastructure. In fragile or crisis-affected contexts, these impacts can exacerbate existing socio-economic risks, increasing competition over scarce resources, displacement, and conflict. At the same time, violent conflict and political instability can undermine climate change adaptation and the sustainable management of ecosystems, leaving vulnerable communities poorer, less resilient, and ill-equipped to cope with the effects of climate change.

Member states, the UN Security Council, the African Union, the EU, and civil society worldwide have called for improved analyses of environmental and climate-related risks to peace and stability to inform policy and programs in fragile and crisis-affected contexts. However, the capacity for data-driven assessments of converging complex risks has long remained in the hands of a limited set of experts.

The Strata platform—a joint initiative of UNEP and FAO within the framework of the EU-UNEP Climate Change, Environment and Security Partnership—aims to democratize the analysis of environmental and climate risks for peace by making such capacity available to practitioners and policy makers without prior technical know-how.

Strata is a web-based, open access, and free geospatial data platform to identify and track where environmental, climate, and security stresses converge with socio-economic vulnerabilities and instability. It requires no technical knowledge of GIS or data tools to generate actionable information for a range of assessments and analyses, policy and planning processes, and programming investments.

Using FAO's Earthmap technology and powered by Google Earth Engine (GEE), the app aggregates multiple environmental, climate, and socioeconomic indicators to map hotspots where different risks are converging. Strata, which currently covers 82 countries, uses 28 indicators to monitor climate-related peace and security stresses in three main pillars:

→ **Climate and environmental hazards,** including flooding, drought, land degradation, deforestation, and heatwaves;

→ **Peace and security,** including battles, remote violence, protests, riots, and violence against civilians; and

→ **Socio-economic exposure and vulnerability,** including population (female, elderly and children), irrigation, food insecurity, population growth, travel time to healthcare, and urban expansion.

The indicators are calculated from near real-time geospatial data streams that are continuously updated, primarily through cloud computing based on satellite imagery and derived datasets. Recognizing the need to tailor analytical outputs to local contexts, Strata's datasets and indicators are available at subnational spatial resolution (adm1) and lower granularity in most cases.

Strata aggregates the indicators into the hotspot map using the Convergence of Evidence methodology developed by the EU's Joint Research Centre. The data and results are open access with clearly annotated scripts of the algorithms through Google Earth Engine.

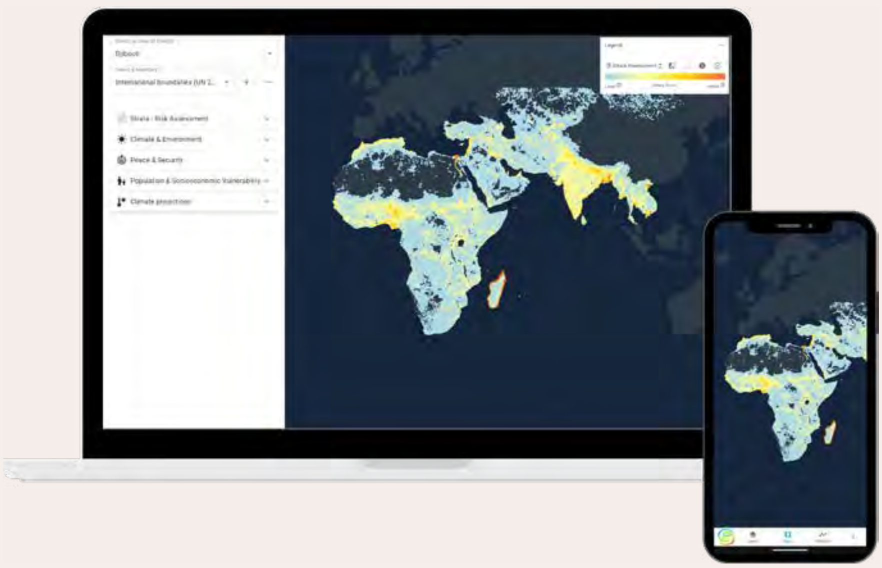
For each indicator, the STRATA methodology (FIGURE 2.6) uses a threshold to determine where conditions reach stress levels. These thresholds vary according to the indicator and are classified as: (i) Absolute thresholds, where a fixed value is set as a threshold that determines when particular stresses are experienced; this value is fixed across all locations; (ii) Thresholds relative to past conditions, where the threshold is set to flag conditions that are significantly different from historical conditions; and (iii) Thresholds relative to other locations: where data is only available at one point in time or is updated very infrequently, thresholds are set to flag the locations with the values corresponding to the highest level of stress or vulnerability across the selected area.

FIGURE 2.6: DESCRIPTION OF EACH STEP IN STRATA'S METHODOLOGY.

CLIMATE, ENVIRONMENT & SECURITY	POPULATION EXPOSURE	SOCIOECONOMIC VULNERABILITY
Threshold → Stressor Flag! Sum of stressors 0-n, where n = number of stressors	Log transformation population Re-scaled to 0-1, where 1 = higher population	Threshold → Stressor Flag! Sum of stressors +1 / total number of indicators+1

Through these 3 pillars Strata highlights areas where the indicators overlap and where they coincide with vulnerable populations

Strata Risk Assessment



Source: unepstrata.org

Users can use Strata to:

- → **Identify hotspots** where environmental vulnerabilities intersect with historical conflicts at local and national scales.
- → **Prioritize areas for intervention** through climate adaptation, natural resource management, and peacebuilding programs.
- → **Design conflict-sensitive interventions** that address environmental challenges while considering local social dynamics.
- → **Monitor and evaluate** the impact of interventions for adaptive management and informed decision making.

By leveraging Strata for analysis and decision making, users are better equipped to address complex challenges and promote resilience among vulnerable communities, countries, and regions.

2.3 RISKS AND CHALLENGES

With the rapid advancements and increasing accessibility of big data and AI technologies, next-generation EWEAS are continually enhancing their predictive capabilities. This progress opens up numerous possibilities to identify and provide early warnings on how environmental degradation, natural resources, and climate change are acting as drivers of conflict.

The effectiveness of current EWEAS is often constrained by the limited availability, interoperability, and spatial resolution of conflict and natural resource data. Many systems operate at a coarser resolution, relying on datasets that are more readily available, but less precise. This limitation hampers the accuracy and scale of risk analyses, affecting the identification of natural resource and climate-related security risks, maladapted livelihoods, and drivers of forced displacement. The integration of Earth observation data with diverse sources, such as social media and citizen science data, holds promise for enhancing the spatial and temporal resolution of future EWEAS.

Intellectual property ownership of key datasets and related AI models presents another challenge that needs addressing to advance these systems. Ethical standards must be established concerning the identification and targeting of at-risk audiences, as well as the communication of uncertainty and "explainability" inherent in AI-based early warning alerts.

Furthermore, there is a notable gap in systematic, evidence-based impact evaluations of EWEAS, particularly regarding their effectiveness in triggering rapid response mechanisms or preventive diplomacy.[54] Understanding how environmental, natural resource, or climate change drivers of conflict are detected against other conflict drivers is critical. Equally important is discerning which immediate interventions can effectively mitigate acute risks. Future iterations of EWEAS should not only facilitate the detection or forecasting of risks but also aid in identifying appropriate response measures for specific locations and conflict drivers.

More fundamentally, there are social and political risks associated with issuing early warning alerts. Publicly highlighting disaster or conflict risk can lead to capital flight or panicked livelihood responses in the forecasted areas, potentially exacerbating tensions. The credibility of EWEAS can be undermined by false alarms, leading to skepticism and a bias toward short-term investments in conflict-prone areas. Additionally, there is a risk that conflict parties might exploit early warning models for strategic gains, using them to catalyze preemptive actions that serve their objectives. Addressing these challenges requires a multifaceted approach, balancing technological advancement with ethical, social, and political considerations to ensure the responsible use of EWEAS in conflict and disaster-prone contexts.

2.4 CONCLUSIONS AND NEXT STEPS

As demonstrated in this chapter, people-centered, multi-hazard EWEAS could be essential tools with a substantial potential for monitoring conflict risks from environmental degradation, natural resources, and climate change across the peace and security continuum. The integration of big data and machine learning to forecast migration, forced displacement, and conflict is a significant stride forward, demonstrating the capabilities of these systems in combining multidimensional factors for more accurate predictions.

To further enhance the effectiveness and impact of EWEAS in addressing environmental, natural resource, and climate change drivers of conflict, three steps are crucial.

First, there is a need for improved modeling that comprehensively examines the interplay between natural resources, the environment, and climate with conflict dynamics. This modeling should be adaptable to local conditions, moving away from a "one size fits all" approach and towards solutions that can be tailored to the specific variables and circumstances of different regions.

Second, the communication of uncertainty and the "explainability" of AI models used in early warning reports are vital for their acceptance and understanding by policy makers and other users. Clear and transparent communication about the capabilities and limitations of these models is essential to build trust and ensure that users can make informed decisions based on early warning data.

Finally, strengthening the programmatic connections between early warning and early action is imperative. This involves not only predicting potential conflicts but also researching and implementing effective environmental solutions to mitigate rising tensions. More research and action are needed to translate early warnings into proactive measures that address the root causes of environmental conflicts.

While EWEAS have demonstrated potential in conflict prediction and prevention related to environmental factors, their future development hinges on more nuanced modeling, transparent communication, and a stronger link between early warning and early action. By addressing these areas, EWEAS can become even more powerful tools in the pursuit of peace and security in the face of environmental challenges.

CHAPTER 3

Preventive Diplomacy

MIRZA SADAQAT HUDA • ISEAS–Yusof Ishak Institute

3.1 INTRODUCTION

Preventive diplomacy, as conceptualized in the United Nations Millennium Declaration,[55] focuses on addressing the roots of disputes[56] before they can escalate to potentially violent conflict.[57] In the last decade, these strategies have been utilized to address political crises in Syria, Sudan, and Yemen with varying levels of success.[58] Diplomatic efforts, apart from being a critical tool for conflict prevention, can also be used in all other phases of the peace and security continuum.

In the realm of preventive diplomacy, the specialized areas of environmental and climate diplomacy have evolved in response to the growing recognition of environmental degradation and climate change as catalysts for tensions and conflicts between divided groups. These diplomatic interventions are designed to identify policy measures and field interventions aimed at preventing the destabilization of ecologically vulnerable states and communities. They focus on reducing tensions and disputes over natural resources.[59]

A key technique in this approach involves providing all parties with objective environmental information and analyzes. This helps to address information asymmetries and mistrust, and is crucial in preventing the spread of misinformation. By ensuring all parties have equal access to high-quality, accurate information, preventive diplomacy endeavors to "technicize" the problem. This often involves identifying low-stakes topics where agreements can be more easily reached, thus enabling cooperation and the building of confidence among the parties involved.

3.2 USE CASES

Our horizon scanning identified three use cases demonstrating how digital technologies can significantly inform and enhance preventive diplomatic processes, particularly those linked to the environment, natural resources, and climate change.

The first use case focuses on the application of digital technologies such as remote sensing and Earth observation to increase the quality and quantity of environment, natural resource, and climate data together with the identification of important conflict drivers. This data, originating from "objective sources," is often more reliable and trusted compared to data provided by conflict actors. When combined with data from citizen science and traditional knowledge, Earth observation data can also effectively clarify and validate claims about environmental damage, conflict risks, or illegal resource exploitation. CASE STUDY 3.1 focuses on the Water, Peace, and Security (WPS) partnership, which utilizes a machine learning methodology alongside big data to forecast water-related conflicts and support preventive diplomacy interventions.

Second, digital technologies can help parties in creating interactive data sets, graphs, and maps to visualize mutual dependencies on natural resources as well as shared economic opportunities and risks. This approach helps to build transparency in resource consumption and risks; and this transparency can be essential in informing and driving change. This can also provide both solid technical information to parties to inform their negotiating strategies as well as help the parties identify and model mutual benefits from cooperation over natural resources. CASE STUDY 3.2 highlights Borderscapes, a digital and dynamic atlas that facilitates visualization and cooperation on shared resources that transcend international borders.

The third use case highlights the role of digital communication technologies in broadening stakeholder engagement within a preventive diplomatic process. By incorporating a wider variety of groups with vested interests in conflict resolution, these technologies foster more inclusive and comprehensive environmental diplomacy.[60] CASE STUDY 3.3 focuses on increasing stakeholder engagement and inclusion in water diplomacy processes using digital approaches by the Stockholm International Water Institute (SIWI).

Additional use cases of interest involve digital technologies fostering economic interdependence among the conflicting parties. One such initiative by the Asian Development Bank involves implementing several cross-border electricity grids powered by renewable energy across politically volatile regions of Central and South Asia, serving as conduits for diplomacy, technical cooperation and economic integration.[61] Similarly, NGOs such as EcoPeace Middle East are working to establish water-renewable energy economic interdependence among Israel, Jordan, and Palestine.[62] This model proposes the production of fresh water through desalination on Israeli and Palestinian coasts, with the additional electricity requirements met through solar energy investments in Jordan's deserts. Here, digital technologies play a crucial enabling role in managing the exchange of resources and supporting the necessary technology grids.

These use cases underscore the diverse ways digital technologies can be leveraged to support preventive diplomacy, offering novel solutions and platforms for cooperation, conflict resolution, and peacebuilding linked to the environment, natural resources, and climate change.

3.2.1 Preventive diplomacy for water security

The landscape of environment and climate diplomacy is vast and intricate, encompassing a diverse array of actors who may be motivated to compete or collaborate on a wide range of environmental issues. These issues span from greenhouse gas mitigation to addressing challenges such as soil erosion and water pollution. However, the complexity of these efforts is heightened by the fact that environmental concerns often overlap with other national priorities, such as economic development and trade policies. Furthermore, environment and climate diplomacy efforts face the challenge of navigating through myopic defense-security perspectives, which often assert sovereign rights over shared natural resources such as transboundary rivers and forests. In this context, recent advancements in technology present promising avenues to address these multifaceted challenges.

As illustrated in the previous chapter, the integration of remote sensing with artificial intelligence plays a crucial role in generating early warning alerts for specific environmental issues. These alerts are instrumental in prompting preventive diplomatic actions to alleviate escalating tensions. Such analytical tools equip policy makers with vital insights into geographical areas and specific environmental issues that necessitate bilateral or multilateral cooperation to avert conflicts arising from natural resource disputes. CASE STUDY 3.1 on the Water, Peace, and Security Partnership showcases the use of early warning systems in driving preventive diplomacy linked to water conflicts. It demonstrates how stakeholders can be engaged proactively to address critical concerns like water security.

Photo: Wadi El Ku covers a 50 km stretch of the wadi, upstream and downstream of El Fasher, North Darfur. © Howard Bell/UN Environment Programme

CASE STUDY 3.1
THE WATER, PEACE, AND SECURITY PARTNERSHIP IN ACTION IN MALI

MIRZA SADAQAT HUDA • ISEAS–Yusof Ishak Institute

The lack of safe and adequate supplies of water poses significant challenges to socioeconomic development and human health. Currently, one-third of the world's population lives in areas with high levels of water stress and 50 million people are affected by droughts. In the future, water crises are likely to be exacerbated by population growth, urbanization, and the effects of climate change. Water insecurity is not only a threat to food production and livelihoods, it also creates societal tensions which can spill over into conflicts.

The Water, Peace, and Security (WPS) partnership was founded in 2018 to address increasing levels of water insecurity in multiple regions of the world. The WPS partnership analyzes water-related conflicts and undertakes advocacy and outreach efforts on mitigation mechanisms.[63]

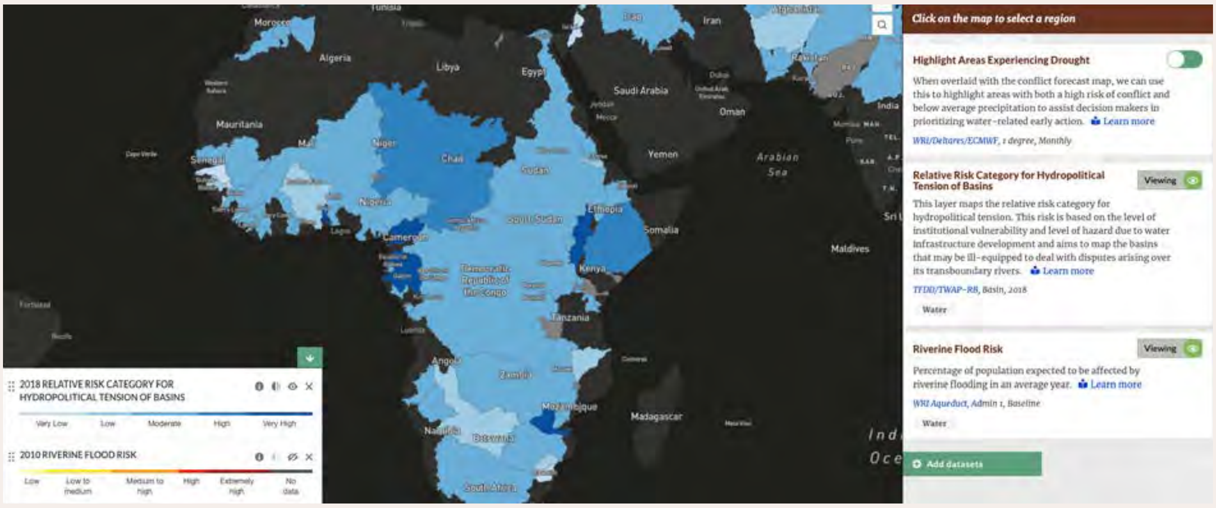
The WPS partnership uses cutting-edge technologies such as big data, artificial intelligence, remote sensing, and other tools to generate a data-driven understanding about the risks of water-related security threats. These technologies provide policy makers with warning signals and decision support tools that indicate both where and when risks are increasing, and how they might be addressed. The WPS uses a machine learning methodology to forecast water-driven conflict up to a year in advance using a random forest model. The forecasts are accessible via a digital map, which allows the user to examine conflicts instigated by multiple hydrological factors, such as floods, water pollution and seasonal variations (FIGURE 3.1).

The information generated by digital technologies is used by the WPS partnership to reach out to a broad range of stakeholders in governments, international organizations, and civil society to enhance their awareness and understanding of water-related security threats. This includes trainings and capacity development on mitigating current and future crises and facilitating dialogue on water cooperation and peacebuilding. Such workshops are preventive diplomacy in action on the basis of the risk analysis and early warning.

For example, in July 2019, WPS organized a training workshop for Malian stakeholders in Bamako (FIGURE 3.2) to build their capacity to use the information and models generated by WPS. The participants included experts from governmental organizations, such as the Niger River Basin Agency and the Directorate General of Civil Protection, as well as representatives of NGOs such as the Malian Red Cross. The focus of the workshop was water and security in the Inner Niger Delta, a fertile area which supports livelihoods of two million people. Through the insights provided by the WPS methods and tools, participants developed skills in conflict-sensitive planning and environmental cooperation and identified policy responses to the linkages between water scarcity and security in the Inner Niger Delta.

FIGURE 3.1: WATER, PEACE, AND SECURITY MAP SHOWCASING TRANSBOUNDARY RIVER BASINS

Relative hydro-political tensions in basins that may be ill-equipped to deal with disputes arising from the transboundary nature of rivers.



Source: WPS 2021.

FIGURE 3.2: WATER, PEACE, AND SECURITY ANALYSIS WITH MALIAN EXPERTS DURING WPS TRAINING IN 2019.

Source: WPS 2021.

3.2.2 Catalyzing transboundary resource management and cooperation

Territorial conflicts in many states have resulted in national policies emphasizing a defense and security approach to international borders, which often overlooks mutual dependence on shared transboundary natural resources and related environment and climate risks. Digital maps and interactive databases on transboundary natural resources can help shift perceptions of borders and encourage regional approaches to shared management of transboundary resources. If digital information on transnational resources is accessible to a wide variety of stakeholders, it can contribute to developing regional identities and to creating an understanding of shared ecological dependencies across national borders. CASE STUDY 3.2 highlights Borderscapes, a digital and dynamic atlas that facilitates visualization, analysis and cooperation on shared resources that transcend international borders.

CASE STUDY 3.2
BORDERSCAPES: A DIGITAL AND DYNAMIC ATLAS OF ECOLOGICAL COOPERATION FOR CYPRUS

ANNA GRICHTING SOLDER • University of Vermont Rubenstein School of Environment and Natural Resources

Borders and territorial disputes have been causes of violent conflict throughout history. There are more than 100 active territorial conflicts in the world and some of them have major environmental dimensions.

As a collaborative mapping tool to design ecological peace, Borderscapes is an interactive and dynamic atlas intended as a complex, map-based resource with ecological and cultural-based solutions offered for border areas impacted by conflict. The atlas seeks to offer a holistic approach, with an emphasis on environmental cooperation and bio-cultural diversity, and to mobilize these values in building trust and peace between opposing parties. It articulates best practices with potential approaches for cross-border ecological cooperation, including alternative maps of potential stabilization zones in areas of current uncertainty and conflict. It is also intended to connect bottom-up peacebuilding approaches with top-down and more conventional forms of multilateral diplomacy.

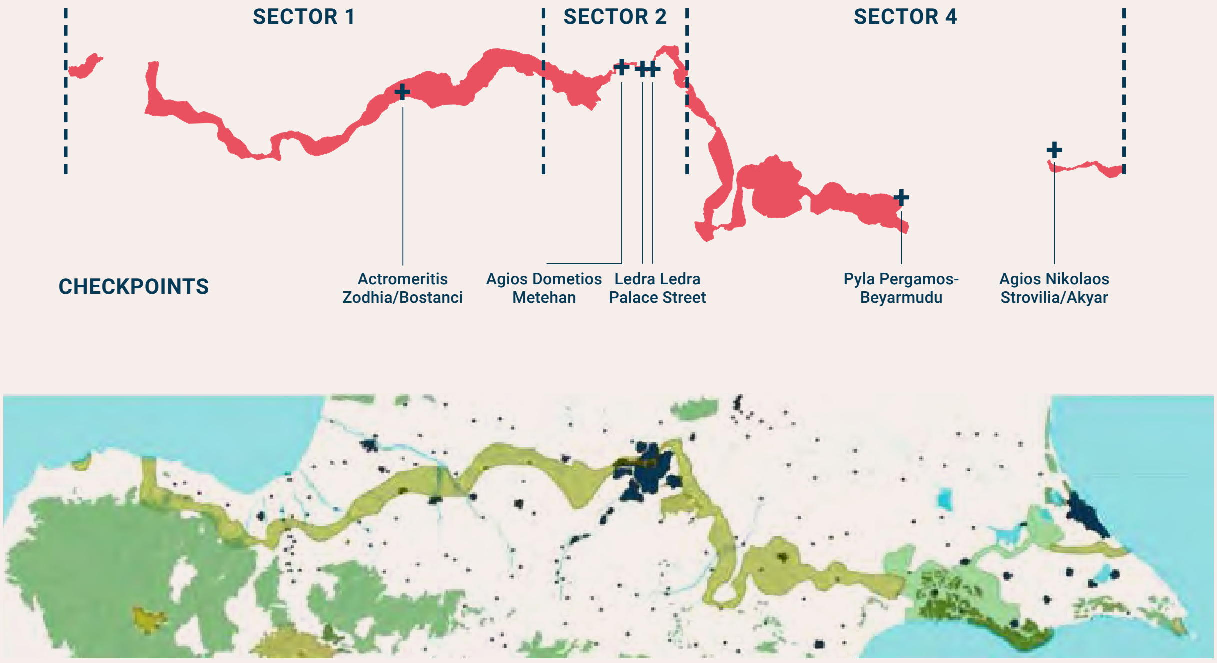
The digital platform seeks to connect stakeholders, initiatives, and data concerning border zones, creating potential opportunities to design alternative futures for these militarized and conflict landscapes. The atlas can include both public and confidential data, as well as data from experts and citizens, with different levels of accessibility dependent on the users' and stakeholders' roles.

A prototype of this atlas was developed for the Green Line Buffer Zone, that has divided the island of Cyprus since 1974. This border area, which has significant ecological and historical value, serves as a possible backbone for reconciliation between the conflicting parties. The project builds on research and a series of consultations with Cypriot communities, international NGOs, academia, and the United Nations.

The work was conducted on two levels: within Cyprus, with the engagement of the communities on both sides and within the buffer zone to produce collaborative maps and data; and at the international level, in connection with similar cases in the region and worldwide, including the Korean Demilitarized Zone and the German Green Belt. Data from several sources (including the World Wildlife Fund, the International Union for Conservation of Nature, and UNEP) provided the baseline information for a series of maps that identify eco-regions in conflict areas and include existing natural conditions, cultural sites, economic activities, conflict impacts, and rehabilitation plans specific to the region (FIGURE 3.3).

FIGURE 3.3: LAYERS AND STAKEHOLDERS OF THE DIGITAL AND DYNAMIC ATLAS FOR ECOLOGICAL COOPERATION.

Military representation of the buffer zone combined with the ecological and landscape mapping of the Green Line.



MILITARY BUFFER	ENVIRONMENTAL BUFFER	BUFFER MEMORY
SEPARATES opposing forces and prevents hostilities	PROTECTS resources and biodiversity	STORES Processes memory, temporary storage

MILITARY BUFFER
DISCONNECT OF COMMUNITIES
PRESERVATION OF NATURE

PROCESS OF RECONCILIATION

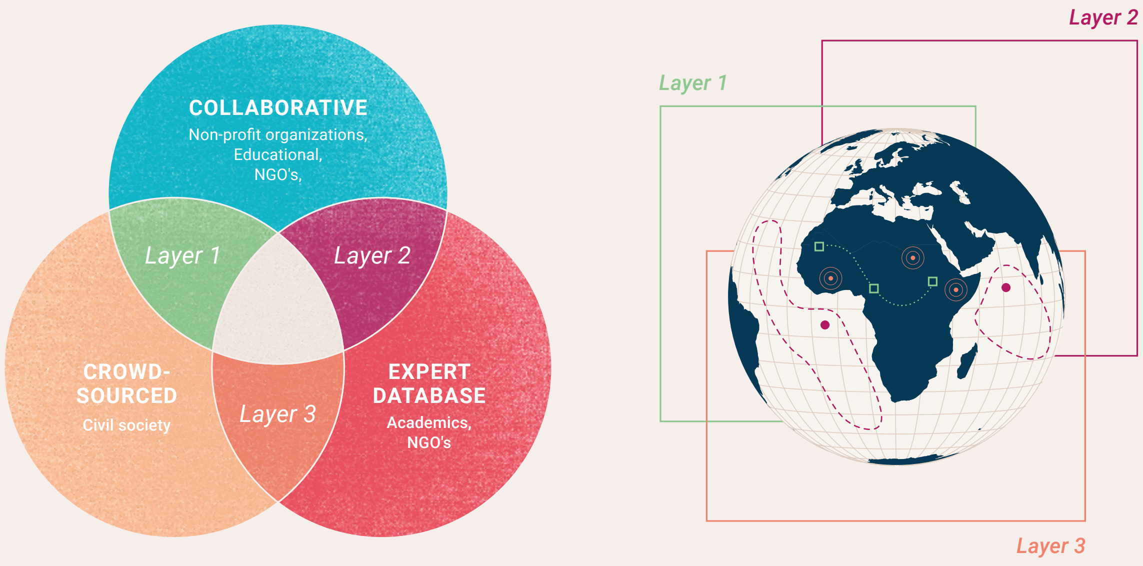
LANDSCAPE OF MEMORY AND LABORATORY OF ECOLOGICAL PLANNING AND RECONCILIATION

CONNECT HISTORIES
CONNECT ECOSYSTEMS
CONNECT COMMUNITIES

Source: Borderscapes 2020.

The goal of this digital atlas is to find new methods in other disciplines and geographical regions with which to approach the collaborative mapping, visualization, and solution-design process. The complex nature of the map and the different layers of information allow the display of a layer to depict various realities and narratives, and to show a process in time (FIGURE 3.4). With the digital atlas, different border narratives can be contextualized from civil society, experts, academia, and government representatives. Interdisciplinary research that integrates ecological landscape planning with conflict research and peacebuilding can help create new outlooks and structures within which fragmented territories and ruptured communities can reach agreement on a common vision for resource management.

FIGURE 3.4: LAYERS AND STAKEHOLDERS OF THE DIGITAL AND DYNAMIC ATLAS FOR ECOLOGICAL COOPERATION.



Source: Borderscapes 2020.

3.2.3 Enhancing inclusion and diversity among stakeholders in environmental diplomacy

Historically, the process of environment and climate diplomacy has predominantly been the realm of a select few elite representatives from various stakeholder groups. A significant challenge within these negotiations is the frequent exclusion of those who are most likely to be impacted by the outcomes, such as local communities, women, and indigenous groups. Moreover, in certain contexts, environment and climate diplomacy is conducted behind closed doors, leaving key stakeholders from civil society and grassroots organizations on the periphery, uninformed about the nuances and dynamics of the negotiations. Transforming environment and climate diplomacy into a more inclusive process is essential. Such inclusion ensures that environmental agreements are more reflective of and responsive to the needs of the broader population, fostering local ownership and enhancing commitment to implementation.

In this evolving landscape, the advent of digital communication technologies opens new horizons for environment and climate diplomacy, offering the potential to reimagine these processes to be more inclusive of traditionally underrepresented stakeholders. By leveraging these technologies, diplomatic interventions can reach a wider audience and facilitate greater participation in decision making processes. CASE STUDY 3.3 sheds light on this transformative potential. It explores how digital technologies are being harnessed to broaden stakeholder engagement in water diplomacy processes, with a specific focus on the initiatives supported by the Stockholm International Water Institute (SIWI). This case study exemplifies the pivotal role of digital technologies in democratizing the process of environment and climate diplomacy, ensuring that it is more accessible, transparent, and representative of diverse perspectives. However, it also highlights that the digital architecture of the entire process must be considered as the very structure of digital platforms fundamentally shape decisions and influence outcomes.

CASE STUDY 3.3
DIGITAL ENABLING OF WATER DIPLOMACY

ELIZABETH YAARI AND MARTINA KILMES • Stockholm International Water Institute (SIWI)

Environmental diplomacy approaches can be applied to different natural resources. For example, water diplomacy supports a variety of stakeholders to collectively find mutually beneficial solutions for the joint management of shared freshwater resources.

Recent developments in water diplomacy recognize that the online platforms or spaces where water dialogues are conducted impact process design, trust building, transparency, information and data-sharing, assessments of shared risks, inclusion, and ultimately decision making.

As new digital water diplomacy processes are being adopted for both formal and informal dialogues, new challenges and opportunities are emerging, including in some of the most conflict-sensitive basins. Adapting a negotiation process to digital spaces requires more than just sharing a meeting link. The digital architecture of the entire process must be reconsidered.

Engaging in digital water diplomacy necessitates an even higher level of preparation from participants and the actors who facilitate the process as they work to establish a shared narrative to address challenges. In practice, potential issues can be partially mitigated by establishing clear codes of conduct, decision making mechanisms, timelines, collaboration in setting the agenda, and a joint understanding of the challenges.

Some online water dialogues benefited from previous in-person exchanges, during which participants had established trust and an understanding of one another's priorities. Initiating new discussions or including new actors in ongoing dialogues without sustained personal contact can reinforce or maintain status quo positional bargaining—when participants dig deeper into their positions—rather than fostering a more principled negotiation.

While there are few examples, water negotiation processes since 2020 have mostly been a continuation of pre-pandemic talks moved to digital platforms. For example, negotiations between Eastern Nile countries regarding the Grand Ethiopian Renaissance Dam have continued online (FIGURE 3.5). Likewise, in Central Asia, water negotiations continued online between Turkmenistan and Tajikistan, and between Afghanistan and Turkmenistan. The latter resulted in a signed protocol that furthered a cooperation strategy for the management of shared water resources.

Digital access impacts participation for better and for worse. Digital water diplomacy can provide an opportunity for broader and more inclusive participation while also reducing environmental impacts and travel costs. However, it is crucial to adapt and contextualize the tools and processes of digital water diplomacy to local contexts to ensure that online access is not a barrier to participation. The digital divide can contribute to excluding some stakeholders from the dialogue, with disproportionate impacts on the most vulnerable communities. At the same time, some informal and formal water dialogues have benefited from remote access to dialogue and decision making processes, as it became possible to convene actors more frequently, including high-level officials.

FIGURE 3.5: SUDAN'S MINISTER OF IRRIGATION AND WATER RESOURCES, YASIR MOHAMED, TAKES PART IN A VIDEO MEETING ON THE GRAND ETHIOPIAN RENAISSANCE DAM ON JUNE 9, 2020.

Source: Albawaba 2021.

Ultimately, decision making by the parties is highly influenced by structural factors around the process, and new digital platforms hosting dialogue processes fundamentally shape decisions and influence outcomes. Digital water diplomacy and hybrid dialogue processes, integrating both digital water diplomacy and traditional in-person meetings, are likely to become the new norm. Leveraging the benefits of these shifts to improve transparency and inclusiveness while mitigating the challenges to cooperative dialogues is critical.

3.3 RISKS AND CHALLENGES

Digital technologies are poised to become increasingly integral to preventive diplomacy efforts, including in addressing the environmental, natural resource, and climate risks that exacerbate tensions between divided groups. However, the integration of these technologies also introduces specific risks and challenges, spanning both technical and political spheres.

One notable risk is the potential for complacency among policy makers. While digital technologies can provide valuable insights into potential conflicts over natural resources, there is a danger that these tools may lead to a reliance on short-term solutions. Policymakers might resort to quick fixes to address acute risks, neglecting the underlying unsustainable practices fueling chronic environmental degradation and climate change. In this context, forecasting technologies risk becoming tools that help address only the symptoms, not the root causes, of environmental challenges.

Interactive maps and databases on natural resources that transcend national or community-level boundaries can effectively advocate for cross-border collaboration and cooperation. However, their capacity to influence entrenched territorial disputes and counter nationalistic rhetoric remains uncertain. While these tools offer a technical perspective on the status of natural resources, they may struggle to override dominant political narratives or foster incentive structures that encourage peaceful conflict resolution and de-escalation.

The digitalization of environment and climate diplomacy processes can certainly broaden stakeholder participation. Nonetheless, this inclusiveness is contingent on stakeholders having adequate access to the internet and communication technologies as well as sufficient digital literacy. In fragile and conflict-affected regions, grassroots organizations and local communities might be under-equipped, limiting their effective involvement in preventive diplomatic processes. While digital platforms can offer new channels for including remote communities, they might also replicate existing inequalities of traditional diplomacy, such as limited access for marginalized groups like women and minorities. Moreover, digital interactions cannot fully substitute for in-person meetings and engagements that are often vital for trust building and establishing social relationships.

While digital technologies offer promising avenues for enhancing preventive diplomacy, their application must be carefully managed to address these inherent risks and challenges. Ensuring that these technologies complement rather than replace traditional diplomatic processes and addressing the underlying political and social dynamics is key to realizing their full potential in conflict prevention and resolution.

3.4 CONCLUSIONS AND NEXT STEPS

This chapter has showcased how digital technologies hold immense potential in enhancing the technical basis as well as the inclusiveness and effectiveness of preventive diplomacy processes, especially those concerning environmental issues, natural resources, and climate change. While these technologies offer promising avenues for transformative change, their integration into diplomacy processes is not without challenges and requires careful consideration of various caveats.

Looking ahead, several priorities emerge for effectively leveraging digital technologies in support of preventive diplomacy.

First, there is a need for extensive research into the synergies between digital technologies and traditional preventive diplomacy processes. It is crucial to explore the pathways through which this combination can effectively mitigate rising tensions and foster increased cooperation among divided groups. Understanding how digital tools can complement and enhance traditional diplomacy methods will be key to realizing the full potential of these technologies in resolving environmental conflicts.

Second, rapidly building digital literacy among all stakeholders is imperative to empower them to effectively utilize digital tools and engage in virtual diplomatic processes. This involves not only providing training and resources to enhance technical skills but also ensuring that stakeholders understand the implications and potential of these technologies in diplomatic contexts. Addressing the digital divide is essential to ensure that all parties, irrespective of their technological background, can participate fully and meaningfully in preventive diplomacy processes.

Third, a deeper understanding of how digital platforms and digitally enabled processes fundamentally influence decision making and related outcomes is essential. Investigating how the digital architecture itself constricts or enables conflict resolution will provide valuable insights. This includes examining the design and implementation of digital platforms, and how they shape the dynamics of dialogue, negotiation, and consensus building in preventive diplomacy. By understanding the nuances of digital architecture, its potential biases, and its influence on decision making processes, practitioners can better harness these tools for effective conflict resolution.

In conclusion, while digital technologies present significant opportunities to advance preventive diplomacy in the context of environmental, natural resource, and climate change issues, their successful integration hinges on a nuanced understanding of their capabilities and limitations. By focusing on research and digital literacy, we can pave the way for more inclusive, effective, and forward-thinking approaches to conflict prevention and resolution in the increasingly digital world of international diplomacy.

CHAPTER 4

Peacemaking, mediation, and other in-conflict processes

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ALEJANDRO MARTÍN RODRÍGUEZ • European External Action Service (EEAS)

4.1 INTRODUCTION

Peacemaking is the process of addressing an ongoing violent conflict by bringing parties together to resolve their mutual grievances, usually involving the negotiation of ceasefires or peace agreements. Mediation refers to peacemaking activities whereby a third party assists opposing parties, with their consent, to reach mutually acceptable agreements.[64] As many peacemaking and mediation processes directly address benefit sharing or conflict-related damage natural resources, there are also important applications of digital technology for this domain.

This chapter builds on pioneering work conducted by the United Nations Department of Political and Peacebuilding Affairs in partnership with the Centre for Humanitarian Dialogue that explored the role of digital technologies in the mediation of armed conflicts.[65] It extends this analysis by looking at the application of digital technologies in mediation and peacemaking processes from an environmental perspective, and presents three case studies to demonstrate the opportunities and pitfalls associated with their use.

4.2 USE CASES

Our horizon scanning identified three use cases where digital technologies can inform peacemaking and mediation processes that include issues linked to environment, natural resources and climate change.

As highlighted in the previous chapter on preventive diplomacy, one of the most significant potential benefits of digital technologies lies in their ability to democratize the peacemaking and mediation process. By providing digital platforms for engagement, these technologies open the door to broader participation, allowing for the inclusion of groups that are often excluded or marginalized in traditional settings. While the intrinsic value of face-to-face interactions in nuanced exchanges cannot be overstated, the utility of virtual channels as a complementary tool is increasingly evident. These digital engagement methods, encompassing a spectrum from instant messaging to forums and video calls, facilitate direct connections among conflict actors, stakeholders, mediators, community groups, and decision makers. This virtual connectivity can bridge geographical and logistical gaps, bringing diverse perspectives to the table and enriching the mediation process.

Of course, the use of digital technologies in peacemaking and mediation extends beyond mere communication and inclusion. The second major application lies in strengthening the analytical capacity of mediators to understand the environmental dimensions of a specific conflict in terms of drivers, triggers, and the roles of certain actors. Leveraging new data sources, such as from Earth observation, social media, and citizen science, in conjunction with advanced artificial intelligence algorithms, can revolutionize conflict analysis. These technologies support a more detailed and nuanced understanding of how natural resources,[66] environmental factors,[67] and climate change contribute to instability and violence.[68] USE CASE 4.1 illustrates this by exploring the application of remote sensing and other data to track groundwater use for households in Yemen. This analysis was an important part of integrating environmental issues into conflict analyzes that inform the design and implementation of peacebuilding strategies.

The third major application lies in the ability of digital technologies to help improve the understanding of the parties to potential benefits that can be derived from sharing natural resources. Earth observation provides a neutral source of data that does not rely on any of the parties to a conflict to collect; as such, it is more neutral and trusted. As such, it can help unblock situations where natural resource information is contested or where information access is asymmetrical.

Digital technologies can also improve transparency on the implementation of provisions or agreements linked to natural resource. This is especially valuable when information about natural resources is contested or not trusted, as well as situations where access to information is asymmetrical. Data-sharing platforms and digital dashboards can help disseminate these new data and analytical insights to non-technical users, who might have minimal digital literacy, in a more accessible and inclusive manner. Accessible environmental monitoring mechanisms can also contribute to more effective dispute resolution.

In an additional transparency-related application, digital technologies such as remote sensing and AI can enable the parties to objectively assess the environmental damages caused by a conflict or the natural resources that were involved in conflict financing. This, in turn, supports fair compensation claims and environmental restoration as well as accountability and transparency in peacemaking.[69] Monitoring and assessment of damage to the environment and related infrastructure is enabled by the proliferation of free, high-resolution, and near real-time satellite data.[70] For example, changes in night-time light data, using infrared satellite imagery, can be used as a proxy to evaluate the impact of conflicts on displaced populations or on the availability of electricity (FIGURE 4.1).[71]

FIGURE 4.1: LAND CLEARANCE, HOMES REMOVED JULY 2005.

On the left, a "before" panchromatic image 06-25-2000 showing dwellings. On the right, "after" 09-15-2006 Porta-Farm, Zimbabwe.

Source: GeoEye Foundation.

Satellite-based damage and needs assessments can be especially important when there is limited field access due to ongoing hostilities or security threats such as landmines.[72] The second use case (4.2) showcases the potential of open-source investigations using a combination of remote sensing and citizen science data to identify environmental damage and public health risks resulting from armed conflict in Syria. These investigations can assist in prioritizing intervention and recovery activities. Remote sensing damage and needs assessments, supplemented by artificial intelligence (AI), can also be useful in surveying and assessing what would otherwise be an overwhelming number of impact sites. The third use case (4.3) highlights the use of remote sensing and AI to assess widespread damage to buildings in Ukraine.

Practical guidance on improving the efficiency of mediation processes, while avoiding the pitfalls and spoilers that digital technologies can bring to the process, can be found in the UN Digital Mediation Toolkit.[73] To gain complementary insights about the role of climate change in peacemaking, it is recommended to also read the DPPA Practice Note on The Implications of Climate Change for Mediation and Peace Processes,[74] as well as the DPPA and UNEP Guidance Note on Natural Resources and Conflict: A Guide for Mediation Practitioners.[75]

4.2.1 Strengthening the environmental dimensions of conflict analysis

One of the foundations for peacemaking and mediation processes is a solid analysis of the conflict drivers and root cases. Insights derived from a combination of Earth observation data, social media, and citizen science sources can provide constant inputs to conflict analysis, so that mediators can be conflict sensitive in rapidly changing contexts. Such data feeds can also support scenario building in conflict analysis, helping predict plausible developments related to, for instance, rapidly changing livelihoods or economic conditions.[76]

By integrating these diverse data sources, mediators can gain insights into complex conflict scenarios that were previously inaccessible or difficult to discern. For instance, Earth observation data can reveal changes in land use or water scarcity that might be fueling tensions, while social media and citizen science inputs can provide real-time, on-the-ground perspectives and emerging conflict indicators. When combined with AI's predictive capabilities, these data can help forecast potential escalations or identify windows of opportunity for interventions. This enhanced analytical capacity is crucial for developing targeted, effective, and conflict-sensitive mediation processes and strategies. It allows mediators to tailor their approaches based on a deeper understanding of the environmental aspects of conflicts, leading to more sustainable and long-lasting peace agreements.

Moreover, access to quality historical and current data regarding natural resources, the environment, and climate conditions can lead to a more comprehensive understanding of the conflict landscape and the interests of involved actors. In situations where conflict parties use natural resources to finance their activities, remote sensing analysis can identify zones of exploitation and assist in estimating economic dependencies.[77] For example, in 2017, the World Bank analyzed how much oil was being produced by Islamic State of Iraq and the Levant (ISIL) using multi-spectral remote sensing imagery and ground data to determine the conflict finances that were being generated.[78]

Remote sensing can also highlight areas where environmental degradation necessitates restoration, often caused by populations adopting maladaptive livelihood strategies, such as mineral extraction or deforestation. For instance, Afghanistan has experienced critical deforestation of its forests and woodlands due to the unregulated charcoal and wood market, exacerbated by political instability and armed conflict since 1977. The extent of this environmental damage was revealed through remote sensing imagery.[79] Similarly, in Darfur, Sudan, the massive displacement and migration to urban areas between 2003 and 2009 led to significant resource depletion around these urbanized zones, as evidenced by remote sensing data.[80]

With a nuanced understanding of conflict actors, their power, and interests, remote sensing can complement on-the-ground reports to construct informed conflict analysis scenarios. These scenarios can anticipate the needs of populations at risk of maladaptation or displacement.[81] CASE STUDY 4.1 explores the application of remote sensing and other data to inform conflict analysis on water scarcity in Yemen.

CASE STUDY 4.1
USING BIG DATA AND AI TO SUPPORT CONFLICT ANALYSIS ON WATER SCARCITY IN YEMEN

EOGHAN DARBYSHIRE AND LEONIE NIMMO • Conflict and Environment Observatory (CEOBS)
DOUG WEIR • Conflict and Environment Observatory (CEOBS) and King's College London (KCL)

Before the current conflict in Yemen, more than 70 percent of households depended on agriculture to sustain livelihoods, despite Yemen being one of the most water-insecure nations. Water scarcity was further compounded by "development projects," which encouraged groundwater abstraction using diesel-reliant operations at the expense of traditional spate irrigation systems. This occasionally contributed to local water conflicts.[82] In 2014, following the removal of diesel subsidies, the price of groundwater abstraction became too costly for many Yemenis, leading to protests and grievances which, in turn, contributed to the seizure of power by Houthis.[83]

The importance of agriculture for rural livelihoods and food security means water security is vital to conflict dynamics and peacemaking in Yemen. During the conflict, agricultural and water infrastructure was deliberately targeted, and access to agricultural inputs, transportation systems, and diesel for water pumps was limited. At the institutional level, the collapse in governance disrupted traditional local water management structures and led to a loss of monitoring capacities for water wells. Consequently, previously productive agricultural areas showed signs of degradation and unsustainable management.[84]

To compensate for the lack of diesel fuel, solar power was deployed throughout the country to extract groundwater resources. At first glance, this alternative bypassed diesel costs, reduced CO_2 emissions and supported decentralized energy systems. However, this growth in solar power came with the risk of unchecked and unsustainable water extraction.

The methodology for the conflict analysis on water scarcity used water data from diverse sources of Earth observation. For example, terrestrial water storage, comprising surface water, soil water and groundwater, was obtained from NASA's Gravity Recovery and Climate Experiment mission.[85] Groundwater data was derived, albeit with substantial uncertainty, from the surface and soil data using the European Space Agency's (ESA's) Copernicus Climate Change Service combined with soil moisture data.[86]

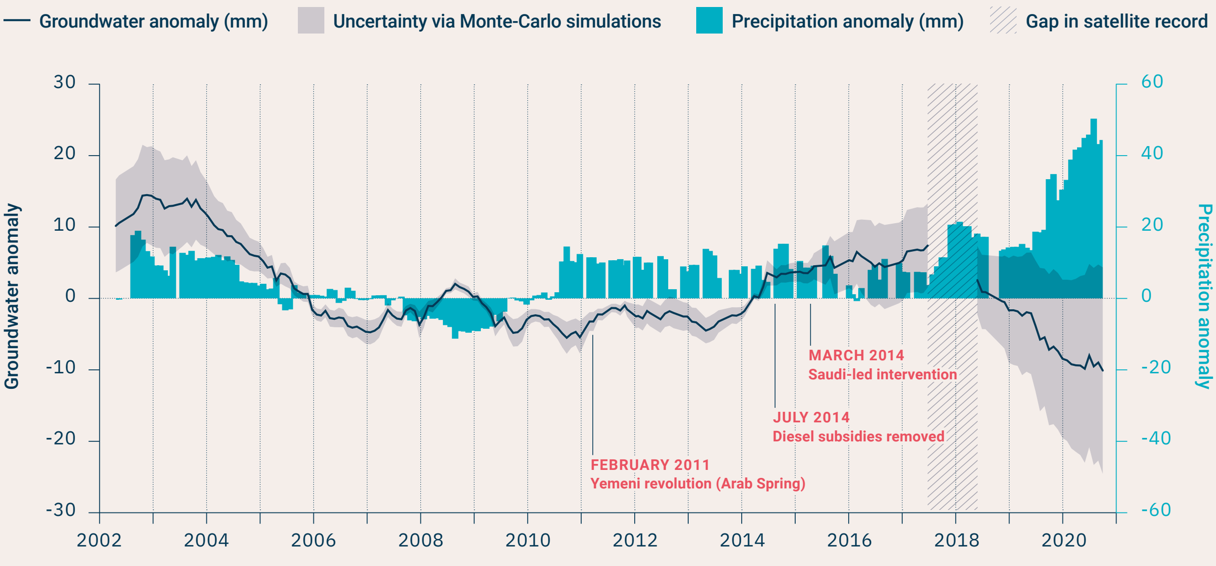
To establish the drivers of the observed groundwater changes, other big data sets were incorporated into the analyzes, including data on precipitation, vegetation, night-time lights, conflict events, agricultural statistics, diesel prices, and trade data. This holistic approach allowed hypotheses to be defined, which were then tested and enhanced via expert interviews.

The analysis results indicated that between 2018 and mid-2020, groundwater dropped across western Yemen to the lowest level based on satellite-derived records, despite above-average rainfall (FIGURE 4.2).[87] The investigation suggested that the growth of solar-powered irrigation was the driving factor, a hypothesis supported by local studies on the ground.[88] Given the lifesaving benefits of solar power, this unintended consequence requires careful management on the part of all stakeholders, from well owners and communities to development agencies and local authorities.

The water crisis in Yemen is a major challenge embedded in a humanitarian catastrophe following years of war. In this context, human security and conflict resolution directly depend on water security and sustainable management. Digital technologies have a significant role to play in supporting peace practitioners to tackle water security. However, they also face important limitations. Continued monitoring of groundwater from space is required, but since this method is limited to governorates (regions) in terms of spatial scale, measurements on the ground are also essential. Low-cost sensors and citizen science could hold promise for monitoring individual wells. However, introducing these technologies in a conflict setting should be done with caution. In the context of Yemen, it is fundamental that water users own the process and the monitoring technology.

FIGURE 4.2: GROUNDWATER AND PRECIPITATION ANOMALIES IN WESTERN YEMEN FROM APRIL 2002 TO SEPTEMBER 2020.

24 month moving mean of anomaly (baseline 2004-2009). Groundwater calculated from NASA GRACE gravimetry and Copernicus C3s soil moisture products. Changes in millimeters detected from space equate to changes in the scale of meters in individual wells.



Source: CEOBS 2021.

4.2.2 Understanding, visualizing and monitoring shared environmental benefits from peace

Given that an estimated 40 to 60 percent of intrastate conflicts have their roots in disputes over natural resources,[89] it is often important for peace mediation processes and their subsequent agreements to address the sound management and equitable distribution of specific natural resources such as oil, minerals, timber, and land. In such contexts, digital technologies can play a pivotal role in facilitating successful mediation by aiding conflicting parties in understanding and visualizing the potential mutual benefits derived from natural resources.

In this regard, one of the primary advantages of digital technologies is their ability to help parties comprehend the complexities and potential outcomes of resource-sharing agreements. This is achieved through the use of advanced simulation software and predictive models, which can forecast various scenarios of mediation, particularly those linked to the sharing of revenues generated from natural resource exploitation. Decision support tools and other technologies enable stakeholders to explore and evaluate different distribution models and their long-term impacts, fostering a more informed and constructive negotiation process based on a mutual understanding of available resources.

Furthermore, once an agreement is reached, digital technologies offer robust tools for monitoring and enforcing the agreed-upon terms. Dashboards, for instance, can provide real-time information on extraction volumes, production rates, and revenue statistics, ensuring transparency and accountability in the implementation of benefit-sharing agreements. This transparency is critical in building and maintaining trust among parties and in ensuring that the provisions of the peace agreement are adhered to.

Moreover, digital platforms can serve as effective channels for continuous dialogue and the reporting of new grievances or disputes. They can facilitate ongoing communication and engagement among stakeholders, which is essential for the dynamic and evolving nature of post-agreement phases. By providing a means for regular updates and feedback, these tools help to quickly address emerging issues before they escalate, thereby contributing to sustained peace and stability.

4.2.3 Identifying and verifying conflict-related environmental damage

Environmental damage resulting from armed conflict poses significant threats to human health and disproportionately affects vulnerable populations reliant on natural resources and ecosystem services. A common challenge in many mediation processes is the disputed nature of environmental damage, often exacerbated by asymmetrical access to high-quality data among the conflicting parties. Additionally, the prevalence of misinformation can adversely affect perceptions regarding the causes or the extent of environmental damage, further complicating the mediation process.

Assessing conflict-related environmental damage has two primary functions. The first and most common reason is to understand the nature and extent of environmental damage to inform post-conflict peacebuilding recovery priorities. As such, environmental information is important to prioritize environmental restoration, reform of natural resource governance, rebuilding livelihoods, and support macroeconomic recovery.[90] Post-conflict environmental assessments ascertain the current environmental conditions and inform broader post-conflict needs assessments, as well as donor conferences.

The second important reason for assessing and verifying conflict-related environmental damage is for accountability. In a growing number of instances, countries and individuals have been held accountable for wartime environmental damage.[91] Gathering information for post-conflict accountability is less common than for post-conflict recovery and peacebuilding. Moreover, there are differences: information used in recovery does not need to be admissible as evidence, so it is easier to utilize citizen science in recovery. Moreover, there may be legal concerns (including privacy) regarding use of remote sensing data. Accountability often focuses on causality (did this particular person or actor cause the environmental damage?), while recovery often takes a broader view of environmental damage (regardless of the source, what are the environmental priorities for recovery?).

As previously discussed, high-resolution satellite imagery plays a vital role in validating and verifying claims about environmental damage, often made through citizen science or by civilians. Digital technologies can empower conflict-affected populations to actively participate in identifying areas of damage, thereby enhancing the inclusiveness and accuracy of the assessment process.[92]

While establishing causality can be challenging, the corroboration of field evidence through Earth observation techniques can significantly bolster confidence in these claims.[93] A notable example from Sudan illustrates this, where Landsat data was instrumental in locating burned villages amid ethnic violence.[94]

A combination of Earth observation data, social media, and citizen science source can also be paired with armed conflict data.[95] Data sets such as the Uppsala Conflict Database Program (UCDP)[96] and the Armed Conflict Location and Event Data (ACLED)[97] provide georeferenced violent conflict reports and allow for in-depth analysis of the social and environmental impacts of armed conflict when integrated with other data sets such as satellite imagery, household surveys, and big data scraped from social media.[98] This approach can also contribute to quantify conflict intensity[99] and or to more thematic applications like identifying damage to World Heritage Sites.[100]

CASE STUDY 4.2 showcases the potential of open-source data and digital technologies to contribute to the identification of potential environmental and public health risks resulting from armed conflict in Syria. These investigations can assist in prioritizing mitigation and recovery activities, as well as expanding the knowledge base on mapping conflict risks and impacts.

CASE STUDY 4.2
THE POWER OF OPEN-SOURCE SATELLITE INVESTIGATIONS TO IDENTIFY ENVIRONMENTAL DAMAGE IN SYRIA

WIM ZWIJNENBURG AND OLLIE BALLINGER • PAX for Peace (PAX)

The application of remote sensing combined with open-source investigations (OSINT) to identify and monitor environmental damage during armed conflicts has seen massive growth in recent years. From identifying the impacts of makeshift oil refining in Syria and Iraq,[101] to revealing the targeting of water infrastructure and the shelling of chemical factories in eastern Ukraine,[102] a combination of social media reports and satellite images have become instrumental in locating environmental risks and threats to human health in near real-time.

Vast amounts of environmental data are now openly available and aggregated through cloud-based services such as Google Earth Engine (GEE) or the Microsoft Planetary Computer. These services host petabytes of analysis-ready satellite imagery and are able to perform large AI-driven computations in seconds. Leveraging such platforms enables detailed monitoring of environmental damage in conflict zones that would be otherwise unfeasible.

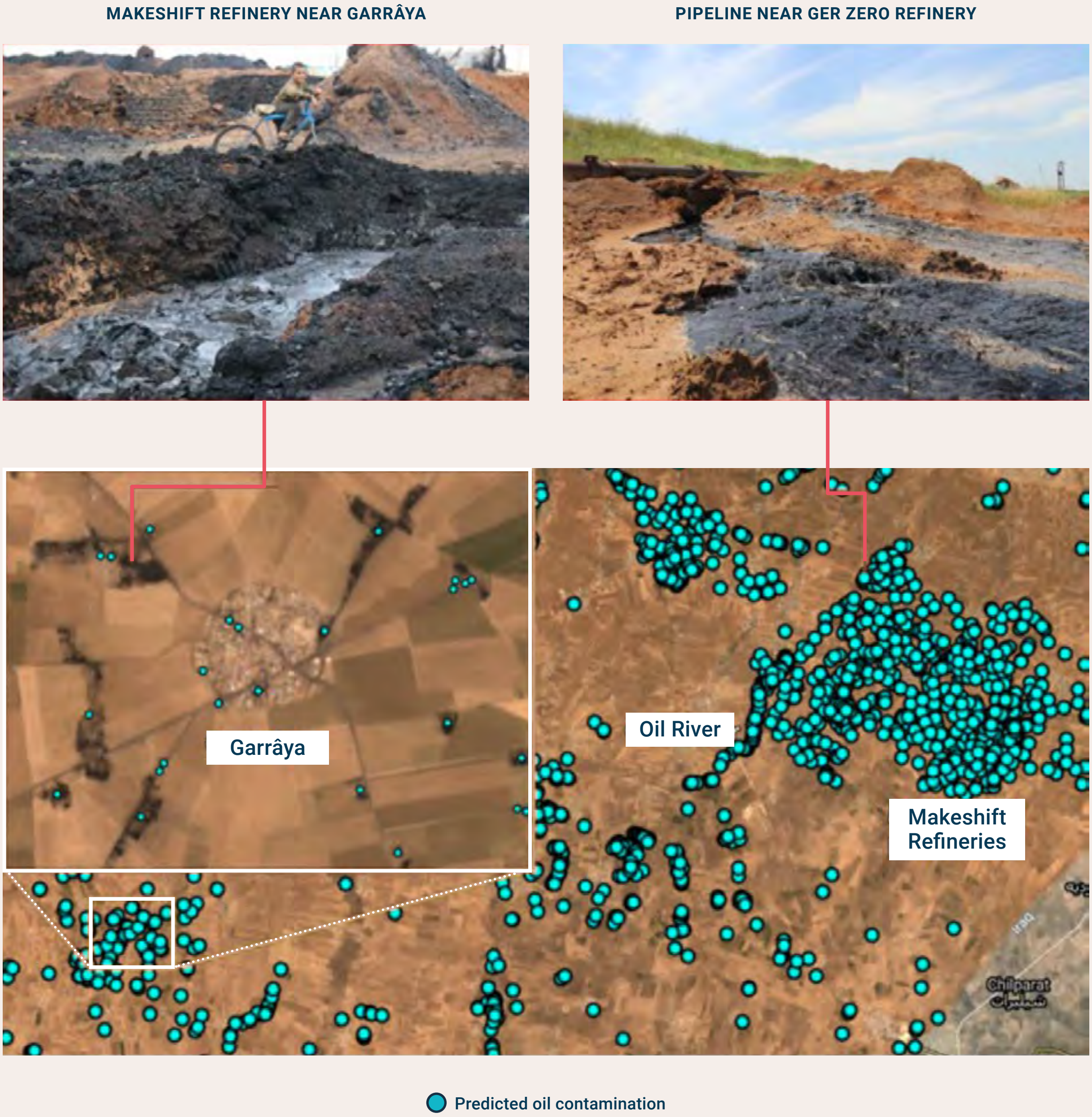
For example, the environmental toll from the destruction of Syria's oil industry is massive, ranging from bombed refineries and oil storage sites to air pollution and leakages into the soil and rivers.[103] Through fieldwork undertaken by PAX, a limited number of oil spills were confirmed on the ground. Photos taken at a refinery south of Gir Zero village (FIGURE 4.3) showed vast swaths of land contaminated by oil, which were clearly visible in multispectral satellite imagery of the area. These confirmed spills were used to train a machine-learning algorithm in GEE, which enables it to distinguish the unique spectral profile of oil from other types of land cover.

Once trained, the algorithm can be applied to thousands of square kilometers to identify areas that display a similar spectral profile. Despite being trained on a limited number of spills, the algorithm accurately identified other oil spills that were verified during fieldwork, including rivers of oil near the villages of Kharab Abu Ghaleb and Tall Maszhan, and leaks from makeshift refineries near Garrâya.

This method helped to identify hundreds of potential oil spills across northeastern Syria. An interactive map of predicted oil contamination was created to allow users to see the number of unique locations and total area of predicted oil spills within a user-defined area.[104] It is worth noting that not all locations identified by the algorithm are confirmed oil spills, and there are likely many false positives. The cause of the oil spill can also be difficult to identify. It is therefore essential to complement AI-based analysis with ground-truthing and field-based validation.

Environmental degradation linked to oil pollution has caused grievances and health concerns among affected communities in northeastern Syria. The rapid assessment of oil contamination hotspots is crucial to start clean-up, remediation, and restoration programmes as part of the peacebuilding and reconciliation process.

FIGURE 4.3: SITES OF OIL CONTAMINATION WERE IDENTIFIED USING MACHINE LEARNING IN SYRIA.



Source: PAX 2021.

CASE STUDY 4.3
REMOTE SENSING AND AI TO ASSESS WARTIME ENVIRONMENTAL DAMAGE IN UKRAINE

JENNAH COLBORN • Environmental Peacebuilding Association

Assessments of environmental damage have historically been performed post-conflict, but Ukraine quickly recognized the need for technological support in performing real-time assessments of the environmental impacts of the war with Russia. A variety of well-established and innovative technologies have been deployed since the early days of the conflict.

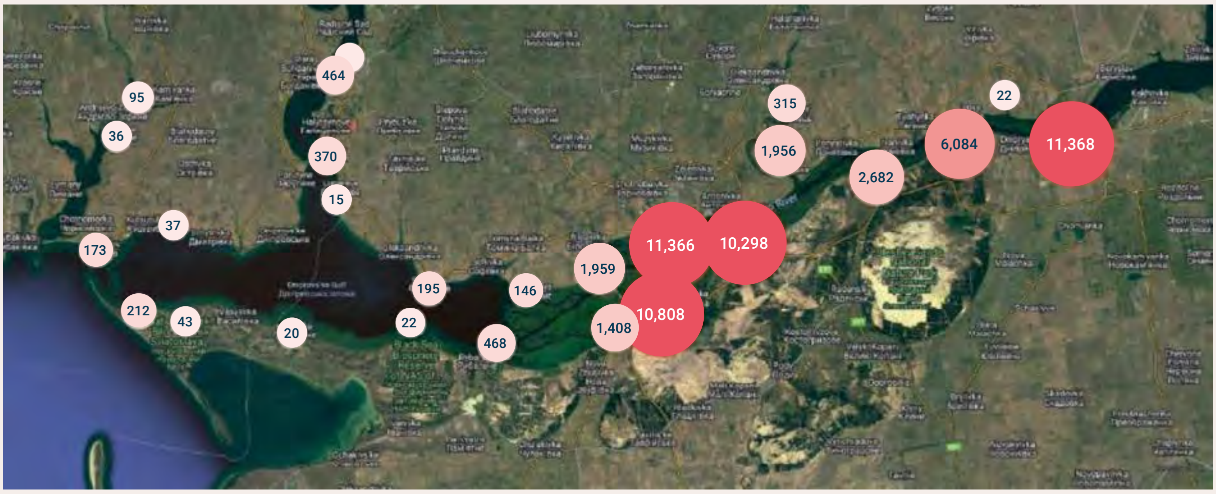
Assessing environmental damage can be dangerous, particularly with the conflict still ongoing, so remote sensing technologies have been key. Responding to a request from Ukraine, UNEP, together with partners, launched the Ecodozor platform, which builds on media reports supplemented by information from the authorities, academia, civil society, and other sources, including social media, for almost real-time information on environmental impacts of the conflict. UNEP has also trained national authorities on the use of remote sensing technologies to assess environmental impacts of the war.

The Kyiv School of Economics uses remote sensing and artificial intelligence to track destruction of buildings across the country in almost real-time. Using a combination of high-resolution satellites and low-flying drones, researchers have collected detailed, quality images of buildings in conflict regions. To ensure completeness of the dataset, both photos and videos are taken, and metadata such as building height, type, and address are also gathered from verified outside sources. GIS specialists, aided by artificial intelligence, then digitize all buildings and assess their damages according to several metrics: size and type of building, number of floors, level of damage (possible, light, severe, and total), and the number and size of destroyed objects. Finally, the digitized data and imagery is stored in an IT system to allow easy access and comparison with other maps.[105]

The Kyiv School of Economics also used remote sensing technology to support real-time environmental assessment of damage from the destruction of the Kakhovka dam. On 6 June 2023, footage captured by a Ukrainian military drone showed water from one of Europe's largest reservoirs gushing through a gaping breach in the dam. Researchers compared satellite imagery from before and after the flood, establishing the dimensions of the flood line, then referenced geospatial and elevation data from NASA's DEM (Digital Elevation Model) to determine the height difference between the flood line and each building in the flooded region to infer the extent of flooding across buildings (FIGURE 4.4).

Further, a remote sensing network has proven useful in monitoring agricultural systems. A team at NASA Harvest has been helping the Ukrainian government to digitally map cropland since early 2022, observing such variables as crop type, season, and artillery damage.[107] Additionally, research groups have been studying the vegetation indices extracted from remote sensing data, employing novel statistical methods and machine learning to better understand climate trends, soil water content, nitrogen uptake, and crop health.[108] Priority has been given to monitoring important food security crops, such as rapeseed, given Ukraine's status as a major exporter of oilseeds and grains to the global market.[109]

FIGURE 4.4: MAP SHOWING THE NUMBER OF FLOODED BUILDINGS IN THE KHERSON AND MYKOLAIV OBLASTS AFTER THE DESTRUCTION OF THE KAKHOVKA DAM.



Source: Kyiv School of Economics 2023.

Finally, Ukraine's open-source intelligence (OSINT) team also employs open-source networking tools to help evaluate the impacts of conflict, environmental or otherwise. OSINT aggregates information across social media posts, video recordings, photographs, audio, eyewitness accounts, news stories, and written records. To verify the credibility of these sources, Ukraine's OSINT team uses a variety of digital forensics technologies: reverse image searches can identify the original source of the content and any manipulations performed thereafter, metadata analysis can reveal information relevant to the creation and modification of the content, and deepfake detection algorithms can separate AI-generated content from authentic media.[110] Using these methods, OSINT was able to produce an environmental damage report in December 2023, covering air pollution, soil damage, and forest fires linked to the war to date.[111]

4.4 RISKS AND CHALLENGES

Digital technologies, while offering transformative opportunities for peacemaking and mediation, also present a paradox. Their capability to engage communities more inclusively in the peace process is counterbalanced by significant risks associated with their advanced nature, which demands high digital and data literacy. A reliance solely on sophisticated technological tools can widen the digital divide, potentially eroding trust in the mediator, the technology used, and the overall peace process itself. Mediators who lack digital literacy may be unaware of novel technological applications employed by conflicting parties or the potential misuse of these technologies, leading to a trust deficit in the peace process. Implementing conflict-sensitive approaches in the application of technology can play a crucial role in mitigating these risks. At the country level, the manipulation of internet connectivity by authorities and other actors has become an increasingly common instrument of power.

Mediators need to be cognizant of the limitations inherent in social media analyzes, which often assume uniform access to mobile devices, networks, and active social media usage across all stakeholder groups. In reality, marginalized and vulnerable social groups, especially in conflict-affected countries, may lack access to these technologies. This is particularly true for women and rural communities. Consequently, insights derived from social media can be heavily biased, potentially reinforcing the discrimination and marginalization of already vulnerable groups. Recognizing and addressing these biases is vital to ensure that the use of digital technologies in peacemaking and mediation processes is truly inclusive and representative of all stakeholders' voices.[112]

4.5 CONCLUSIONS AND NEXT STEPS

This chapter has illuminated the significant role that digital technologies can play in enhancing peacemaking and mediation processes, particularly in conflicts driven by environmental, natural resource, and climate change factors. While these technologies present unparalleled opportunities for inclusive engagement and advanced analytical capabilities, they also introduce unique challenges and risks that need careful consideration and management.

Looking forward, three key priorities emerge for the effective utilization of digital technologies in peacemaking and mediation linked to natural resources, environmental factors and climate change.

First, there is a need for additional research and best practices on the conflict-sensitive implementation of digital technologies. This research should not only focus on the technical aspects but also explore the social, political, and cultural implications of their use in mediation processes. Simultaneously, efforts are required to address the digital literacy gap among mediators and stakeholders, ensuring equitable access to and understanding of these technologies. Developing best practices for rapidly enhancing digital skills, particularly in conflict-affected regions, is crucial to ensuring that all parties to a mediation process are able to understand and use these technologies.

Second, a deeper understanding of how digital technologies can "technicize" conflicts over natural resources is necessary. This involves exploring how these technologies can help parties focus on the more technical components of political conflicts. By focusing on the technical aspects of conflicts, digital tools can provide a more neutral ground for discussion and facilitate the identification of practical, mutually beneficial solutions. One of the major priorities is visualizing and modeling benefit streams and helping parties identify the mutual economic benefits from peace stemming from cooperation over shared interests in natural resources and the environment.

Third, the development of integrated approaches that combine digital technologies with traditional mediation methods is vital. This hybrid approach would leverage the strengths of both digital and traditional methods, ensuring a more comprehensive and effective mediation process. It would involve not only the use of advanced technologies for data gathering and analysis but also the incorporation of traditional negotiation and consensus-building techniques, thereby enriching the mediation process with a blend of innovation and human-centric approaches.

By addressing these priorities, the full potential of digital technologies can be harnessed for peacemaking and mediation, overcoming the challenges and maximizing their impact for more effective conflict resolution and sustainable peace.

CHAPTER 5

Peacekeeping and humanitarian operations

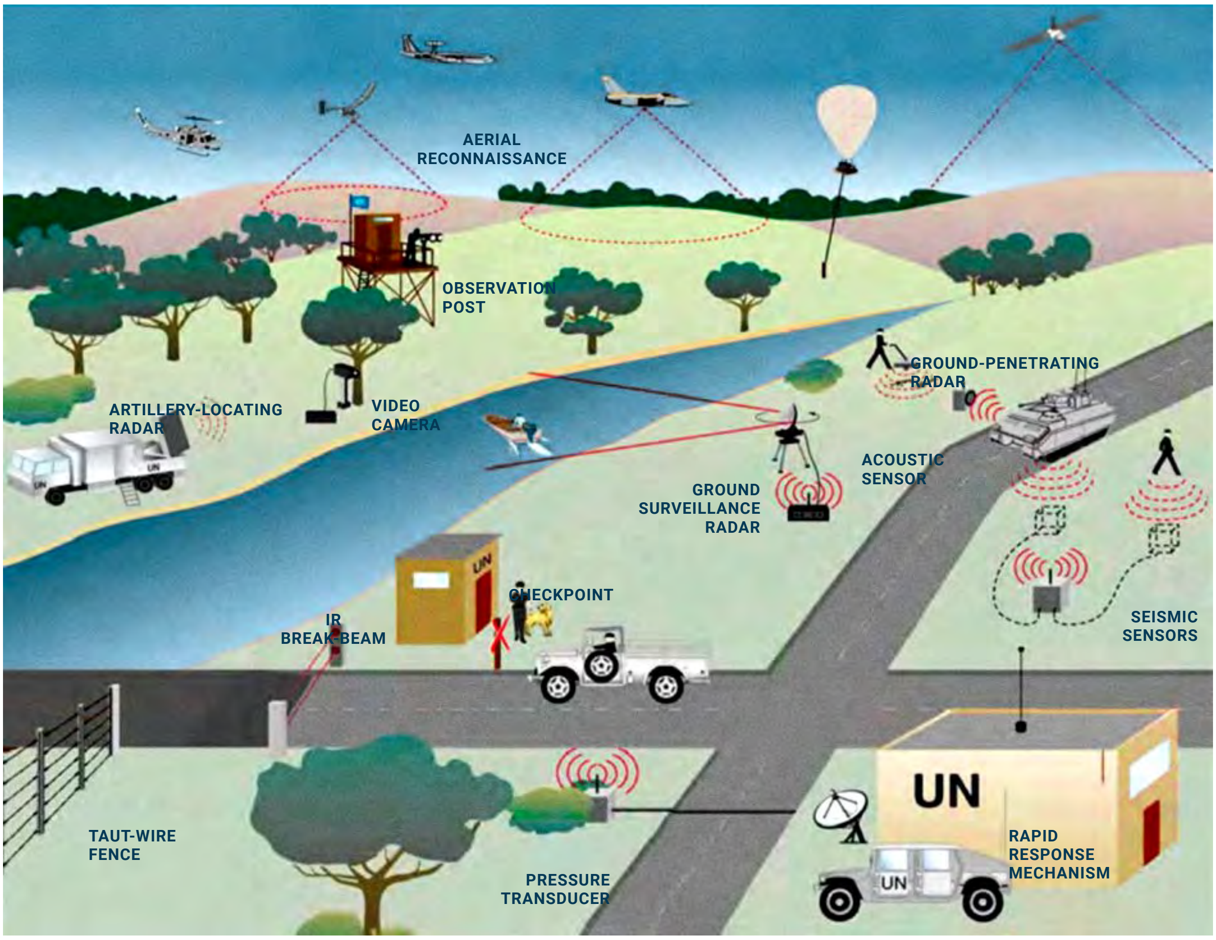
MARIE SCHELLENS • United Nations Environment Programme (UNEP)

5.1 INTRODUCTION

The intertwining of technological innovation with the military and defense sectors has been a hallmark of modern history. Significant developments such as the creation of the Internet (originally ARPANET) for decentralized communication and the development of the Global Positioning System (GPS) for submarine tracking highlight this connection. Despite this close relationship between technological development and the peace and security sector, it is only quite recently that peacekeeping missions have sought to fully integrate advanced digital technologies into their operational frameworks. In 2021, the UN launched a Strategy for the Digital Transformation of Peacekeeping, emphasizing the importance of adapting to the digital age. This strategy aims to drive technological innovation both at the UN Headquarters and in field missions, maximizing the potential of current and emerging technologies. These technologies are not only augmenting traditional peacekeeping methods, but they are also opening new frontiers in how peacekeeping missions are conducted and managed. Indeed, digital technologies are already enabling peacekeepers to carry out more effective operations including intelligence gathering, surveillance, reconnaissance, and knowledge management (FIGURE 5.1).[113]

In assessing potential applications of digital technologies, it is important to recognize the changing nature of peacekeeping operations. While originally focused on monitoring ceasefires and peace agreements, these operations have transformed into multi-dimensional endeavors that address a broad spectrum of needs in conflict-affected countries. Today, peacekeeping missions extend beyond traditional security roles to provide comprehensive support in political, peacebuilding, and environmental domains, all while navigating the intricate civil-military pathways to a sustainable peace. In situations where land, oil, and other natural resources had a significant role in the conflict, a growing number of peacekeeping missions have received a mandate to support improvement of environmental and natural resource governance, as well as monitoring potential disputes over natural resources so they can intervene before the disputes escalate.

FIGURE 5.1: KEEPING WATCH: MONITORING TECHNOLOGY AND INNOVATION IN UN PEACEKEEPING.



Source: UN University, Tokyo; A Dorn 2011.

5.2 USE CASES

Our horizon scanning identified three important use cases in which digital technologies have enabled peacekeeping missions and humanitarian operations to implement mandates linked to natural resources and the environment. The case studies highlight the transformative impact of these technologies in supporting peacekeeping and humanitarian mandates, illustrating their role in advancing operational effectiveness and contributing to the broader objectives of maintaining peace and security in complex conflict contexts. From advanced data analytics to remote sensing, the chapter explores how digital innovation is reshaping the landscape of modern peacekeeping and humanitarian support.

UN peacekeeping missions collect and use intelligence on emerging sources of conflict and insecurity through the Situational Awareness Geospatial Enterprise (SAGE) event database tool and the Joint Mission Analysis Centre (JMACs).[114] In practice, these early warning systems mobilize action once an event has occurred. They also have the potential to use predictive analytics to anticipate events on the ground based on finer and disaggregated data that measures factors contributing to the onset and termination of violent conflicts in a given area.[115]

CASE STUDY 5.1 shows how Earth observation data and participatory processes can be used to support the resource governance mandates of peacekeeping mission.[116] It discusses the use of remote sensing to conduct sustainability assessments of Colombian landscapes and provide agroecological guidance in collaboration with local communities. In this case, remote sensing was also used to assess the impact of conflict on agriculture and other resource-based livelihoods.

The second use case relates to demining. High-resolution satellite imagery, below 10cm resolution, can be used by geospatial models to analyze and estimate locations most exposed to unexploded ordnance,[117] as tested in Cambodia.[118] Unmanned aerial vehicles like drones, robots, and other technologies have improved land mine detection and removal significantly.[119] CASE STUDY 5.2 illustrates the use of AI and satellite imagery to facilitate the detection and clearing of mines and unexploded ordnance.

Digital technologies can enable both peacekeeping missions and humanitarian operations in a peacekeeping context to minimize environmental risks to their operations. CASE STUDY 5.3 discusses the use of the Nexus Environmental Assessment Tool (NEAT+), which assists humanitarian organizations in assessing and mitigating environmental issues in field operations.

5.2.1 Identifying and preventing illegal natural resource exploitation and trade

Illegal and illicit extraction of and trade in minerals, timber, animals, and other natural resources can destabilize communities and countries. The extraction of and trade in conflict resources can both finance and drive conflict. Moreover, the illegal and illicit often provide incentives for peace spoilers, and addressing conflict resources—and thereby laying the foundation for a sustainable peace—is often complicated by the involvement of organized crime.

Transnational organized crime is a global threat affecting local livelihoods and destabilizing countries. Drugs, firearms, wildlife, waste, and human trafficking flow across country borders and customs. Estimates from 2018 indicate that transnational organized crime generated about US$1.3 trillion,[120] from which environmentally sensitive commodities account for approximately US$91-258 billion annually.[121] Digital technologies can help take more effective action and prevent illicit trade by automatically detecting illicit goods.

Where the illegal and illicit extraction of and trade in natural resources played a role in financing armed conflict, peacekeeping missions often have a mandate to help restore government control over these resources. Peacekeeping missions in the DRC, Liberia, and Sierra Leone, among others, have had direct mandates to help reestablish control over diamonds, timber, and other natural resources. In the DRC, for example, the UN Security Council empowered UN peacekeepers to cooperate with national authorities to inspect mineral shipments at transit points; conduct joint operations to dislodge rebels from mining sites; and support traceability systems to fight illegal trade in conflict resources.[122]

Artificial intelligence (AI) is the backbone of automatic detection because it provides an improved capacity to screen and identify the illegal exploitation of natural resources and their trade. Applications include automatically detecting artisanal and small-scale mining or oil refining from satellite imagery,[123] online ivory trade using machine learning,[124] unregulated fishing by assessing the trajectories of vessels,[125] illegal forest logging through remote audio sensing,[126] and even authenticating the certified diamond trade with blockchain.[127] Automated detection can identify illegal substances and items at international borders, and AI increases detection capacities with less manual interaction and hinders illegal trade and the funding of criminal organizations.

5.2.2 Enhancing natural resource management, livelihoods, and economic recovery

In conflict-affected and transitional settings, weakened governance structures and inadequate basic service provisions often lead to the overexploitation of natural resources. Communities in such war-torn environments frequently depend on these resources for essential needs like food, water, and income, as basic services are commonly disrupted or absent. In this context, a healthy environment becomes a critical pillar for supporting livelihoods, driving economic recovery, fostering stabilization, and nurturing peace.

One way affected communities in post-conflict settings can benefit from digital technologies is through the use of IOT (Internet of Things) devices and related tools to monitor environmental conditions. This includes tracking the quality of drinking water, assessing soil fertility, observing weather patterns, measuring air quality, or planning for agricultural activities based on forecasts.[128] In some cases, these technologies can be introduced into local communities through the transfer of equipment from peacekeeping missions.[129]

Demobilization programs for ex-combatants also require an integrated understanding of natural resources' role in financing conflicts and the impacts of conflict on the natural environment. These programs, aiming to curb the economic motivations of armed group members, often necessitate collaboration across various sectors, including customs and border controls, financial institutions, extractive industries, and land tenure systems.[130]

Digital technologies can help kickstart sustainable livelihoods for both local communities and ex-combatants, smoothing the transition towards peacebuilding and sustainable development. CASE STUDY 5.1 discusses the use of remote sensing to conduct sustainability assessments of Colombian landscapes and provide agroecological guidance in collaboration with local inhabitants.

Photo: An Afghan woman spinning wool outdoors in Kabul, Afghanistan. © Zahra Khodadadi/UN Environment Programme

CASE STUDY 5.1
A MULTISCALE SUSTAINABILITY ASSESSMENT OF PRODUCTIVE LANDSCAPES IN POST-CONFLICT REGIONS OF COLOMBIA

SERENA CAUCCI AND JAIRO GUZMAN • United Nations University – Institute for Integrated Management of Material Fluxes and of Resources (UNU-FLORES)

For more than 50 years, Colombia's rural regions suffered from conflict with the FARC-EP, a revolutionary guerrilla movement, and other armed groups. The mediation and peace processes between the government and the FARC-EP led to the end of the armed conflict in 2016.[131] The conflict directly affected over nine million people, leaving behind deep-rooted challenges that have destabilized social structures and rural governance mechanisms, as well as unsustainable land use change. Cultivated lands have expanded to the detriment of previously wild areas, leading to diminishing native forests in post-conflict areas,[132] harming biodiversity, and causing an increase in CO_2 emissions[133] through unsustainable farming and forest loss.[134]

Post-conflict environmental and socioeconomic impact assessments were crucial to evaluating the state of the natural environment and to informing programming priorities. They were also used to strengthen the participation of vulnerable communities affected by the conflict in decision making processes.[135] These assessments recommended re-establishing the balance between the altered and natural environment through the restoration of ecosystem services and the implementation of sustainable agricultural practices, as well as by supporting the reintegration of ex-combatants through green jobs. Since then, more than 13,000 ex-combatants have benefited from the national government's peacebuilding and demobilization programs, which often rely on natural-resource based livelihoods.[136]

UNU–FLORES joined forces with United Nations and national peacekeeping forces in Colombia to scale up sustainable farming practices and increase trust between institutions and communities in conflict areas. The Colombian Ministry of Defense played a critical role, mediating between institutions and citizens thanks to its position as a trusted institution. The Eighteenth Brigade and the Fifth Division of the Colombian army collected environmental data and documented agro-environmental practices in post-conflict municipalities, which were later analyzed by UNU-Flores (FIGURE 5.2).

The collected field data was based on a questionnaire that examined agricultural practices, the impact of the COVID-19 pandemic on farmers, natural resources availability and access as well as gender and security perspectives. This data was georeferenced to feed geospatial models that analyzed regions and detected vulnerabilities, threats, and opportunities to improve the management of natural resources and sustainable food production in conflict-affected areas of Colombia.

The methodology used to determine priority areas was based on the analysis of a set of environmental and social vulnerabilities, combining field and Earth observation data. Satellite and climate-derived land-use typologies, combined with data at the food producer level were integrated to calculate vulnerabilities, which helped practitioners identify areas for priority action.

FIGURE 5.2: MOORLANDS ECOSYSTEM RECOVERY ACTIVITY AT THE NATIONAL NATURAL PARK CHINGAZA IN CUNDINAMARCA.

Source: Press Office, Eighteenth Brigade 2021.

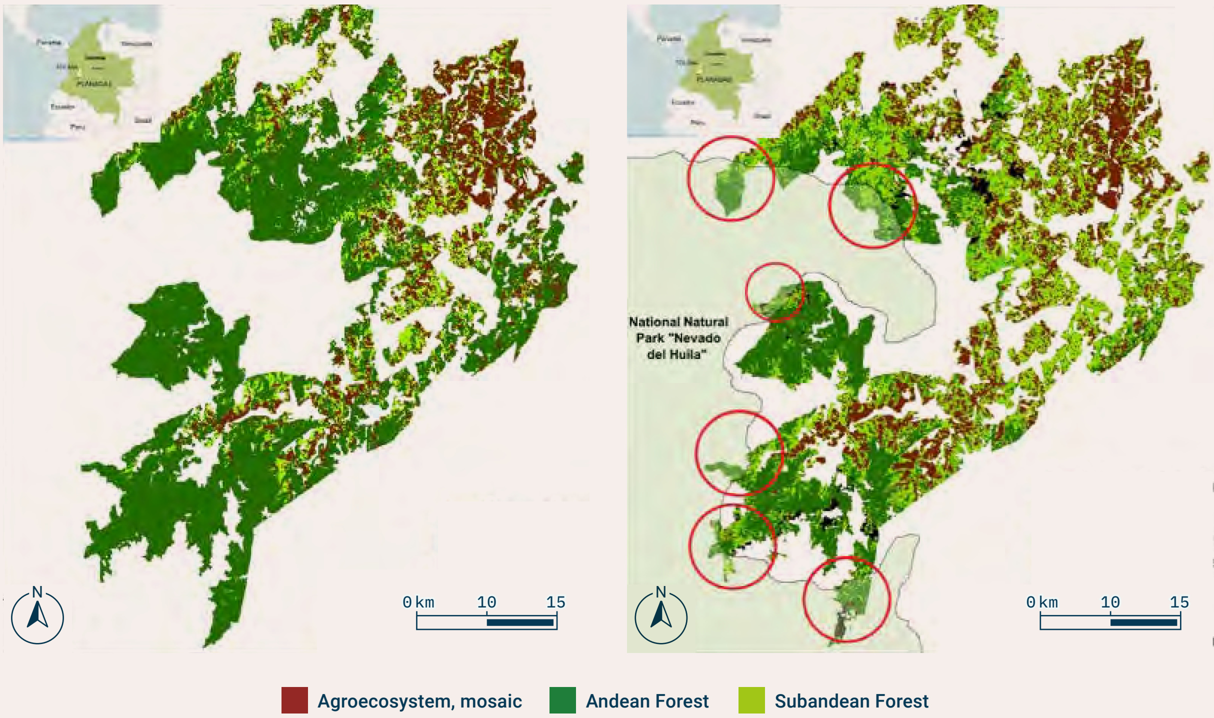
Once critical areas for intervention were identified, their ecosystem services, including soil maintenance, food production, and drinking water production, were examined in detail to determine the deterioration caused by climate change and natural resources exploitation (FIGURE 5.3). The outputs from the geospatial exercise were then discussed in community workshops with relevant stakeholders to find nature-based solutions to restore degraded ecosystem services and introduce more sustainable farming practices.

As a result of the cooperation between UNU-FLORES, local communities, the Colombian Ministry of Defense, and UN peacekeepers, a database with more than 280 entries has already been developed and shared with the interested communities. Additionally, more than 300 small food producers in Planadas are working in the framework of a pilot project on sustainable agricultural practices (FIGURE 5.4). With this programme, UNU-FLORES aims to establish a data- and community-driven knowledge platform that supports decision making processes by relying on natural resource management and cooperation, within a holistic approach to the care for degraded ecosystems at the community level.

FIGURE 5.3: SPATIOTEMPORAL LAND COVER SCENARIOS FOR THE MUNICIPALITY OF PLANADAS-TOLIMA.

(A) The land cover in 1985 was developed by a supervised classification method (Landsat-5 image).
(B) Land cover in 2020 (Landsat-8 image), supervised classification with a combination of bands 6-5-2.
Red circles mark the expansion of the agricultural border into the protected area of the Natural Park Nevado del Huila.

A - LANDCOVER PLANADES 1985 **B - LANDCOVER PLANADES 2020**



Source: UNU-FLORES 2021.

FIGURE 5.4: CITIZEN SCIENCE PROJECT CARRIED OUT IN PLANADAS, TOLIMA REGION.

Source: Astrid Rocio Gutierrez 2021.

5.2.3 Supporting the identification of mines and unexploded ordnance

Landmines and unexploded ordnance (UXO) present ongoing threats to public health long after a conflict ends. They also mean that land is unavailable to support livelihoods, food security, and economic recovery. As a result, detecting and removing mines and UXO is a priority for post-conflict peacebuilding. Digital technologies offer innovative solutions for the detection of mines and UXO, significantly enhancing safety and programming in post-conflict areas. Utilizing a combination of advanced sensors, robotics, and artificial intelligence, these technologies can precisely locate and identify hidden dangers that traditional methods might miss.

One of the key technologies in this field is ground-penetrating radar (GPR). GPR systems use electromagnetic waves to scan the ground and create images of subsurface structures. This technology is particularly effective in detecting non-metallic mines and UXO, which are often difficult to find with conventional metal detectors.

Drones equipped with sophisticated sensors have also become an invaluable tool in mine detection. They can cover large areas quickly and safely, providing real-time data and high-resolution imagery.

Another innovative approach involves the use of robotic systems. These remotely operated or autonomous robots can enter hazardous areas to perform mine detection tasks, reducing the risk to human deminers. Equipped with a variety of sensors and sometimes even manipulator arms for disarming or marking mines, these robots represent a significant advancement in demining operations.

Artificial intelligence and machine learning play a crucial role in enhancing the capabilities of these technologies. AI algorithms can process vast amounts of data from sensors and drones, identifying patterns and anomalies that indicate the presence of mines or UXO. This not only speeds up the detection process but also improves its accuracy.

The integration of digital technologies in mine and UXO detection marks a significant leap forward in demining efforts. By harnessing the power of GPR, drones, robotics, and AI, these technologies offer safer, faster, and more efficient methods to address the lingering threats of mines and UXO in post-conflict environments. CASE STUDY 5.2 showcases how these technologies are being used to detect unexploded ordnance in Cambodia, Czech Republic, and Ukraine.

Photo: Small-scale farming in Bamyan, Afghanistan. Mountain farming has been a model for sustainable development for centuries and is inherently "green" thanks to its small-scale character and low-carbon footprint.© Alec Knuerr/UN Environment Programme

CASE STUDY 5.2
USING AI AND SATELLITE/DRONE IMAGERY TO DETECT UNEXPLODED ORDNANCE IN CAMBODIA, CZECH REPUBLIC, AND UKRAINE

ASIM ZIA • University of Vermont

There is growing use of artificial intelligence (AI) technologies and remote sensing in post-conflict settings to support the "demining" of unexploded bombs. Machine learning and computer vision AI algorithms can improve both the accuracy and precision of detecting unexploded ordnance (UXO), which is a necessary first step for any demining project that aims to safely remove UXO in post-conflict areas. The approaches are still being developed.

Lin et al. (2020) used a two-stage machine learning algorithm to detect Vietnam War-era bomb craters in Cambodia from satellite images.[137] This AI method increased true bomb crater detection by more than 160 percent over standard methods. By combining declassified U.S. military records with satellite data, Lin *et al.* found that 44 to 50 percent of the bombs in the area studied may remain unexploded. A commercial satellite—multispectral WorldView2—image of a 100-square-kilometer area near the town of Kampong Trabaek in Cambodia was chosen as the study site. This site was the target of carpet bombing by the U.S. Air Force from May 1970 to August 1973.

A two-stage random forest machine learning process was used in developing this AI UXO detection technology. In the first stage, AI algorithms were used that have been previously developed to detect meteor craters on the moon and planets. The second stage of the process builds on the intricacies of how bomb and meteor craters are different by considering the novel features of bomb craters, including their shapes, colors, textures, and sizes, as shown in FIGURE 5.5.

Declassified military data indicated that 3,205 general purpose bombs – known as carpet bombs – were dropped in the area analyzed for this study. This information, combined with demining reports and the results of the study, suggests that from 1,405-1,618 unexploded carpet bombs may still be unaccounted for in the area. That represents 44-50 percent of the bombs dropped there. While this AI method improved detection of UXO in Cambodia, the second "demining" step of actually removing UXO involves costly investments that still need to be fully implemented to save the lives of many farmers living in this area who continue to lose their lives regularly from the UXO.

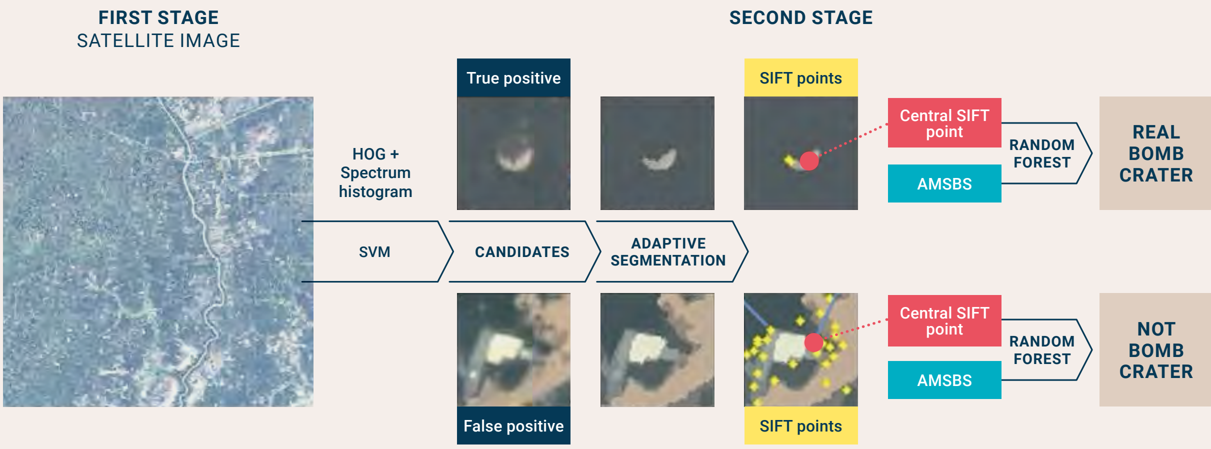
Duncan *et al.* (2023) improved upon the random forest machine learning approach used by Lin *et al.* (2020) by applying deep learning algorithms in a field site in Ukraine that was bombed in 2014.[138] Duncan *et al.* estimates revealed over 22,000 craters in the subregion occupying 1.2 km^2, or 0.14 percent of the region, primarily comprising agricultural fields.

In Northwest Czech Republic, Dolejš *et al.* (2020) applied a convolutional neural network deep learning model on eight Second World War (WWII) aerial bombing crater sites via Airborne Laser Scanned LiDAR-derived digital terrain models with different spatial resolutions.[139] They found that sub-meter resolution data combined with deep learning AI methods can outperform traditional methods.

Kussul *et al.* (2023) further improved the AI method by demonstrating that data fusion AI algorithms that combine data from multiple streaming satellites in real time can further improve demining capacity to detect UXO in a continuous, daily to weekly timescale.[140]

While these AI methods are improving rapidly, harnessing the information generated by these AI technologies to directly support removal of UXO in post-conflict situations needs to be further investigated.

FIGURE 5.5: WORKFLOW OF THE TWO-STAGE FRAMEWORK FOR BOMB CRATER DETECTION.



Source: Lin et al. 2020.

5.2.4 Minimizing environmental risks to and impacts of humanitarian operations

Humanitarian operations focus on alleviating human suffering. Nevertheless, they are affected by environmental risks, and they have environmental impacts, which digital technologies can help minimize.

While this is now changing, humanitarian operations in conflict situations have historically considered environmental impacts as a secondary priority compared to immediate lifesaving services. Considering, however, that refugees spend an average of four to twenty years in camps,[141] humanitarian actors must not only anticipate lifesaving needs, but also prepare for post-conflict and reintegration activities of displaced populations, including by developing sustainable livelihoods based on natural resources. However, safeguards and best practices must be in place to avoid the exacerbation of power asymmetries and discrimination intrinsically linked with the application of data and digital technologies in these operations.[142]

Satellite imagery can be used strategically to design and establish refugee camps to minimize exposure to environmental risks such as natural hazards, slope inclination, climate conditions, and distance to infrastructure and services.[143] After the establishment of bases or camps, satellite imagery can track their growth through object-based classification and estimate the impact on surrounding natural resources. For example, satellite data was used to minimize the impact of Rohingya refugee camps on biodiversity in Bangladesh.[144] Understanding these environmental risks and impacts as well as how to address them has become key to ensuring the effectiveness and sustainability of peacekeeping and humanitarian operations in dynamic and unpredictable socio-ecological contexts. Minimizing local environmental impacts helps prevent grievances and conflicts with local communities while also protecting the reputation of humanitarian organizations.

Data infrastructure and sources such as geographic information systems (GIS) can be used to analyze and screen potential environmental risks. CASE STUDY 5.3 demonstrates the use of the Nexus Environmental Assessment Tool (NEAT+), which assists humanitarian organizations in assessing and mitigating environmental issues in field operations.

CASE STUDY 5.3
MINIMIZING ENVIRONMENTAL RISKS TO HUMANITARIAN OPERATIONS WITH NEAT+

EMILIA WAHLSTRÖM AND THERESA DEARDEN • United Nations Environment Programme (UNEP) and Office for the Coordination of Humanitarian Affairs (OCHA) Joint Environment Unit

While humanitarian response is often focused on immediate lifesaving activities, ignoring environmental considerations can leave displaced and host communities at a greater risk from natural resource degradation or unsafe environmental practices. In rapid and mass resettlement situations, new patterns of unregulated resource exploitation between host and displaced communities can lead to heightened social tensions, increased risks to human health, and negative environmental impacts. Common issues include deforestation, unsustainable water resource management, and limited options for sound waste management.

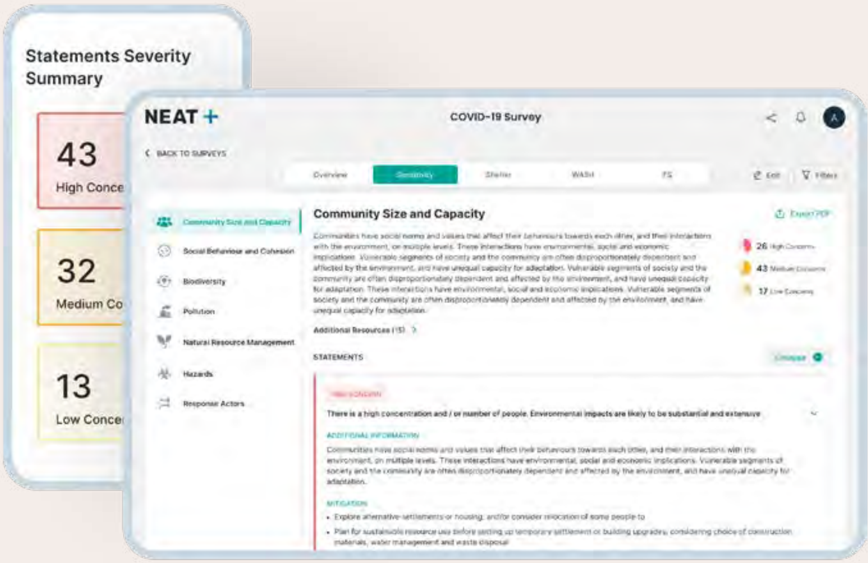
To address this situation, the Nexus Environmental Assessment Tool (NEAT+) was developed in a joint multi-stakeholder project to improve collaboration between environmental and humanitarian actors on the ground. The tool enables humanitarian practitioners to identify potential environmental hazards by conducting a rapid and simple project-level environmental screening in humanitarian settings. It provides a practical approach to integrate more sustainable environmental practices into humanitarian aid.

Recognizing the need to include robust environmental intelligence in the tool, NEAT+ developers integrated technological innovation and multiple sources of data. Algorithms weigh user-generated answers from a simple questionnaire to create detailed automated environmental risk reports and mitigation tips. The NEAT+ assessment questionnaire is completed in the field using KoBo Toolbox, a simple, open-source tool for mobile data collection. The analytics are open-source and can be built on and modified by organizations who wish to change the scale or the language to better suit their operations.

NEAT+ also connects users, who are completing the questionnaire, to environmental spatial data on MapX, an online, open-source mapping platform managed by UNEP/GRID-Geneva. It is built on cloud-computing infrastructure and hosts global environmental data sets from leading research institutions and organizations, as well as project-specific environmental data at the national and local scales. Connecting humanitarian actors to verified environmental global data in NEAT+ enhances the accuracy and reliability of the results in the environmental risk report. The report provides a "traffic light" of potential environmental risks and connects users to mitigation tips and resources for planning sustainable interventions (FIGURE 5.6).

NEAT+ has been successfully tested in over twenty emergency settings worldwide by more than ten different humanitarian organizations, with promising results. Pilot tests have concluded that the tool is easy to use, provides accurate and nuanced results, condenses heavy environmental guidance documents efficiently, and strengthens linkages to planning cycles.

FIGURE 5.6: THE NEAT+ SURVEY ALLOWS PRACTITIONERS TO QUICKLY IDENTIFY ISSUES OF ENVIRONMENTAL CONCERN IN ORDER TO MAKE EMERGENCY AND RECOVERY INTERVENTIONS MORE SUSTAINABLE.



Source: UNEP and OCHA 2021.

For example, at the Mantapala refugee camp in Zambia, a NEAT+ pilot process highlighted extensive deforestation around the camp, caused by the domestic energy and construction needs of the displaced community (FIGURE 5.7). Thanks to the participatory process of completing NEAT+, stakeholders identified that a planned livelihood activity—the production of burnt bricks—would result in more deforestation, and recommended re-programming the intervention.

Since socio-environmental relations and impacts vary greatly between humanitarian operations in urban and rural settings, NEAT+ has two adaptations: rural R-NEAT+ and urban U-NEAT+. This differentiation was needed as over 60 percent of refugees and 80 percent of internally displaced people reside in urban areas. Both tools can be accessed freely from the Environmental Emergencies Centre (EEC).[145]

FIGURE 5.7: MANTAPALA REFUGEE CAMP IN ZAMBIA, ASSESSED BY NEAT+.

Source: UNEP and OCHA 2021.

5.3 RISKS AND CHALLENGES

Peacekeeping and humanitarian operations bear the critical responsibility of ensuring the safety and security of their staff, personnel, and stakeholders. While digital technologies offer significant opportunities to strengthen this mandate of protection, their implementation must be carefully managed to minimize potential harm and avoid unintended consequences.

In many peacekeeping and humanitarian interventions, digital infrastructure can be damaged or compromised, leading to challenges such as limited electricity and connectivity. This is particularly problematic in remote operation areas, where implementing high-tech digital solutions may not always be feasible or the most effective choice. Therefore, practitioners should consider a combination of high- and low-tech solutions, tailored to the specific context as well as the reliability and resilience of the available digital infrastructure.

Another challenge in peacekeeping settings is the scarcity, difficulty in collection, and potential bias or manipulation of field data. This data is fundamental for threat analysis but can be influenced by political motives. Moreover, there is a risk of violence against peacekeepers involved in collecting and sharing sensitive data about local communities or illegal resource exploitation. Civilians cooperating with peacekeepers by sharing information may also face threats or retribution if their personal data is not securely managed.[146]

The growing reliance on digital tools for data collection may prompt some peacekeeping operations to favor remote data gathering to limit exposure to field-based risks. However, this approach can reduce direct interaction and relationship-building with affected communities, potentially weakening collaboration and trust. Moreover, data gathered remotely usually needs to be verified through ground-truthing. To address this, a blended approach that combines digital and in-person methods is essential, enabling the maintenance of social relationships with local communities.[147]

Finally, accessible digital technologies like social media can introduce new risks in conflict settings. These platforms can be utilized for recruiting combatants or spreading misinformation and disinformation. Misinformation campaigns, particularly those concerning land and natural resources, can significantly influence public perception and undermine the credibility of peacekeeping and stabilization efforts. Developing strategies to mitigate and respond to such misinformation campaigns, especially those related to natural resources and the environment, is imperative for the success and integrity of peacekeeping operations.[148]

5.4 CONCLUSIONS AND NEXT STEPS

The development of digital technologies has gone hand-in-hand with the security, defense, and humanitarian sectors and, now by extension, within peacekeeping operations. This chapter has shown how these technologies can be leveraged to support the growing mandates of peacekeepers regarding the environment and natural resources, as well as supporting their other mandates. It has also highlighted the importance of digital technologies in understanding and addressing environmental risks to humanitarian operations. To increase the safe and responsible use of digital technologies to support peacekeeping missions and humanitarian operations in managing the environmental risks and opportunities, the following four priorities have been identified.

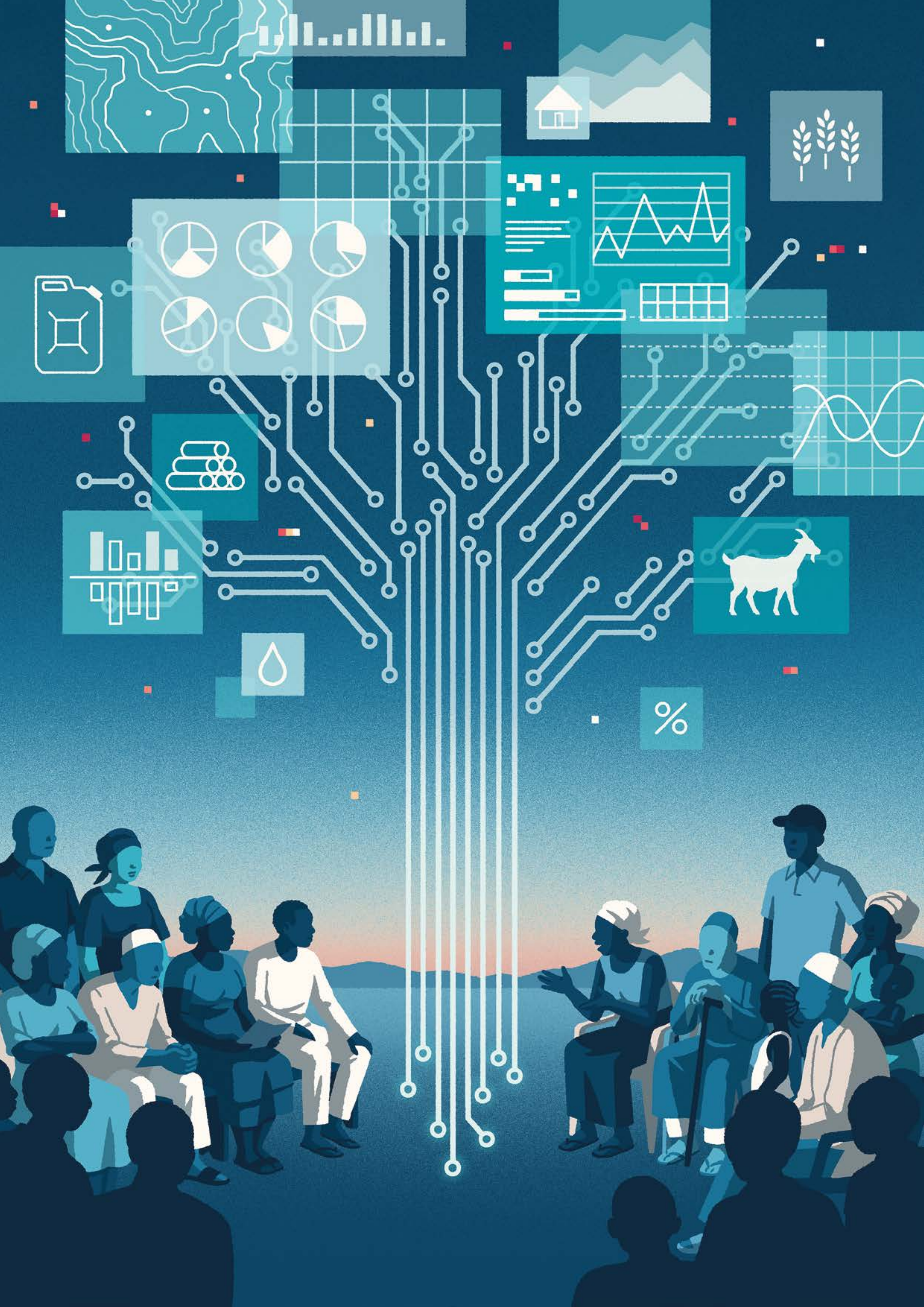
First, there is a critical need to enhance training and capacity building among peacekeeping and humanitarian personnel in the use of digital technologies to collect relevant environmental data, including those related to natural resource use and disputes. This involves not only technical skills but also an understanding of the ethical and security implications of using these technologies in conflict environments.

Second, implementing stringent data security and privacy measures is paramount. Peacekeeping and humanitarian operations often deal with sensitive land and natural resource information that, if mishandled, could jeopardize the safety of communities and ex-combatants as well as the success of missions. Ensuring the secure handling, storage, and transmission of data collected through digital means is critical to maintaining trust and effectiveness in peacekeeping and humanitarian efforts.

Third, adopting a balanced approach that combines digital technologies with traditional peacekeeping and humanitarian methods is crucial. While digital tools offer significant advantages, they cannot replace the insights and relationships built through on-the-ground engagements. A hybrid approach that leverages the strengths of both digital and traditional methods will lead to more comprehensive and successful operations.

Finally, developing and deploying digital technologies to identify and monitor the illegal trade of natural resources is a key priority. This involves using tools like satellite imagery, blockchain for supply chain transparency, and AI-based analytics to track and report illegal resource exploitation. Such technologies can provide crucial intelligence in disrupting illicit networks and supporting legal and sustainable resource management.

In conclusion, while digital technologies offer transformative potential for peacekeeping and humanitarian operations, particularly in managing environmental and natural resource-related aspects of conflicts, their integration must be approached with caution, foresight, and responsibility. By focusing on training, data security, and a balanced approach to technology use, peacekeeping missions and humanitarian operations can harness these tools effectively, enhancing their capacity to achieve their objectives in increasingly complex conflict scenarios.



CHAPTER 6

Post-conflict peacebuilding and sustainable development

ALBERT MARTINEZ • United Nations Environment Programme (UNEP)
RICHARD MATTHEW • University of California Irvine (UCI)[149]

6.1 INTRODUCTION

Post-conflict peacebuilding aims to reduce the risk of relapsing into violent conflict by strengthening national and local capacities for conflict management while rebuilding the social contract and restoring trust in institutions.[150] It is a complex, long-term process of creating the necessary conditions for the state to effectively and legitimately carry out its core functions.

In the last ten years, digital technologies have become ever more prominent in post-conflict peacebuilding.[152] Previous chapters of this report illustrated many opportunities for practitioners to embrace new technologies in early warning, preventive diplomacy, mediation, and peacekeeping interventions. These applications have in common the fact that they often improve the capacities of practitioners to provide more effective services to beneficiaries and stakeholders on conflict risks and peacemaking opportunities linked to natural resources and the environment. However, the greatest potential for digital technology in post-conflict peacebuilding lies in improving the inclusion, engagement, and collaboration of conflict-affected people in the direct management of natural resources and climate change adaptation efforts.[152]

6.2 USE CASES

Our horizon scanning identified four use cases showcasing how digital technologies are supporting peacebuilding processes to address environment, natural resource and climate change risks and opportunities.

Many of the most significant use cases lie in engagement by empowering local participation and supporting peace processes at the community level.[153] Digital technologies offer new engagement avenues for community involvement through social media,[154] civic mobilization websites, and policy change platforms.[155] In fragile and post-conflict contexts, these technologies can help boost civic engagement in local affairs,[156] provide citizen-based early warning services,[157] monitor and report on land or natural resource disputes,[158] strengthen the identity and representation of minorities,[159] and enable marginalized migrant groups to start business ventures.[160] The fundamental commonality for the success of these approaches is their emphasis on local ownership, by combining the empowerment of grassroots initiatives, decentralization, and the rationalization of governmental and international interventions.[161]

The first use case focuses on how new digital innovations, such as blockchain, could increase the traceability of high-value natural resources to tackle systemic corruption,[162] address social and sustainability challenges such as child labor[163] and slavery,[164] and even support the formalization of land tenure and associated rights in an effort to enhance the livelihoods of rural populations.[165] However, in contrast to simple and inexpensive websites, blockchain may be less accessible due to significant upfront costs and the high degree of digital literacy required to understand it. CASE STUDY 6.1 describes how blockchain enables small farmers in Colombia to remain in the cacao business and not divert to the traditionally more profitable cultivation of illegal coca.

The second use case introduces how digital technologies can support spatial data infrastructures which are necessary to underpin the management of information about natural resources and land rights. CASE STUDY 6.2 focuses on how spatial data infrastructures underpin the formalization of land rights through the reconstruction of the land records system in post-conflict Timor-Leste. Similar approaches have been deployed in countries such as Sierra Leone, Afghanistan, and Cambodia.[166]

The third use case depicts how digital technologies can be used to monitor the impact of natural resource regulations. CASE STUDY 6.3 focuses on the Sapo National Park in Liberia demonstrating the use of Earth observation to monitor the results of natural resource management policies and regulations in a peacebuilding context.

Extending beyond the monitoring of natural resource governance efforts, the final use case illustrates the power of digital technologies to help identify and track local conflicts related to land, minerals, and other natural resources. CASE STUDY 6.4 showcases how a conflict-tracker tool can help to monitor community-level disputes over land, water, and forests in Nepal, informing programming, monitoring, evaluation, and learning.

In addition to the four use cases presented in this chapter, a number of initiatives are under development to equip decision makers and practitioners with concrete models of interventions that can support sustainable peace through improved natural resource management. For example, UNEP has partnered with PAX and a coalition of other institutions to develop a Digital Catalog of Nature-based Solutions (NbS) for Peace that provides users with relevant examples that can be replicated or adapted in climate adaptation and peacebuilding. Users can search the Catalog using a broad range of criteria, including region and country, type of ecosystem and type of intervention, and a decision making tool helps less experienced users identify the most relevant cases for their specific context. While available as a standalone tool, the Digital Catalog will be integrated into the Strata platform, where it will enable users to view examples of solutions that have been used to address the constellation of risks highlighted by the Strata algorithm for the selected area.

6.2.1 Formalization and equitable benefit sharing in natural resource exploitation

To build sustainable peace, it is essential to address the social, political, and environmental issues related to high-value natural resources, from minerals like gold and diamonds to crops such as cashews, poppy, and coca. It is also necessary to establish local level governance frameworks for renewable resources such as water, land, and agriculture.

The international community has tried to control the illegal extraction and trade of oil, gas, and minerals (often referred to as "extractive resources") by establishing Security Council sanctions and other methods like the Kimberley Process Certification Scheme for diamonds or the Extractive Industries Transparency Initiative. A growing number of efforts also seek to support local communities to formalize rights to the resources that they depend upon and thereby support sustainable livelihoods and contribute to income security, better working conditions, and community benefits.[167]

Digital technologies such as blockchain or digital product passports have the potential to both enhance the traceability of high-value natural resources[168] and support the formalization of their exploitation. Blockchain could be instrumental in managing extraction, supply chain transparency, and revenue-sharing for high-value natural resources and agricultural goods. CASE STUDY 6.1 describes how blockchain enhances sustainable cacao production through greater financial independence and traceability, allowing small farmers in Colombia to remain in the cacao business and not divert to the traditionally more profitable cultivation of illegal coca.

Photo: UNEP Multimedia exhibition: Accessing UNEPLive at UNEA Multimedia exhibition.©UN Environment Programme

CASE STUDY 6.1
EMPOWERING LOCAL CACAO FARMERS IN COLOMBIA WITH BLOCKCHAIN

SARAH NOURALY AND MATT WHITEMAN • Choco4Peace (2021)

Fragile contexts, where governance and institutions struggle, hinder sustainable development and fair profits. In the post-conflict regions of Colombia, many cacao farmers live in poverty due to a lack of access to education, finance, insurance, markets, and technology.

In 2016, the Colombian government reached a peace agreement to end a 50-year conflict with guerrilla groups and initiated a program to substitute productive agricultural crops such as cacao for illicit crops such as coca—the core ingredient in cocaine. In return, farmers received multiple benefits, including funds and technical assistance. Private sector participation in this program was fundamental to mobilize capital and support market access, as well as provide education and tools to improve the chances of success for farmers and ensure their ability to transition to cacao cultivation successfully.

Colombian cacao farmers primarily sold their products at bulk prices to two Colombia-based multinational companies who bought over 80 percent of Colombian cacao. Neither company paid a premium for the higher quality of local *fino de aroma cacao*, which constitutes the vast majority of Colombian cacao.[169] Furthermore, the bulk nature of trading prevented small farmers from accessing international markets, for which they would need intermediaries who offered premium prices. Consequently, small-holder farmers were poorly paid for their high-quality cacao and often reverted to illegal coca cultivation which offered a more lucrative alternative for survival.

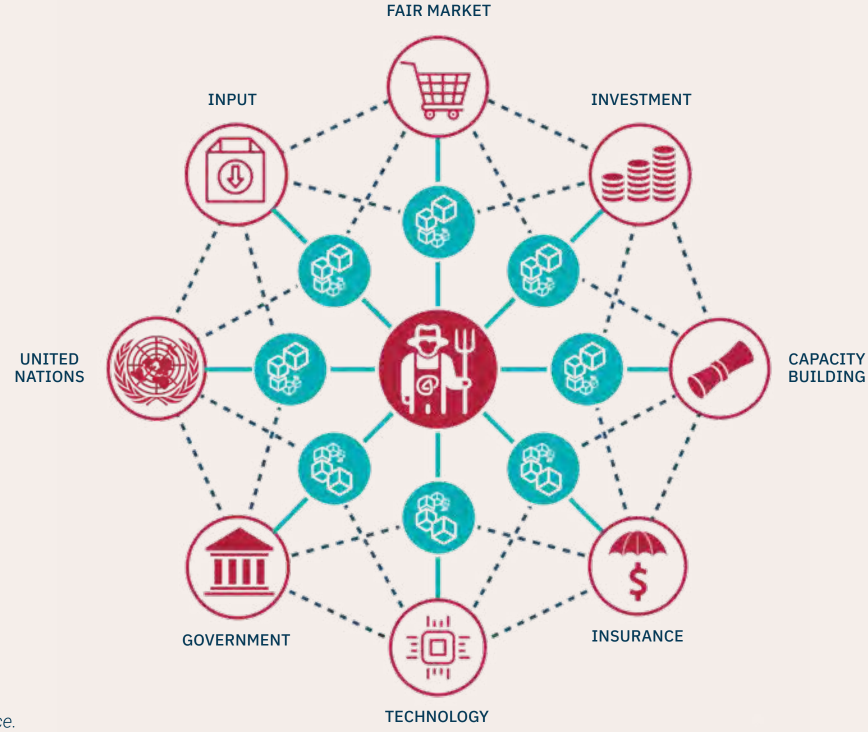
To address this situation, Choco4Peace helped small holding farmers to use smartphones to access a digital platform, which facilitated international market access, including direct communication with buyers, banking and insurance options, and essential market information. The platform enabled farmer and farming cooperatives to record cacao quality, the social and environmental impact, and the provenance information. This way, buyers could gain access to crucial supply chain information which added value to their purchase.

Choco4Peace also developed an innovative business model using blockchain to power a decentralized inclusive economic network, that offered digital tracking and certification of any transaction (FIGURE 6.1).

This blockchain-based system aggregated cacao growers, investors, and buyers, providing cacao producers with capacity building, finance, insurance, technology, and certification services necessary to produce cacao and mitigate investment risk sustainably. Using this digital platform, banks could reach farmers directly and offered loans and financial support which addressed the US$215 million per year financing gap of the Colombian cacao sector.

Choco4Peace's project promoted peacebuilding through sustainable agricultural practices and the empowerment of marginalized people. It provided a platform that builds trust, transparency, and traceability while reducing time spent and costs, thus supporting small farmers to transition from illegal crops to cacao cultivation.

FIGURE 6.1: MODEL OF CHOCO4PEACE'S DECENTRALIZED INCLUSIVE ECONOMIC NETWORK.



Source: Choco4Peace.

The project initially operated in Tumaco, located in the southwestern corner of Colombia, near the border with Ecuador. Here 80 percent of farmers lived below the poverty line, and 74 percent of people were unemployed, which often drove individuals to resort to illegal activity for survival. The platform helped to lift 100 farming families out of poverty, most of whom were war victims and ex-coca producers, with priority support to women and indigenous producers (FIGURE 6.2). Thanks to partnerships and new funding, the project was scaled up to 1,000 farmers and aimed to support all 70,000 cacao farmers in Colombia. Choco4Peace's model shows that digital technologies can enable formalization of livelihoods, market access, and poverty reduction outcomes.

FIGURE 6.2: COLOMBIA'S FARMERS AND ENTREPRENEURS USING BLOCKCHAIN TO TRADE THEIR CACAO.

Source: Choco4Peace.

6.2.2 Spatial data infrastructures and land administration systems

Spatial data infrastructures (SDIs) play a crucial role in modern land administration systems, particularly in the context of peacebuilding and sustainable development. At a national level, SDIs consist of policies, networks, and standards that facilitate the sharing, interoperability, and utilization of crucial spatial data. This data is pivotal for effective governance and management of natural resources and land tenure rights.

The importance of SDIs lies in their ability to integrate and harmonize spatial information from various sources, ensuring that it is accessible and usable for different stakeholders. This includes governmental bodies, private sector entities, citizens, and international organizations. Effective SDIs enable more transparent, efficient, and equitable land administration, which is essential in conflict-affected areas where land rights are often a contentious issue.

Furthermore, the integration of digital technologies in SDIs can include the use of geographic information systems (GIS), satellite imagery, and drone technology. These tools can provide detailed and up-to-date spatial data, essential for informed decision making in land administration. For instance, high-resolution satellite imagery can be used to map land use and land cover changes over time, providing valuable insights for land policy development and natural resource management.

CASE STUDY 6.2 highlights the transformative potential of digital technologies in supporting the reconstruction of land records in post-conflict Timor-Leste. By establishing digital registries and robust spatial data infrastructures, nations can streamline the process of recognizing and recording land tenure rights. This digital approach to land registration not only enhances the accuracy and reliability of land records but also improves accessibility for landowners and other stakeholders.

Photo: Extensive environmental damage from illegal mining on the Quito River, Chocó region © Juan Bello/UN Environment Programme

CASE STUDY 6.2
DIGITAL RECONSTRUCTION OF THE LAND RECORDS SYSTEM IN TIMOR-LESTE

Environmental Peacebuilding Association

Land records are often destroyed during conflict. This is sometimes a deliberate act; for example, to remove evidence that land was owned by members of a particular group (e.g., Timor-Leste and Afghanistan), or to eliminate the concept of private property (e.g., Cambodia).[170] Digital technology, including SDIs and GIS, can be useful not only in rebuilding those records, but also for preventing their future destruction by keeping back-up files in other countries, far removed from potential targeting.

Timor-Leste gained its independence from Indonesia in 1999. During the Indonesian occupation (1975–1999), much of the rural population was forcibly displaced; and during Timor-Leste's war for independence from Indonesia, land records were destroyed. After the conflict, the new Timorese government rejected Indonesian laws, with the result that there was no legal system governing land for more than a decade.

Despite the absence of a national land law, the Ita Nia Rai ("Our Land") project, implemented with support from the U.S. Agency for International Development and in partnership with the Timorese Ministry of Justice sought to strengthen property rights. From 2007 to 2012, the project undertook a suite of complementary policy, institutional, and practical measures, including the digital reconstruction of land records in all urban and peri-urban areas. The project was undertaken community by community, and was based on developing social agreement regarding the boundaries of each plot and its owners.

The Ita Nia Rai project first used local media and community meetings to raise awareness within communities about the project and its goals. Data collection teams would then visit a given neighborhood and record the names of those who claimed each parcel of land, taking photographs of the claimants; this including ensuring that women were formally recorded as co-owners where land was jointly claimed. The team documented global positioning system coordinates and photographed the markers that defined the corners of each land parcel. They also sought to compile information about the history of the land parcel.

Where there was disagreement regarding boundaries or ownership (e.g., between neighbors or competing claimants), the team recorded the disputed boundaries and identified the competing claimants. Aerial photography was used to create a master map of the community (FIGURE 6.3), in which the team delineated all parcels, including those in dispute. The maps also included photos of the recorded claimants. The maps were publicly displayed for thirty days, during which time people could verify claims and correct errors.

The project gave priority to parcels that were not in dispute, encouraging community members to discuss and resolve disputes. There was a deliberate effort to avoid creating incentives to contest ownership (for example, by providing compensation). Rather, the project provided local staff who were trained to mediate disputes.

The Ita Nia Rai project collected information on more than 50,000 parcels, with an overall dispute rate of less than 10 percent.[171] In 2011, an executive decree formalized all undisputed private claims to land; by December of that year, landowners received their first certificates of land registration.[172] By transparently recreating the national cadaster covering both urban and peri-urban areas, the project improved tenure security in post-conflict Timor-Leste.

FIGURE 6.3: RECONSTRUCTING LAND RECORDS THROUGH THE ITA NIA RIA PROJECT.

Source: Ita Nia Rai 2009.

6.2.3 Monitoring the governance of land and natural resources

In post-conflict peacebuilding contexts, the governance of land and natural resources is a complex and often contentious issue.[173] This complexity arises from the exploitation of these resources by a myriad of actors, each with divergent and competing objectives. Such exploitation frequently occurs in environments characterized by weak regulatory frameworks and limited enforcement, exacerbating the challenges of sustainable and equitable resource management.

Effective governance of land and natural resources is crucial in these settings. First, it plays a pivotal role in stabilizing post-conflict societies, as many livelihoods and key economic sectors heavily depend on these resources. Poor governance can lead to renewed tensions and conflict, undermining peacebuilding efforts. Second, sound governance mechanisms ensure that the benefits derived from natural resources contribute to the economic development and wellbeing of the entire population, rather than being monopolized by a few.

Digital technologies present significant opportunities to enhance the monitoring and management of these resources. Advanced tools such as satellite imagery, GIS, and remote sensing enable the tracking of land use changes, deforestation rates, and other environmental indicators. These technologies provide critical data that can inform policymaking, enhance transparency, and support the enforcement of regulations.

CASE STUDY 6.3 showcases the example of Sapo National Park in Liberia. It illustrates the use of Earth observation to monitor the effectiveness of new forest protection policies and regulatory efforts within the national park.

CASE STUDY 6.3

ASSESSING THE SUSTAINABILITY OF NEW RESOURCE MANAGEMENT POLICIES AND REGULATIONS IN LIBERIA'S POST-CONFLICT PEACEBUILDING PROCESS

ANUPAM ANAND AND GEETA BATRA • Global Environment Fund (GEF)
CARL BRUCH AND SHEHLA CHOWDHURY • Environmental Law Institute (ELI)

The Liberian economy is highly dependent on natural resource exports from the mining, forestry, and rubber sectors.[174] The timber economy played a significant role in the civil war between 1980 and 2003. As revenues from timber and other high-value natural resources were used to support and prolong the conflict, the United Nations Security Council imposed sanctions to prohibit trade in logs in 2003. It also provided a mandate to the peacekeeping mission (UNMIL) to monitor governance of Liberia's natural resources and the environment. In doing so, the international community recognized natural resource reform as key to the country's transition to peace.

Sapo National Park is the largest and first national park in Liberia and is a biodiversity hotspot within the Upper Guinea Forest ecosystem. However, the park has faced long-standing threats from illegal farming, hunting, logging, and mining, including by ex-combatants. During the post-conflict peacebuilding process, international programming efforts prioritized the park to protect and enhance its governance through a series of regulatory reforms, policies, and projects.

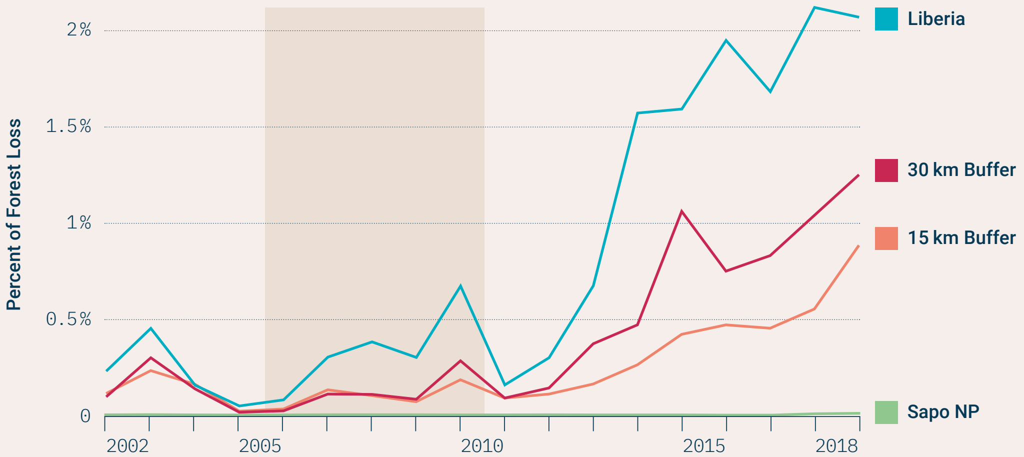
To assess the sustainability of those initiatives, geospatial analysis was conducted based on time series of satellite images taken of the park and its surrounding ecosystems. Results indicated positive and sustained forest conservation trends in project areas. FIGURE 6.4 shows almost no deforestation within the park boundary (flat green line), and only minimal forest loss in the buffer zone. These results are be explained by the prohibition of all economic activities, including mining, enacted by the reformed national park legislation.

The results indicate that the efforts to protect the park's resources were sustained beyond the project duration and supported through subsequent interventions. This trend inside the park contrasts with the phenomenal increase in forest loss outside the park, mainly driven by illegal activities such as mining and logging combined with some legal mining concessions in the buffer zone. The two dips in forest loss outside the park (around 2005 and 2010) coincide with the eviction of illegal gold miners and settlers.[175] The depletion of forest areas in the buffer zones of Sapo National Park can be attributed to several factors, including insufficient financial, technical, and human resources as well as an insufficient legal protection.[176] These limitations hinder effective monitoring and management of artisanal and small-scale mining sites, as well as other illegal activities that contribute to forest loss.

FIGURE 6.4: SATELLITE IMAGE OF THE SAPO NP AND ADJACENT BUFFERS.

Deforested areas are visible in red color around Sapo NP, adjacent 15 km, and 30 km buffers (2001-2018)

Deforestation trend in Sapo National Park, adjacent 15 km and 30 km buffers and Liberia (2001-2018)



Source: Satellite data from University of Maryland and the Global Environment Facility Independent Evaluation Office 2020.

6.2.4 Risks unique to this stage of intervention

In countries recovering from conflict, a common challenge is peacefully managing and resolving disputes over land,[177] minerals,[178] and other natural resources.[179] Digital technologies provide tools to help detect emerging conflicts related to natural resources, and thereby inform interventions to prevent them from escalating. CASE STUDY 6.4 showcases how a conflict-tracker tool can help monitor community-level disputes over land, water, and forests in Nepal, informing programming, monitoring, evaluation, and learning.

CASE STUDY 6.4
MONITORING COMMUNITY-LEVEL NATURAL RESOURCE DISPUTES IN NEPAL WITH A CONFLICT-TRACKER TOOL

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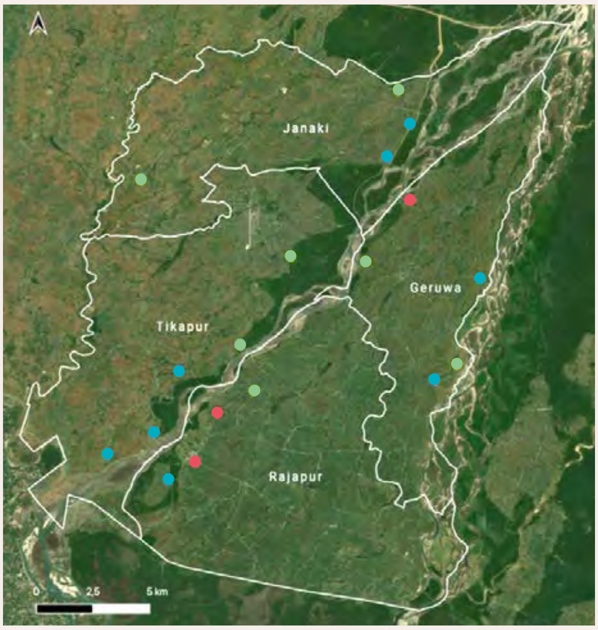
MOLLY KELLOGG, ALBERT MARTINEZ, AND SILJA HALLE • United Nations Environment Programme (UNEP)
LUKAS RÜTTINGER • adelphi

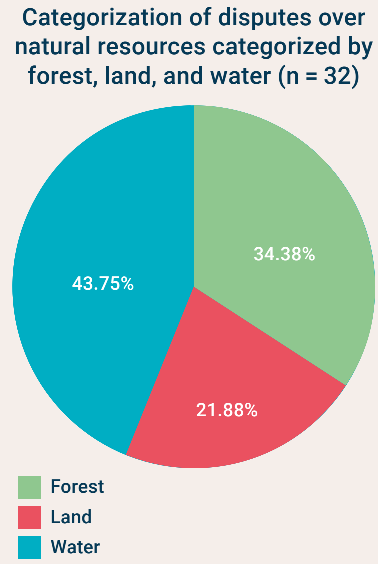
In 2018, the EU-UNEP Partnership on Climate Change, Environment and Security established a pilot project in the Bardiya and Kailali districts of West Karnali, Nepal to improve understanding of climate change risks in the country and test integrated approaches to programming that addressed the underlying drivers of insecurity and enhanced resilience to climate change. Using a combination of climate change adaptation and peacebuilding activities, the project aimed to promote sustainable and climate-resilient livelihood options for vulnerable groups, strengthen local governance capacities for natural resource dispute resolution, and enhance social cohesion and trust between communities.

A conflict tracking tool was used to identify the main conflicts in the Karnali River Basin (FIGURE 6.5) to guide project design and prioritize interventions, and to track them for monitoring, evaluation, and learning purposes. The tool was essentially a georeferenced database capturing each dispute's location in longitude and latitude, the stated reason for the conflict, its intensity, the actors involved in its resolution, and its resolution status. Some of the identified disputes included, for example, a disagreement over a community forest boundary between communities, a dispute over the public use of a pond which sat on both public and private land, or a conflict between government and community members over the extraction of river resources in areas where the Karnali River had changed course due to erosion and cut into private land.

In total, the project identified and tracked 32 disputes at the community level related to natural resources, using the conflict tracker tool to determine that conflict resolution and mitigation mechanisms supported by the project contributed to the reduction or full resolution of 75 percent of the 32 tracked disputes during the two years of project implementation (FIGURE 6.6). The data collected through the tool not only enhanced the evaluation of the impact of its interventions, but also supported more detailed learning on the resolution of different types of disputes. Indeed, most of the resolved or reduced disputes were over forest or water, while land-related disputes, such as conflicts over public land use and boundaries, proved the most complex and challenging to address.

FIGURE 6.5: LOCATION OF NATURAL RESOURCE-RELATED DISPUTES IDENTIFIED AND TRACKED IN NEPAL'S KARNALI RIVER VALLEY AT THE TIME OF PROJECT INCEPTION (2018).



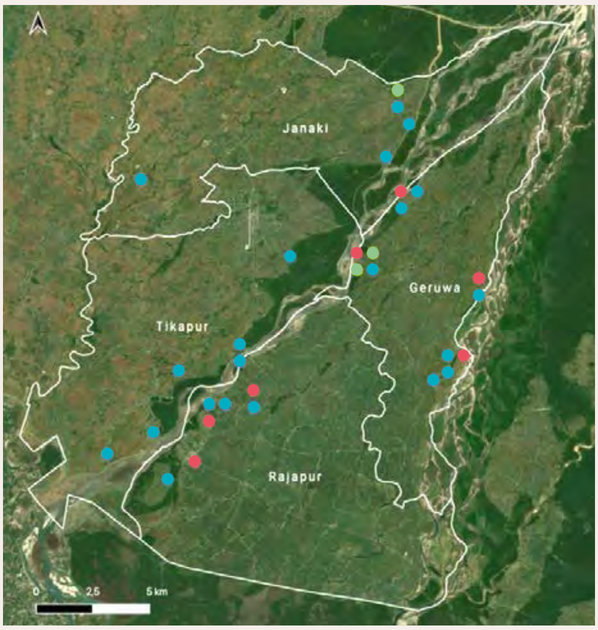


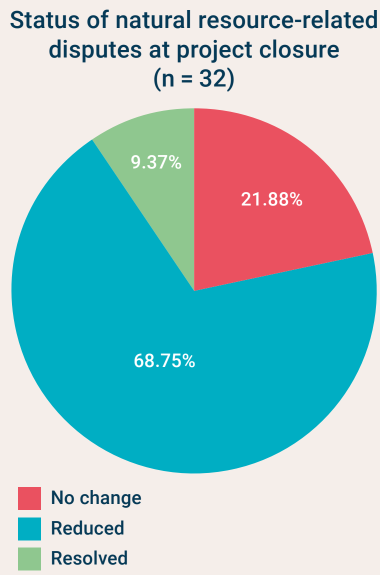
Source: UNEP 2023.

One of the disputes resolved by the communities was over water use between upstream communities in Sonahagaun and downstream communities in Sanakati. The water supply was limited, and downstream residents in Sanakati often did not have enough water for their farming and household needs, leading to disputes with Sonahagaun. To improve the equitable use of water, the project supported the establishment of an inclusive water committee, built capacity on conflict resolution, and facilitated spaces for dialogue to agree on a fair distribution plan and manage water use, which significantly improved communication between the two communities and resolved the longstanding dispute.

This case shows that a combination of a simple database and GIS can enhance environmental peacebuilding approaches at the design, monitoring, and evaluation levels by helping actors to track the evolution of community conflicts related to natural resources, environmental degradation, and climate change issues throughout the project life cycle.

FIGURE 6.6: STATUS OF THE NATURAL RESOURCE-RELATED DISPUTES ADDRESSED BY THE PROJECT THROUGH COMMUNITY-BASED ORGANIZATIONS IN THE KARNALI RIVER VALLEY.





Source: UNEP 2023.

6.3 RISKS AND CHALLENGES

Although post-conflict peacebuilding programs are fundamentally designed to strengthen social cohesion and build institutional capacities for peaceful dispute resolution, the application of digital technologies can also inadvertently lead to negative consequences if the associated risks are not carefully managed. For instance, issues such as limited accessibility to technologies or data, low levels of technical expertise, or challenges related to funding or infrastructure can intensify the exclusion of vulnerable groups. This can also foster mistrust among individuals, communities, and local governments. Therefore, it is crucial for environmental peacebuilding practitioners to assess the impact of digital technologies within specific contexts and align their strategies with the "do no harm" and conflict-sensitive frameworks that are central to peacebuilding practices.

It is essential to recognize that technologies are often conceptualized and developed in locations and contexts that are geographically and paradigmatically distant from their areas of application. Even when efforts are made to adapt these technologies to the nuances of a particular context, there is the potential for unforeseen outcomes and the presence of "unknown unknowns." Digital technologies that are developed locally may also still carry the biases of their creators, who might lack the necessary understanding of the local context and dynamics.[180]

For example, Earth observation technologies, which have become increasingly accessible to non-expert users, present a unique opportunity for peacebuilding practitioners to monitor natural resources using satellite imagery and remote sensing, as demonstrated by case studies throughout this chapter. However, relying solely on these methods for natural resource monitoring—without incorporating local stakeholder involvement—can be problematic. While participatory mapping exercises conducted in the field may be costly and time-consuming, excluding local communities can erode local ownership and participation in natural resource governance and management. This risks creating a disconnect between the peacebuilding initiatives and the communities they are meant to serve.

Moreover, it is crucial to address gender biases in access, ownership, and usability of data and technology. Women, in particular, may face significant barriers in these realms, necessitating an intersectional approach to ensure equity and inclusion in data management and technology usage.[181]

Furthermore, there is a risk that digital technologies might reinforce traditional gender roles in natural resource management, placing men in decision making roles and marginalizing women's participation. Digital solutions need to be designed in a way that disrupts, rather than replicates, traditional power dynamics, empowering women in decision making processes.

As countries transition from post-conflict peacebuilding to sustainable development, national strategies for digital transformation become critical. These strategies provide an opportunity to address the environmental impact of digital technologies, particularly regarding energy and water usage and e-waste generation. They also play a crucial role in enabling countries to meet their Sustainable Development Goals (SDGs) and obligations under various multilateral environmental agreements (MEAs). National digital transformation strategies should also prioritize the resilience of digital infrastructure to withstand disruptions, including those caused by disasters.

6.4 CONCLUSIONS AND NEXT STEPS

This chapter has underscored the pivotal role that digital technologies can play in bolstering natural resource and environmental governance in post-conflict peacebuilding. These technologies have demonstrated their potential in fostering local engagement on environmental issues, enhancing the traceability of conflict-related resources, aiding the formalization and sustainability of high-value natural resource exploitation, and improving the efficacy of natural resource monitoring. To optimize the application of digital technologies in these vital areas, four key priorities have been identified.

First, enhancing natural resource management in post-conflict peacebuilding efforts necessitates a concerted focus on integrating digital tools with traditional and community-based natural resource management (CBNRM) practices. This integration should extend beyond mere technological implementation to include the blending of digital technologies with indigenous and local knowledge systems. Such a holistic approach promises to respect and preserve cultural sensitivities as well as improve the sustainability of local practices. At the same time, it is essential to identify and establish best practices for community-driven data collection and decision making. Providing communities with accessible digital tools and training should ensure their active participation and ownership, thus democratizing the natural resource management process. Utilizing mobile applications and simple data entry tools, local communities can effectively contribute vital data on resource usage, changes, and potential conflicts, thereby making the management process more inclusive, transparent, and effective.

Second, in some countries, there is a growing need for research and the development of best practices to utilize digital tools in empowering women for active participation in natural resource management and the development of resource-based livelihoods and enterprises. This requires a multifaceted approach, focusing on providing women with tailored training and access to digital tools that cater to their unique needs and challenges in resource management. It also involves creating inclusive digital platforms that are user-friendly and provide resources specifically designed for women. Such strategies should be reinforced by policy advocacy to promote gender inclusiveness in technology and natural resource sectors, alongside supporting women-led initiatives through funding, mentorship, and access to necessary resources. Such efforts are critical in ensuring that women are not only beneficiaries but also active decision makers and leaders in the sustainable management of natural resources, leveraging digital technologies to enhance their livelihoods and contribute to their communities.

Third, the formation of synergistic partnerships between technology providers, peacebuilding organizations, and local governments is essential for effective knowledge generation, management, and transfer in natural resource and land management. Such collaborative efforts are instrumental in sharing learning and best practices and introducing innovations in the use of digital technology in these fields. These partnerships should focus on a diverse range of technological solutions, incorporating both advanced commercial software and adaptable open-source solutions. By combining different technological approaches, these collaborations can enhance the management of spatial data infrastructures and land administration systems, fostering a more holistic and integrated approach to natural resource management.

Lastly, establishing best practices for the transparent and accountable use of technology in post-conflict peacebuilding is critical. This involves creating clear and comprehensive guidelines and protocols for all stages of data management, including collection, storage, and sharing. Ensuring transparency in technology use also requires the implementation of mechanisms that facilitate community feedback and enable effective dispute resolution. Such practices not only build trust among all stakeholders but also ensure that the deployment of technology aligns with the broader goals of peacebuilding and respects the rights and needs of local communities. By prioritizing transparency and accountability, post-conflict peacebuilding efforts can leverage digital technologies more responsibly and effectively, thereby contributing to sustainable and equitable natural resource governance.

While digital technologies offer valuable tools for post-conflict peacebuilding, their application requires careful consideration and integration with traditional, community-centric approaches. This blended strategy ensures that technological interventions are effective, equitable, and sensitive to the unique challenges of each post-conflict peacebuilding context.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CHAPTER 7

Cross-cutting risks of data & digital technologies across the peace & security continuum

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7.1 INTRODUCTION

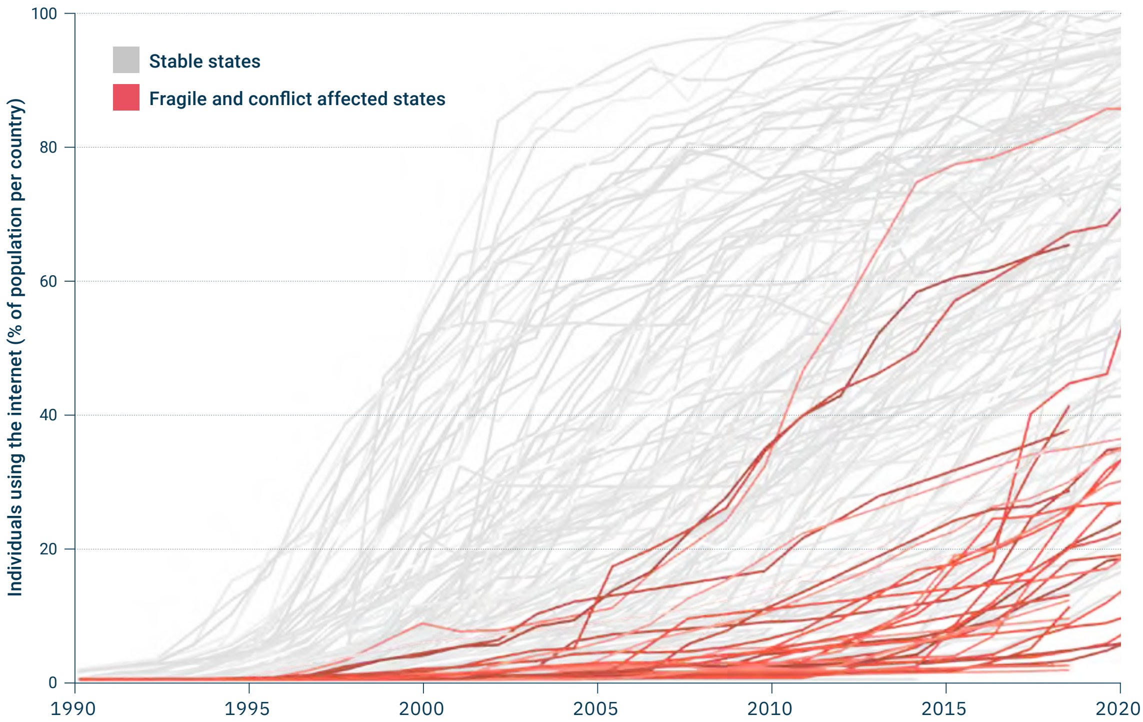
The contemporary digital landscape is characterized by an unprecedented growth in data availability, fueled by a multitude of digital products, services, tools, and platforms. These resources are dedicated to storing, analyzing, and processing vast amounts of data to support decision making processes. The exponential increase in data generation is further compounded by a proliferation of devices, services, and sensors globally, creating a complex web of data collection points.

In this environment, the critical question shifts from the mere existence of data to the methodologies of its collection, analysis, integration, and eventual use for decision making. This chapter reviews the cross-cutting risks associated with collecting and transforming environmental data into informed decisions on the governance of natural resources. It particularly focuses on the unique sensitivities and challenges that arise within the context of the peace and security continuum. As data becomes a cornerstone in environmental governance and conflict resolution, it is imperative to navigate these challenges with a keen awareness of the ethical implications, potential for misuse, and the need for responsible stewardship of information.

For example, it was estimated that in 2020 **only 32 percent of the population living in fragile or conflict-affected states used the Internet,** compared to about 70 percent in stable states (FIGURE 7.1).[182]

FIGURE 7.1: PERCENTAGE OF INDIVIDUALS PER COUNTRY USING THE INTERNET IN THE PERIOD 1991-2020.

The data shows a steady increase in the number of people using the Internet over the years, both in stable and fragile states. However, the number of individuals using the Internet in fragile and conflict-affected countries (shown in shades of orange) has only reached approximately 32 percent, compared to 70 percent for stable states (shown in grey). This illustrates a clear gap in access and use of the Internet between stable and fragile states. *Graphic: UNEP with data from the World Bank 2022.*



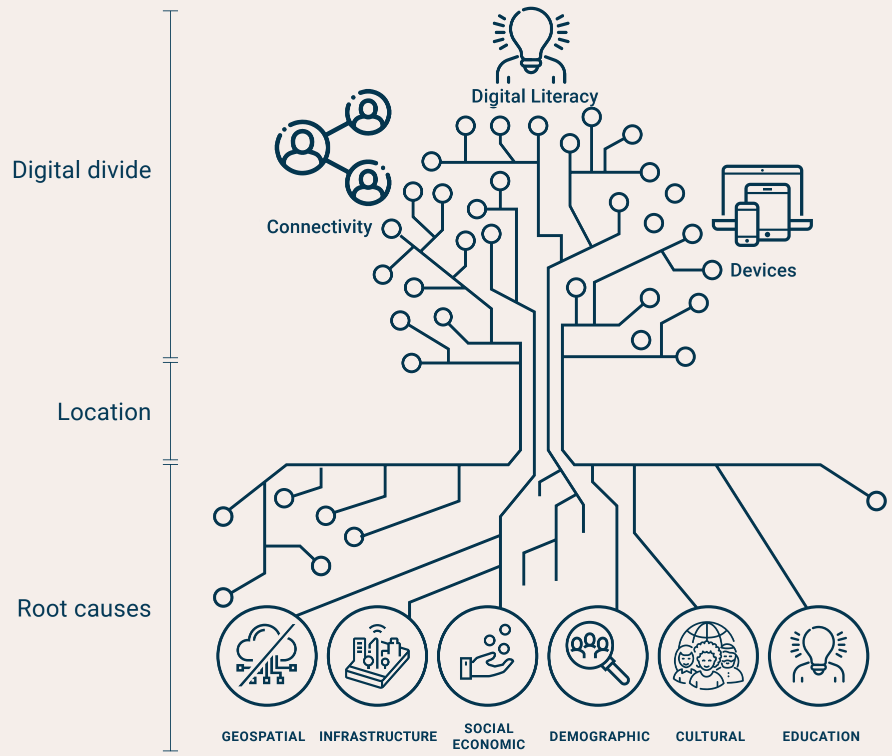
In these settings, access to technology and literacy in its use are starkly unequal, a phenomenon that is known as "the digital divide" (BOX 7.1). Consequently, it is critical for environmental peacebuilding to better understand how to apply digital technologies under a "do-no-harm" approach in these contexts.

BOX 7.1: THE DIGITAL DIVIDE AT A GLANCE.

The digital divide is the gap between people who have access to digital technologies and possess digital literacy skills, and people who do not. Connectivity and digital literacy gaps persist along gender and rural/urban lines, especially in the least developed countries.

- → In 2011, 2.2 billion people had access and used the Internet. Ten years later, in 2023, the number was approximately 5.4 billion people, an increase from 31 to 67 percent of the world's population.[183]
- → Africa is the region facing the most significant connectivity gap, with 23 percent of the population having no access to a mobile broadband network.[184]
- → The greatest digital divide is along rural/urban lines. Globally, urban areas account for 72 percent of households with access to the Internet, while rural areas account for only 38 percent. In the least developed countries, 17 percent of the rural population has no coverage at all.[185]
- → The gender gap persists in the digital sphere. Globally, 55 percent of the male population uses the Internet, compared to 48 percent of the female population. Women in the least developed countries, including in Africa and Arab States, are the least connected.[186]
- → Affordability remains the major barrier to Internet uptake, especially in the least developed countries, with digital illiteracy also a major constraint.[187]

FIGURE 7.2: DIGITAL DIVIDE.



Source: Adapted from UN Habitat 2021.

7.2 DATA COLLECTION

The specific risks associated with data collection in peacebuilding contexts before, during, and after conflict are connected to the nature of the data sources, which include structured, semi-structured, and unstructured data. Understanding these categories is crucial for assessing and mitigating potential risks:

→ **Structured Data:** This type of data is characterized by its highly organized nature, typically formatted in a way that makes it easy to store, process, and analyze. Examples include databases where data is systematically organized in tables with defined lengths and formats. Its structured nature allows for efficient processing, but it can also limit the flexibility in terms of the types of information that can be captured.

→ **Semi-Structured Data:** Semi-structured data may not have the rigid structure of traditional databases but still contains tags or markers to separate semantic elements and enforce hierarchies of records and fields. Examples include XML and HTML files. This data type allows for the integration of information from multiple sources and can adapt to changes more rapidly. However, its irregularity and potential incompleteness can pose challenges in consistency and reliability.

→ **Unstructured Data:** Unstructured data lacks a predefined format or structure, making it more complex to process and analyze. It encompasses a wide variety of formats, including text, audio, video, social media content, and data from sensors and radars. This type of data accounts for a significant and growing proportion of the data generated daily. Its sheer volume and variety necessitate advanced skills and technologies for effective processing and analysis, such as natural language processing and machine learning algorithms.

The rapid growth of unstructured data presents both opportunities and challenges in peacebuilding efforts. On the one hand, it offers a rich source of new information that can provide deeper insights into conflict dynamics and peacebuilding approaches. On the other hand, the volume and complexity of this data require sophisticated analytical tools and skills, raising concerns about biases, privacy, and the potential misuse of information.[188]

As the growth of new data sources and their processing technologies transcends traditional national boundaries, a globalization of data collection, information exchange, and data ecosystems is taking place.[189] This evolving digital landscape brings with it significant challenges and risks, particularly in fragile and conflict-affected settings.

First, the proliferation of remote data collection often results in a detachment from traditional norms of data ownership and adherence to established data standards. This detachment can lead to fraudulent analysis and the targeting of specific groups and individuals, raising serious concerns about the integrity, reliability, and sovereignty of the data collected. The absence of clear boundaries and standards in international data handling exacerbates these issues, creating vulnerabilities in the security and legitimacy of the data.

Second, local data collection efforts can be affected by biases that can skew methods and analysis, potentially leading to discrimination. These biases may be introduced both by outsiders (who may not know the precise social, environmental, social, historical, or conflict context) and by local actors (who may advance their interests or their group's interests). In conflict-affected settings, the accuracy of collected data is often compromised as respondents may provide misleading information for self-protection or to influence perceptions, particularly in situations involving violence. This underscores the challenge of collecting accurate, unbiased information while maintaining the safety and anonymity of contributors.

Third, the principles of anonymity and "do no harm" are particularly challenging to uphold in conflict-affected environments. People who cooperate with peacebuilders at any point across the peace and conflict continuum can face threats and retribution if their personal data is not managed securely. Inadequate data protection measures and ethical considerations can put respondents at risk, highlighting the need for stringent data protection protocols.[190] Effective policies and oversight mechanisms on data collection and usage are often lacking or insufficiently comprehensive. This gap exposes individuals and vulnerable groups to potential abuses, with limited remedies available for their protection.

Fourth access to data and its benefits may be inequitable. The risk of data mining and targeting, especially of vulnerable populations, necessitates strict measures to prevent data collection and analysis practices from exacerbating existing inequalities or creating new forms of discrimination.

Finally, the continuity of data collection is susceptible to disruptions from various factors like pandemics, violence, and infrastructural challenges. These disruptions not only create gaps in information but also open doors for data manipulation by those in power or seeking to influence power dynamics. This situation calls for resilient and adaptable data collection methods capable of withstanding such challenges.

The humanitarian community has started to address some of these data governance gaps, including with the development of the Centre for Humanitarian Data by the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA).[191] This center has produced detailed guidance notes on data responsibility, while the Dutch Red Cross has launched the 510 Data and Digital Responsibility Policy.[192] This framework introduces key principles including data protection, legitimacy and legality, "do-no-harm" approaches. It also includes respect for the rights of human subjects, collection on the basis of necessity and proportionality, and data quality, accuracy, and validity.[193]

In summary, while the globalization of data collection and digital technologies offers new opportunities in fragile contexts, it also introduces a spectrum of risks that require careful management to ensure the security, integrity, and ethical use of data in these sensitive contexts.

7.3 DATA ANALYSIS

The intersection of Internet of Things (IoT), big data, and artificial intelligence (AI) is transforming data analysis capabilities for environmental peacebuilding, as well as more broadly. These interconnected technologies amplify each other's impacts, creating powerful tools that can be used across the peace and security continuum.

IoT sensors via mobile phones and other devices can be deployed to track and measure several activities and interactions between people and the environment. These capabilities are already being deployed on a community scale to help manage the deployment and monitoring of water, food, batteries, and other supplies in humanitarian relief operations. UNHCR is increasingly applying IoT technologies to humanitarian crises—for example, in Uganda, Northern Iraq, and the refugee settlements in Cox's Bazaar (Bangladesh)—to optimize the delivery of water by monitoring the efficiency of delivery, leak detection, water quality, and energy consumption. This helps both reduce costs and enhance the impact of humanitarian aid.[194]

The analysis of big data is usually divided into three categories, and each come with their specific risks:

DESCRIPTIVE ANALYSIS

Relies on data aggregation and mining to process and analyze historical data and present it in a way that identifies patterns and trends. These can support the understanding of environmental, economic, and social changes over time (e.g., understanding historical trends in water availability across the Sahel).

PREDICTIVE ANALYSIS

Includes the analysis of past data patterns and trends along with data mining, statistical modeling, and machine learning to forecast potential future outcomes and the likelihood of their occurrence (e.g., using the historic trends in water availability across the Sahel to model and run multiple potential climate scenarios).

PRESCRIPTIVE ANALYSIS

Integrates the results of descriptive and predictive analytics to provide recommendations towards a best course of action based on multiple scenarios (e.g., analyzing the historic trends and the climate scenarios to determine where to build future dams or irrigation schemes across the Sahel).

There are five main risks that need to be taken into account across these categories of analysis when applied across the peace and security continuum.

First, big data can be reductionist in granularity. By taking data from highly complex settings and ignoring concrete and contextual realities about the environment, conflict dynamics, and human societies, it can lead to oversimplification of the dynamics—and a resultant selection of inappropriate environmental peacebuilding strategies.

Second, while data is often considered neutral, data analysis methods and interpretation are designed by humans based on their knowledge, experience, and beliefs. Four major biases that stem from these considerations include sampling bias (the collection of non-random, selective and partial information), activity bias (time-based correlations of user activities), information bias (the misguided belief that more information always results in better decisions), and inductive bias (assuming that the future has a direct correlation to the past and thus minimizing potential future disruptions).[195] Each of these biases need to be considered and mitigated.

Third, there it is often thought that the use of anonymization techniques enables big data to respect privacy, research has shown that only four spatiotemporal points are necessary to identify 95 percent of individuals in a data set, where the location of an individual is specified by mobile antenna networks.[196]

Fourth, the dramatic increase in AI-driven cloud computing also carries potential biases and related risks. There are at least eight distinct biases in AI that need to be considered and mitigated: social bias, measurement bias, representation bias, label bias, algorithmic bias, evaluation bias, deployment bias, and feedback bias. The use of AI can also have significant implications in terms of international human rights law.[197] Miscalculation and mischaracterization of information can also negatively impact investigations into mass atrocities and human rights abuses. For example, killings committed in broad daylight and disseminated across social media can influence machine learning models to disproportionately marginalize acts of sexual violence, environmental crimes, and other crimes that may get less or no public attention.

Finally, IoT systems themselves carry specific risks. Compromised individual devices can corrupt data and reduce transparency, while the timestamping and geotagging of metadata can compromise privacy and anonymity. The high heterogeneity of IoT data can be challenging to process, analyze, and validate, thus reducing the quality of the data.[198]

These risks need to be considered and mitigated in the design of data analysis methods linked to the management of environment and natural resources risks and opportunities across the peace and security continuum.

7.4 APPLICATIONS FOR DECISION MAKING

Decision making involves identifying differences between multiple courses of action combined with the process of evaluating and selecting an option. Across the peace and security continuum, national governments, emergency services, humanitarian organizations, and other actors are faced with identifying which situations are more or less urgent (who will receive assistance or supplies first), which action will lead to greater or lesser impact (determining staffing resources, or deciding whether to begin an individual response or wait for inter-agency support), and the degree of uncertainty in these decisions (unpredictability and instability regarding current or future situations).

These decision making processes are even more complicated with environmental peacebuilding. First, a single resource can be relevant to multiple sectors, objectives, and actors, and it can be challenging to coordinate decision making. For example, in post-conflict Liberia, forest resources were simultaneously central to livelihoods, macroeconomic recovery, fighting corruption, and conservation (including, in due course, efforts to fight climate change). Second, environmental peacebuilding frequently involves more actors, bridging environmental, security, humanitarian sectors. Finally, the different dimensions of environmental peacebuilding often involve different datasets, timeframes, and uncertainties, posing challenges of integration.

The wealth of data and analysis available can inform a vast number of policies and decisions about environment, natural resources, and climate change risks, but awareness of the uncertainties and the sensitivities is crucial. In consideration of the challenges and risks identified in previous sections, it is important to clarify the implications for three domains: situational awareness informing operational decision making; translation, adaptation and communications of data products; and long-term information management and stewardship.

The use of big data and digital technologies has become increasingly pertinent in navigating the complex and dynamic contexts across the peace and security continuum. These technologies offer a significant opportunity to enhance situational awareness, providing valuable insights into crisis settings and potential future developments.[199] However, this approach is not without its risks.

One primary concern is the potential mismatch between the scale of data products (often national) and the specific decision making needs (often local or sub-national) they are intended to support. There is a risk that these products might be developed at a granularity that does not align with the level of detail required for operational decisions. Additionally, the possibility of misinterpretation of data or its application for purposes inconsistent with its inherent characteristics presents a significant challenge.

For example, there is no consensus on the criteria needed to determine whether a poverty map is fit for use in the allocation of resources. However, poverty maps are extensively used and relied upon for benchmarking, prioritization, and for strengthening the accountability of decisions. For this reason, procedures and protocols should remain at the core of operational decision making, while acknowledging that the situational knowledge provided by these technologies can be helpful where gaps in information exist or where additional context might be needed.

To mitigate these risks, it is essential to establish clear guidelines on the suitability of various data products for different types of decision making scenarios. This involves understanding the limitations and appropriate applications of each data product, ensuring that they are used in contexts where they can provide the most value. Furthermore, there needs to be clarity regarding accountability, particularly when data products are used for unintended or unsuitable purposes. Establishing such parameters will help ensure that big data and digital technologies are leveraged effectively and responsibly, enhancing decision making processes in peace and security operations while minimizing potential pitfalls.

The second challenge in the utilization of data products for decision making lies in their translation and adaptation to formats that are compatible with their intended functions. This often involves integrating and manipulating structured, semi-structured, and unstructured data into a coherent form that supports specific decision making processes. However, a significant divide frequently exists between those who collect and process data and those who depend on this information for situational awareness and operational decision making. This gap underscores the need for data science expertise to not only interpret various data products but also effectively connect and communicate them to a set of decisions in a way that preserves data integrity and accuracy. The concept of data literacy becomes crucial here, encompassing the ability to read, understand, and communicate data in context. It involves an understanding of data sources and constructs, analytical methods, and the ability to interpret and use the outcomes of data processes.

The third aspect of effective data utilization involves adopting an interdisciplinary approach to the training and validation of data, emphasizing the integration of both qualitative and quantitative data. This holistic approach acknowledges that comprehensive understanding often emerges from the convergence of different data types, offering a more nuanced and complete picture of complex situations. To facilitate this, significant investment is required in building technical capacities and enhancing data literacy. This investment should span the entire data life cycle, from initial collection to the final decision making process. It should not only focus on the technical competencies necessary for handling and analyzing data but also extend to crucial aspects such as data protection and security. By cultivating a broad spectrum of skills and knowledge across different disciplines, stakeholders can ensure that data is not only accurately collected and analyzed, but also responsibly managed and securely protected, thereby reinforcing the reliability and integrity of data-driven insights.

Finally, responsibility for long-term stewardship about big data and digital technologies is essential for promoting the innovative use of these capabilities in trustworthy ways that respect human rights and democratic values. Recognizing the importance of such stewardship, the Organization for Economic Co-operation and Development developed a series of value-based principles and provided recommendations for policy makers and practitioners on how to consider and implement these principles. Understanding that big data and digital technologies can play a role in advancing inclusive growth and sustainable development, the principles defer to human-centered values: fairness, transparency and explicability, robustness, security, safety, and accountability.[200] Data cooperatives and intermediary organizations can create built-in accountability mechanisms that can facilitate the collection, analysis, application, and sharing of sensitive data and other data with associated protections. Further, data trusts have emerged to offer low-cost means to collect and share data in international contexts where international data sharing agreements do not exist.

Sustainability of the digital technology system is central to long-term stewardship. Consequently, it is necessary to plan for the long-term maintenance of running, maintaining, upgrading digital systems that are established initially with external support. Local institutional ownership and capacity development are essential. This is especially true in fragile and conflict-affected contexts, where institutions are weak in first place. UNEP experience in trying to establish a simple online database platform for environmental impact assessment (EIA), which would allow the government to move away from a paper-based EIA and permitting system, and start to work with digital tools by uploading documents into a value chain repository highlighted **four key lessons:**

1 It is critical to understand the IT context of the ministries in which you work. Understanding this context includes knowing what systems they use, what programming language are they most comfortable with, what assets exist including human personnel, the level of understanding of digital tools, and individuals' access to the Internet.

2 From the outset, it is necessary to the long-term management, maintenance, and resource needs of running these digital platforms. These considerations relate to data management and updates, human personnel (including IT personnel), cloud storage spaces, and website domain addresses. For all of these considerations, it is necessary to decide who in the government will actually own, host, manage, and pay for the domains, data, staff, and other expenses over the long term.

3 It is necessary to have a government champion to help initiate and sustain these efforts, as well as building internal government ownership of the process at different levels, from technical to senior management to the minister.

4 Be careful about assuming that people are open to and will necessarily embrace digital technologies. The reality is often more complicated. While many individuals want to embrace new technology, they are sometimes reluctant to relinquish the familiar way of doing things (i.e., paper). Moreover, they may not have the time or energy, as they are often already overstretched and may not be able to dedicate additional time to learn a new application, platform, or system. And some individuals may not want to increase transparency. It is often important to consider the how to change work cultures and business practices (and the time this takes) and which incentives are necessary to build individual, institutional, and political support.

While these lessons are from a particular context, they reflect similar lessons from other countries and regions.

7.5 CONCLUSIONS AND NEXT STEPS

This chapter has provided an overview of the cross-cutting risks associated with the collection, analysis, and application of big data and digital technologies across the peace and security continuum. These capabilities offer tremendous opportunities for improving situational awareness and decision support, given the vast amount of data and information available.

However, the risks associated with the propagation of these capabilities are substantial and require careful consideration. Biases about the collection and analysis of data can lead to the exploitation and marginalization of vulnerable groups, and poor interpretation can lead to unintended consequences or even lives lost.

To mitigate the risks inherent in big data collection, analytics, and application, it is essential to foster an environment that promotes close collaboration between data scientists and decision makers. This collaborative environment should focus on addressing critical issues such as data protection, discrimination, manipulation, transparency, and the effective translation of data into actionable insights. Establishing platforms like data collaboratives, data commons, and data trusts can play a pivotal role in this context. These entities facilitate the creation, curation, maintenance, and analysis of shared data assets, fostering an evolving, interoperable resource that benefits a wide range of communities with vested interests.

Enhancing communication and collaboration among a diverse set of actors is crucial for developing equitable approaches to data usage. This involves not only sharing data and insights but also engaging in ongoing dialogues to understand different perspectives and needs. By doing so, stakeholders can work together to identify potential risks and biases in data practices and develop strategies to safeguard against harmful outcomes. Such cooperative efforts are key to ensuring that big data serves as a tool for positive change and does not inadvertently perpetuate existing inequalities or injustices. Creating a more integrated and responsive data ecosystem will be instrumental in harnessing the full potential of big data across the peace and security continuum in a responsible and beneficial manner.

Photo: Interview with local community-based organizations on peatland restoration from Muara Manompas village, Indonesia.© Mohammad Hasnain

BOX 7.2: RESOURCES TO DEVELOP DATA AND DIGITAL LITERACY WITH A CONFLICT-SENSITIVE LENS.

CENTRE FOR HUMANITARIAN DATA https://centre.humdata.org/data-literacy/	The most complete resource to learn data responsibility and data standards. These resources are critical to assess the risk of disclosing personal information when practitioners conduct surveys and needs assessments on the field and teach statistical methods to reduce such risk.
UN PEACEMAKER DIGITAL TOOLKIT DPPA, Centre for Humanitarian Dialogue, Build Up https://peacemaker.un.org/digitaltoolkit	A toolkit intended for mediators. Together with its accompanying Report, it assesses opportunities and risks related to the use of digital technologies in mediation contexts. It also provides concrete examples and advice from practitioners and experts.
OPEN ONLINE COURSES BY BUILD UP Build Up https://howtobuildup.org/community-learning/courses-overview/	A series of courses to discover and learn how technology can be used to build peace, including using data for peace, transformative online conversations, responsible and effective design processes, developing strategic communications for peace, and more. The courses are offered in English, Spanish, French, and Arabic.
DIGITAL4SUSTAINABILITY LEARNING PATH United Nations System Staff College and United Nations Environment Programme https://www.unssc.org/courses/digital4sustainability-learning-path	A course that explores the transformational role that digital solutions and innovations can play in advancing environmental and social sustainability. It teaches key concepts including digitalization, digital transformation, and digital sustainability. It also delves into the role of digital transformation in countering the triple planetary crisis of climate change, nature loss, and pollution.
ECOSYSTEM MAP: DATA FOR PEACEBUILDING AND PREVENTION New York University – Center on International Cooperation https://cic.nyu.edu/data-for-peace-map	An interactive digital tool that maps existing global organizations working at the intersection of data and peacebuilding.
DIGITAL PEACEBUILDING TOOLKIT Swisspeace https://miro.com/app/board/uXjVO0yD9cc=/	A toolkit for peacebuilders, it aims to strengthen their ability to understand research, and implement digital peacebuilding projects and programming.
OPERATIONAL GUIDANCE ON DATA RESPONSIBILITY IN HUMANITARIAN ACTION[201] Inter-Agency Standing Committee (IASC), February 2021	IASC templates and tools are designed to support the implementation of the recommended actions for data responsibility presented in the Operational Guidance. These templates and tools are examples to help organizations put the actions into practice.

CHAPTER 8

Conclusions & Recommendations

The horizon-scanning approach used in this report aimed to identify how local communities, governments, civil society, and international organizations use digital solutions to pursue environmental peacebuilding objectives, while acknowledging inherent risks.

Structural aspects associated with digital technologies and environmental peacebuilding are critical to their effectiveness, efficiency, and equity. **Five key overarching findings** emerged on the potential benefits and outcomes digital technologies can enable based on the 17 use cases presented in the report:

KEY FINDING 1

BENEFIT-SHARING TRANSPARENCY

The use of digital technologies in tracking, displaying, and communicating the benefits from natural resources significantly enhances transparency and equity in resource-sharing provisions connected to peace agreements. Blockchain and other digital ledger technologies are particularly effective, providing a secure and immutable record of transactions and agreements that is crucial in contexts where power imbalances might otherwise lead to mistrust in the execution of these arrangements, and offering an unprecedented level of traceability to conflict resources such as diamonds, oil, gas, cocoa, and timber. This level of transparency ensures that all parties have access to the same information, reducing the likelihood of disputes and fostering a sense of fairness and collaboration. Additionally, these technologies can be used to create accessible and user-friendly dashboards, offering real-time insights into resource extraction, production, and revenue generation, and use. By ensuring that all stakeholders have a clear and shared understanding of how benefits are being distributed, digital technologies can play a crucial role in building and maintaining trust across divided groups, an essential component of any successful environmental peacebuilding effort.

KEY FINDING 2

ENHANCED RESOURCE MANAGEMENT & ENVIRONMENTAL MONITORING

Digital tools, including blockchain and digital product passports, provide sophisticated means to track and trace commodities, which can be particularly beneficial in situations where illegal and illicit resource exploitation has fueled conflict or served to finance armed groups. Earth observation and remote sensing enable automated monitoring of resources, aiding in the detection of illegal extraction, pollution, or degradation. Blockchain offer an unprecedented level of traceability to conflict resources such as timber, cocoa, gold, and diamonds, reducing their environmental impact, breaking the link with illicit operations, and increasing consumer awareness of the ecological and social impact of purchases. Mobile technologies can support local economies by providing access to market information, facilitating financial transactions with fewer middlemen, and enabling micro-entrepreneurship related to natural resources or payment for ecosystem services. Digital technologies such as drones, AI-driven image analysis, and sensor networks can play a crucial role in tracking environmental degradation, increasing pollution, biodiversity loss, and climate impact assessments, providing key information to prioritize action to strengthen implementation of standards, enhance environmental governance, and begin adaptation projects. This is crucial in fragile and conflict-affected situations where less resilient communities and governments may be more vulnerable to conflict and instability linked to environmental degradation. Overall, digital technologies can also support spatial data infrastructures (SDIs) that can help digitally document and manage natural resource and land tenure rights, empowering communities to make informed decisions about natural resource management. This can particularly benefit marginalized groups, including women.

KEY FINDING 3

INCLUSIVE DECISION MAKING & COLLABORATION

Digital technologies can help include additional stakeholders within decision making, mediation, and dispute resolution processes related to natural resources and the environment, thereby addressing historic marginalization and exclusion and making agreements more resilient to future climate realities. They can also help improve the transparency of the processes and underpin collaboration around key outcomes, such as the joint monitoring and implementation of environmental provisions of peace agreements. Digital tools can also facilitate more transparent and equitable participation by offering various channels for input and feedback, accommodating different communication preferences and capabilities, allowing easy access to and understanding of environmental and climate data, reducing the need for technical skills. That said, digital environments cannot fully replace face-to-face contact; contacts and relationships must often first happen in an in-person manner before they can be transferred into a digital realm. Process design is fundamental. Tools such as community mapping and participatory GIS enable communities to contribute to and benefit from resource mapping and planning, fostering a sense of ownership and empowerment. This is particularly important in fragile and conflict-affected situations, where local involvement is key to sustainable management and conflict resolution.

KEY FINDING 4

CAPACITY BUILDING

Digital technologies significantly enhance capacity building for environmental peacebuilding by providing access to a wealth of training materials, good practices, and knowledge-sharing platforms. Utilization of e-learning tools and online courses enables various parties—including local communities, government officials, and NGO staff—to gain crucial skills and knowledge in resource management, conflict resolution, and environmental governance. Mobile technologies, in particular, can be instrumental in reaching broader audiences, making educational resources accessible even in remote or underserved areas. This approach helps bridge the gap created by a lack of traditional educational resources and ensures that all stakeholders, regardless of their location or background, can contribute effectively to peacebuilding efforts, especially regarding the natural resources upon which their livelihoods and food security depend. Furthermore, digital platforms facilitate the sharing of experiences and lessons learned from various contexts, fostering a global community of practice, and encouraging the informed adoption of innovative and effective strategies in environmental peacebuilding, particularly among women and youth, enabling them to actively participate in environmental peacebuilding initiatives.

KEY FINDING 5
OBJECTIVE INFORMATION & ANALYSIS

Digital technologies, using Earth observation systems and other remote sensing technologies, offer broad access to objective environmental data, helping to level the playing field among various stakeholders. This inclusiveness in information access is crucial for informed decision making, counteracting misinformation, and distrust regarding natural resource data. Integrating multiple data types such as armed conflict events, availability of natural resources and climate projections enhances complex analysis, modeling, and forecasting of natural resource-related conflicts also facilitates a more comprehensive and data-driven understanding of potential scenarios, shared risks, and potential solutions, including prioritization for preventive diplomacy and climate security programming. Data analytics and simulation models can help shape policy decisions related to natural resource governance; for example, hydrological modeling of rivers shared by countries in conflict can help find entry points for mediation and cooperation. Moreover, these technologies are key in generating early warnings about escalating risks related to natural resources or impending hazards and disasters that could incite tensions. Blending these digital insights with traditional knowledge is important, ensuring that technology complements, rather than replaces, local expertise and ownership.

At the same time, **five risks** were identified from the review that need to be addressed in the application of digital technologies for environmental peacebuilding:

RISK 1
TOP-DOWN IMPLEMENTATION

The application of digital technologies in environmental peacebuilding often follows a top-down approach, neglecting user needs and lacking human-centered design. Such an approach, without involving local stakeholders and end-users in the co-design process, can lead to unintended negative consequences, reduced ownership, and unsustainable adoption by local communities. Practitioners must remember that digital technologies are tools to facilitate broader outcomes and should not be seen as goals or ends in themselves. Emphasizing a participatory and conflict-sensitive approach that engages local communities in technology design and implementation is crucial for sustainable and effective use of these tools.

RISK 2
OVERRELIANCE ON DIGITAL TECHNOLOGIES

Excessive dependence on digital technology in natural resource management and peacebuilding can sideline local capacities, traditional knowledge systems, and trust-building processes that are critical for sustainable resource management in fragile and conflict-affected situations. Overreliance on digital technologies can result in technology dependency, marginalizing and overshadowing local dispute resolution mechanisms and traditional knowledge, particularly from women, who often hold valuable knowledge about natural resource management, and who may be sidelined in decision making processes dominated by technology-driven solutions. In areas with underdeveloped or unreliable technological infrastructure, this dependency risks significant disruptions if these systems fail. Additionally, focusing too heavily on digital solutions can shift attention away from underlying sociopolitical issues integral to resource conflicts. Integrating digital and traditional (often, in-person) approaches and acknowledging the value of local knowledge and practices are essential for holistic and sustainable resource management.

RISK 3
DATA SECURITY, PRIVACY, & BIAS CHALLENGES

The integration of digital technologies in natural resource management, environmental mediation, and climate adaptation introduces significant data security, privacy, and bias risks, especially in fragile and conflict-affected states with weak or absent regulatory frameworks. Technologies such as remote sensing and big data analytics necessitate handling sensitive data from geological information to community resource ownership and usage. Inadequately protected, this data is prone to breaches and misuse, endangering community privacy and security. The unauthorized access or manipulation of data in areas with existing resource conflicts and sociopolitical tensions can aggravate conflicts, encourage resource capture and illegal exploitation, or lead to targeted violence. Women and other marginalized groups may be at greater risk of exploitation or misuse of their personal information, exacerbating existing vulnerabilities. Therefore, implementing robust data protection measures and respecting community privacy rights are paramount. Considering potential sources of bias in the collection, processing, and interpretation of data is also fundamental.

RISK 4
AMPLIFICATION OF MISINFORMATION

Digital technologies can inadvertently amplify misinformation about natural resources, conflict, and peace, potentially driving new tensions and conflicts. In fragile situations with volatile information ecosystems, misinformation can distort public perception of resource management, environmental damages of war or disasters, potentially increasing tensions and instability. Examples include baseless rumors about resource scarcity or exploitation, which can trigger competition or violence, and misinterpretation of complex algorithms used for conflict forecasting, which could lead to faulty interventions. Weak governance and low public trust in institutions compound the issue, challenging effective and equitable resource management, joint environmental protection action, and peaceful climate adaptation, which require trust between actors. Strategies to combat misinformation and enhance information literacy are essential in these contexts, and especially so at the national level, where coordination between groups is essential to peacefully address environmental and climate crises.

RISK 5

DIGITAL DIVIDE & LITERACY GAPS

In fragile and conflict-affected situations, the digital divide and a lack of digital literacy often hinder the widespread use of digital technologies in environmental peacebuilding. With only about 32 percent of the population in these countries having Internet access, compared to 70 percent in more stable states, the gap in basic technological infrastructure and Internet accessibility limits the use of digital technologies. Additionally, digital literacy often mirrors the rural-urban, gender, and socio-economic divides, potentially exacerbating existing inequalities. Women, in particular, may face barriers such as limited internet access, digital literacy, and control over digital assets, hindering their meaningful participation in environmental peacebuilding efforts. Environmental peacebuilding initiatives should incorporate non-digital alternatives to prevent the exclusion or marginalization of disconnected groups. Capacity building efforts need to prioritize reducing this digital divide, ensuring that digital literacy is an integral part of program design.

Based on these findings of the core opportunities and risks, the report presents **five recommendations** to better prepare the environmental peacebuilding community to access and deploy these technologies in a safer and more responsible manner. These recommendations have been conceptualized for all stakeholders, from local communities to governments, international practitioners and technology developers working in peace and security.

RECOMMENDATION 1

ADOPT A HUMAN-CENTERED, PARTICIPATORY, CONFLICT-SENSITIVE APPROACH

The deployment of digital technologies in environmental peacebuilding must be guided by a human-centered design philosophy, which actively involves local communities and stakeholders at every step, from the initial design phase to final implementation. This approach requires facilitating co-design and collaborative decision making processes, ensuring that the development and application of digital solutions are informed by local knowledge and needs, ensuring technically, culturally, and contextually relevant technologies. This should go hand in hand with the implementation of gender- and conflict-sensitive approaches to avoid unintended consequences such as potentially creating or exacerbating existing tensions and biases. These approaches involve thorough analysis of the conflict landscape and gender dynamics, continuous monitoring of the impact of technological interventions, and adaptive strategies that respond to evolving conflict dynamics. By integrating conflict sensitivity, practitioners can more effectively navigate the complexities of natural resource disputes, harnessing technology as a tool for peace rather than a catalyst for further conflict.

RECOMMENDATION 2

INTEGRATE DIGITAL & TRADITIONAL KNOWLEDGE SYSTEMS

Effective environmental peacebuilding requires the integration of traditional knowledge systems and processes (often focused on in-person approaches) with digital technologies for a comprehensive strategy of managing natural resources, the environment, and the climate. This integration involves enabling policies that encourage mutual learning and knowledge exchange between digital technology experts and local community members. This integration can also help to reduce the impact of false positives associated with digital technologies. Ensuring that digital solutions complement rather than replace traditional practices is critical for achieving sustainable and culturally sensitive resource management strategies. This integration of modern technological advancements and traditional wisdom is essential for the long-term success and acceptance of environmental initiatives in fragile and conflict-affected situations.

RECOMMENDATION 3

ESTABLISH ROBUST DATA PROTECTION & PRIVACY STANDARDS TOGETHER WITH SPATIAL DATA INFRASTRUCTURES

In fragile and conflict-affected situations, where data sensitivity is heightened due to potential conflicts and violence, establishing and enforcing effective data protection regulations is essential. Policies should focus on safeguarding sensitive environment and natural resource information gathered through digital technologies. Privacy-preserving measures, including data anonymization and secure data storage, must be implemented to protect the identities and data of local communities, especially in politically sensitive environments. This will not only ensure data security but also build trust among stakeholders about the use of digital technologies in resource management. Moreover, the development of spatial data infrastructures (SDIs) should be a parallel priority. These infrastructures are pivotal for the digital documentation and management of natural resource and land tenure rights, offering a structured approach to organizing and accessing spatial data. By supporting national and local authorities in establishing comprehensive SDIs, the accurate and transparent management of land and resource data can be greatly enhanced. This not only aids in conflict resolution and informed decision making, but also contributes to long-term stability and sustainable resource management.

RECOMMENDATION 4

COMBAT MISINFORMATION & ENHANCE INFORMATION INTEGRITY

With the risk of misinformation being amplified through digital means, it is imperative to develop initiatives aimed at combating misinformation and promoting digital information literacy linked to natural resources. This includes establishing fact-checking services and conducting public awareness campaigns. Collaboration with local media, civil society, and educational institutions is vital to disseminate accurate and reliable information about natural resources and environmental concerns. Such efforts are key to maintaining a well-informed public discourse and making responsible decisions based on credible information.

RECOMMENDATION 5

PROMOTE DIGITAL INCLUSION & LITERACY OF NATURAL RESOURCE & ENVIRONMENTAL MANAGEMENT STAKEHOLDERS

To effectively implement digital technologies in fragile and conflict-affected situations for natural resource and environmental management, it is crucial to prioritize policies that bridge the digital divide. This involves expanding access to technology and Internet connectivity, particularly in rural and underserved communities. Alongside improving access, digital literacy programs should be established, tailored to cater to diverse demographic groups, with an appropriate gender lens. These programs should not only impart the technical skills needed to utilize digital technologies but also emphasize critical thinking skills essential for understanding and evaluating digital information. This approach ensures a more equitable and informed engagement with digital resources across all segments of society. In addition, it is necessary to develop digital infrastructure strategies that ensure resilience against technological disruptions and minimize their environmental footprint. Until the necessary capacities and infrastructure are in place, programs should use a mix of digital and non-digital implementation strategies on a case-by-case basis.

These policy recommendations are designed to guide environmental peacebuilding practitioners toward a responsible, inclusive, and effective deployment of digital technologies in the complex and sensitive context of natural resource and environmental management in fragile and conflict-affected situations.

In response to this report, a more structured process is essential, one that brings together environmental peacebuilding practitioners at various levels—from the local to the global—to actively shape future policies and direct research efforts. This collaborative process should facilitate open discussions about values, principles, best practices, and the risks associated with digital technology in environmental peacebuilding. It is also critical to catalyze the creation of robust safeguards, detailed guidance, and comprehensive training programs for the application of these technologies in the field. Such coordinated and intentional action is crucial for ensuring that digital technologies are applied judiciously and effectively in fragile and conflict-affected contexts, thereby preventing potential misuse and unforeseen negative impacts. The success of digital technologies in environmental peacebuilding hinges on collectively navigating the complexities and harnessing the transformative potential they offer for environmental peacebuilding.

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ANNEX 1. CONFLICT-SENSITIVITY CHECKLIST FOR DIGITAL TECHNOLOGY

A critical recommendation from this report is to ensure a conflict-sensitive approach when using technology and data in any intervention in conflict-affected and fragile contexts. To this end, this annex presents a non-exhaustive list of questions practitioners could consider. These questions contextualize the application of technology and help avoid potential negative impacts when conducting conflict analysis, designing peace interventions, and implementing programs. Remember that different groups experience the same issues differently. To ensure a do-no-harm and sensitive approach, it is recommended to use an inclusive lens when answering the questions below, taking into account factors such as gender, age, ethnicity, religious association, and socioeconomic status.

CONFLICT ANALYSIS	DATA RESPONSIBILITY	INTEGRATED PROGRAMMING	TECHNOLOGY DEVELOPMENT
• Is there basic infrastructure to access digital technologies at the community and country levels? How widespread and affordable are smartphones and Internet access? • How digitally literate are different population groups in communities and in the country? Consider gender, age, religion, socioeconomic status, and rural/urban lifestyles. • How open and accessible is the Internet? What is the status of infrastructure related to information and communications technologies in the community and country? Are there regular power or connection blackouts? Consider the roles and connections between the government and communication service providers. • What is the role of digital technologies in the conflict context? Is there a history of actors conducting conflict or peace activities in the digital sphere?	• What are the positive and negatives impacts of data management activities in the intervention? What types of data will be managed and what are their benefits and risks? • How are issues regarding data sensitivity considered, including biases (sampling, activity, information, and inductive), privacy, ownership, and human rights? Are there safeguards? How are the safeguards implemented? • How does the intervention incorporate data protocols for its responsible management? Who has access to data, its analysis, and who can share it? • How could intervention activities using such technology affect the communities and the conflict? How are risks monitored and managed? How does the monitoring and evaluation framework reflect the interaction of the project with conflict dynamics?	• Is the design of the intervention informed by a conflict analysis, including an assessment of the role of technology in the conflict? How frequently is the conflict analysis updated? • Is the intervention designed with digital technologies aspects considered from the beginning? What are the added values of applying the selected technology in the intervention? What are its adverse or potentially unintended effects? • How do the intervention workplan and budget reflect the use and cost of technology? Are there needs in terms of technology supply and capacity-building? What is the digital and data literacy of the practitioner team? • What underlying values and attitudes related to technology may drive inequalities, and how can these affect the intervention? • Are beneficiaries involved in decision making and planning around the program design, implementation, and monitoring? Are beneficiaries digitally literate and comfortable with the use of technology? What feedback and accountability mechanisms have been built into the program implementation plans	• How are similar technologies and digital services used in conflict settings? • Has the technology been assessed for potential unintended uses, which could lead to negative societal impacts, including the exacerbation of existing vulnerabilities and even conflict? • Have measures to reduce the potentially negative impacts of the technology been developed? • Has the technology been tested in conflict-affected settings?