NUS National University of Singapore
Lloyd's Register Foundation Institute for the Public Understanding of Risk

AI+

USING AI TO ASSESS AND MANAGE ENVIRONMENTAL RISK

A TOOLKIT FOR THE PUBLIC SECTOR

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Top 6 take-aways about AI and environment risk management

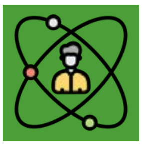
1.THERE ARE FIVE AREAS OF ENVIRONMENTAL RISK MANAGEMENT WHERE AI CAN BE MOST HELPFUL

These five areas are:
- Environmental monitoring
- Compliance and violation detection
- Disaster prediction, planning and response
- Resource use planning
- Stakeholder engagement

These areas are best-suited for AI because they align with what AI is good at: automating some elements of data input, synthesising data from many different source types, analysing enormous volumes of data quickly, producing real-time insights about what is happening, and making predictions.

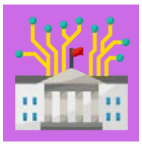
2. AI IS NOT THE RIGHT TOOL FOR EVERY JOB

AI's strengths make it uniquely useful for certain tasks. But it isn't the right tool for every job. AI also comes with some unique problems that can run counter to the mandates of environmental risk professionals. For one, AI can produce incorrect results that can be difficult to recognise. This is especially problematic in light of environmental agencies' statutory requirements. The use of AI itself also creates large environmental impacts, as it requires relatively large amounts of energy and water to operate. The approach chosen for any given environmental risk activity should be the one that is best suited for the specific task—whether AI or a more traditional data management approach.



3. HUMAN EXPERTISE AND INVOLVEMENT IS STILL CRITICAL

Humans and AI each bring a different set of strengths and weaknesses to environmental risk management. AI should be used as a way to augment human understanding, not to replace human judgement, decision-making or relationship building. As noted in the New York Times, "A.I.'s most revolutionary potential is helping experts apply their expertise better and faster. But for that to work, there has to be experts."[1]



4. MANY GOVERNMENTS AROUND THE WORLD ARE USING AI FOR ENVIRONMENTAL RISK ACTIVITIES

Government agencies have started to use AI for a range of environmental risk related tasks, such as monitoring coastal erosion, stopping wildlife poaching, managing waste dumping, detecting illegal deforestation, responding to toxic spills, preventing fires, and managing land use trade-offs. In many cases, the government agencies partnered with an external vendor who was able to provide AI systems and technical expertise.

5. MANY POWERFUL AI TOOLS FOR ENVIRONMENTAL MANAGEMENT ARE PUBLICLY AVAILABLE AND FREE

There is a growing number of AI-based tools that have already been developed and that offer great value to people engaged in identifying and managing environmental risk. The most powerful of these combine satellite observation, computer vision and machine learning to visualise and analyse environmental conditions across the planet. Many of these tools are available for free, as a public good. Examples include Global Forest Watch, Land & Carbon Lab, Google FloodHub, WildMe, MethaneSat, Planet, and SkyTruth.

6. A COMMUNITY OF PRACTICE COULD BOOST LEARNING FOR ENVIRONMENTAL PROFESSIONALS ON HOW TO USE AI RESPONSIBLY, CHEAPLY AND WELL

AI is still relatively new for most environmental professionals and organisations. A Community of Practice—where experiences and knowledge can be documented and shared—could be an important step toward building capacity and accelerating effective use.

Foreword

Over the past decade, the volume and diversity of data available to monitor environmental risks has increased exponentially. This data revolution—from satellites orbiting the Earth to sensors in our homes and phones in our pockets—holds the promise of transforming how we assess and manage environmental risks. Alongside this are modelled and synthetic datasets that simulate environmental conditions or risks where direct observation is not possible. But while data availability is no longer such a challenge, the capacity to make sense of it certainly is.

For environmental regulators responsible for setting, monitoring and enforcing standards, making decisions around permitting and licensing, and engaging with policymakers, the media and the public, the availability of data may feel more like a burden than a boon.

AI, with its ability to detect patterns, model complexity, and support rapid decision-making, offers new and powerful tools to help meet this challenge. By applying machine learning, natural language processing, and other AI techniques, regulators and other stakeholders can better understand risks, identify early warnings, and develop more effective responses. Yet the use of AI also introduces new risks, including questions of bias, opacity, and data privacy, particularly within the context of regulatory decisions. For regulators, the principles of accountability and transparency are paramount.

At the Institute for the Public Understanding of Risk (IPUR), one of our core missions is to explore how risks intersect—across health, environment, and technology—and how societies can navigate this complexity. While much of our work has examined how risks can compound and cascade across systems, we are also interested in how they can balance and counteract each other. This report contributes to that line of inquiry, examining how AI might be used to understand and manage environmental risks, while also acknowledging and addressing the risks inherent in the use of AI itself.

Bridging the gap between technical expertise and public understanding is also at the heart of IPUR's work. We aim to enable dialogue between domain specialists and the wider public, so that communities can make informed decisions, and experts can better understand public values and concerns. We aim to facilitate meaningful exchanges between experts and the public, ensuring that AI applications in environmental risk communication and management are not only effective but also accepted and trusted by the communities they serve.

This report extends our earlier work, including Using Artificial Intelligence to Support Healthcare Decisions: A Guide for Society, and our AI and maternal health project in Bangladesh, developed in partnership with the Government of Bangladesh and the Association of Pacific Rim Universities with support from Google. These projects brought researchers and policymakers together, illustrating the importance of trustworthy, context-aware AI applications in the health domain.

This report is primarily targeted at environmental regulators, policymakers, researchers, and other stakeholders at the forefront of understanding and addressing the complexities of modern environmental challenges, particularly in the context of the data revolution and the integration of AI technologies.

It is designed to provide these professionals with insights into leveraging AI to enhance decision-making processes, improve risk considerations, and foster transparent and accountable regulatory practices. Additionally, the report could serve as a valuable resource for educators and communicators dedicated to promoting informed public discourse on environmental and technological issues. We hope this report contributes to the growing conversation on how AI can be responsibly harnessed for environmental risk communication and regulation, and we look forward to continuing to explore the critical intersections between technology, health, and the environment.

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Who this toolkit is for

This toolkit is for people who work in the public sector and who need to understand, assess, manage or mitigate environmental risk.

This may include people working in regulatory agencies; people involved in resource management, land use planning, risk assessment or impact assessment; people charged with preparing for environmental risk or disasters; and those who communicate with external stakeholders.

These personnel face enormous pressure to deliver environmental outcomes that are rapid, robust and useful. As for many workers in the knowledge economy, AI can sometimes be a way to help deliver on those outcomes faster, better and cheaper. This is because AI is really good at synthesising large amounts of data and using that information to make predictions—tasks that underpin a lot of environmental risk work.

However, environmental professionals may not understand where to start or may be intimidated by the idea of using AI.

This toolkit is intended to help. It provides a simple introduction to how and where AI may be useful for public sector environmental risk professionals.

The toolkit:

- Identifies different kinds of environmental risk activities that could be helped by AI.
- Gives real-world examples illustrating where and how AI has been used for environmental risk.
- Reviews some AI tools and approaches that environmental risk professionals could use.
- Discusses some considerations for how to implement AI and some cautions to be aware of.

A note about the term "environmental risk"

The terms "environmental risk," "environmental risk assessment," and "environmental risk management" can have very narrow technical definitions that align with specific, formal processes (such as assessing the likelihood, duration, frequency, and severity of a particular event).

However, this document uses the term "environmental risk" more broadly to talk about the potential for change or damage to the overall health and functioning of environment systems.

Examples of questions about environmental risk that AI can help answer

- Where is it going to flood?
- How can I figure out what areas need the most help in an emergency?
- Which species and ecosystems are most at risk from habitat loss?
- Which areas should be prioritized for conservation to maximise biodiversity?
- What regions might be prone to drought in the future?
- How is the health of our coral reefs changing over time?
- Which industrial sites are most likely to cause water contamination?
- What environmental concerns do different groups of stakeholders have?
- What is the best way of presenting information to stakeholders so that they understand risks?
- Would it be more effective to spend money on flood prevention or wildfire management?
- How should we balance the competing water needs of agriculture, industry, and residents?

AI Use Cases: Five environmental risk areas where AI can be useful

This section describes five key environmental risk-related activities where AI has been successfully applied:

- **A. Environmental monitoring**
- **B. Compliance and violation detection**
- **C. Disaster prediction, planning and response**
- **D. Resource use planning**
- **E. Stakeholder engagement**

This is not an exhaustive catalog of how AI can be used in the context of environmental risk, but it does provide a structured way to illustrate practical uses of AI in these areas.

For each of the five areas, real-world examples ("use cases") are provided showing how AI has been implemented by government agencies or NGOs. Importantly, these examples demonstrate the application of AI in actual decision-making and operational contexts, rather than just theoretical or research environments. They highlight the range of *what* AI can do — although they offer less insight into *how* these organisations approached designing and building the AI systems and *whether* the implementation was successful.

A. Environmental monitoring

Monitoring and analysing data on environmental media is at the heart of risk management and mitigation. There are numerous environmental dimensions that governments monitor: water quality and quantity, air quality, soil health, biodiversity, forest health, coral reef health, wildlife status, vegetative cover and many more.

In recent years, environmental monitoring has experienced a data explosion. Advances in sensor technologies have resulted in a profusion of data being produced from remote sensing platforms like satellites, drones, and airborne LiDAR as well as from field studies, citizen reports and historical records. This surge presents enormous challenges in terms of management, integration and analysis of the data.[2]

AI can be useful here, because AI can automate some elements of data input, synthesise data from many different sources, analyse data quickly, produce real-time insights about what is happening, and draw inferences about future conditions. As a result, the use of AI has made inroads at every stage of environmental monitoring, from data collection to analysis, prediction, and decision-making.[3] Although AI can be useful for these tasks in any jurisdiction, it may be of particular help in regions that have limited human resources for sampling and analysis.[4]

Real-World Examples of AI used for environmental monitoring

Monitoring coastal erosion, Japan

Japan's Ministry of Land, Infrastructure, Transport and Tourism is establishing a program to detect coastal erosion that will use AI to analyse satellite and drone imagery. The system obtains images from private satellites and drones. The shorelines in the images are traced by the AI and compared over time. Information about coastal erosion is then sent to prefectural governments so they can establish mitigation measures such as constructing breakwaters and wave-dissipating concrete blocks. Trials of the system were introduced in 2024, with nationwide deployment intended for 2026.[5]

Assessing and restoring vegetation cover, United Arab Emirates

The Environment Agency of Abu Dhabi has launched an AI-based assessment program to better understand the state of native vegetation cover and how it is being impacted by human use, and to undertake restoration efforts. The programme was established by the Agency in partnership with Dendra Systems, a technology company that provides an AI-based platform for environmental management.[6] The programme uses remote sensing to capture images that are combined with the Agency's habitat vegetation maps, covering an expanse of 10,000 hectares.[7] The data is used to inform drone-based re-seeding efforts.

Assessing soil health, Europe

AI 4 Soil Health, part of the EU Soil Mission, is developing a program to help farmers halt and reverse soil health decline. The organisation is producing an open-access, Europe-wide soil health measurement app that will be launched in 2026 across sites in Spain, Wales, France, Greece, Netherlands, Croatia, Finland, Sweden, Denmark and Italy. The app will use AI modelling integrated with technologies such as digital twins and satellite mapping to provide actionable information to farmers, other soil users and government policy makers.[8]

Identifying water loss, Brazil

Brazil has been losing large volumes of surface water over the past few decades. The MapBiomas water project, which was established by Brazil's Climate Observatory along with the World Wildlife Fund, has used AI to identify both the scale of loss and the location of problem areas.[9] Using machine learning, the project processed more than 150,000 satellite images that spanned the years 1985 to 2023, a task that the project leaders state could not have been done without AI.[10] The project was able to demonstrate that Brazil has lost 15% of its surface water since 1990.

Tracking elephant movement, India

The state of Chhattisgarh, India, has developed an AI-powered elephant tracking system that identifies the presence of elephants within a 10-km radius of villages. The project works with an elephant tracking system and human patrolling teams, both of which feed information about the presence and movement of herds of elephants to the AI. Alerts are automatically sent to registered users in the vicinity. The project has reduced human-elephant conflict to zero.[11]

B. Compliance and violation detection

Compliance and violation detection is used to ensure that there are no unauthorised breaches of environmental thresholds, requirements, standards, or regulations—no unauthorised releases of pollutants, toxins or methane emissions, no artisanal mining or unauthorised deforestation, no construction or operation of unpermitted facilities, no tailings failures, no excess CO_2 emissions, no animal poaching, etc.

AI can be used to monitor compliance with permits and environmental regulations—especially when the AI selected is good at image recognition and processing and is used in combination with other advanced technologies like satellite monitoring and Internet-enabled sensors.[12]

AI can assist by analysing real-time or near-real-time data to identify anomalies or detect when thresholds are breached. It can also combine different information types to provide insights or make predictions about what facilities or conditions are most likely to be out of compliance, helping target in-person inspections toward the highest risk cases. Additionally, AI can analyse social media data to understand what is happening on the ground.

Real-World Examples of AI used for compliance and violation detection

Air pollution from illegal brick kilns, Bangladesh

Bangladesh's Department of the Environment partnered with researchers from the National University of Singapore to build and implement a "brick kiln tracker" that identifies illegal brick kilns, estimates the air pollution emitted from individual kilns, and enables enforcement officers to target priority inspections.[13] The Brick Kiln Tracker uses a machine learning (convolutional neural network) algorithm to identify the brick kilns in the satellite data. Pollution from each kiln is estimated by coupling satellite data with air quality modelling.[14]

Wildlife poaching, Sri Lanka

AI can analyse input that include historical movement patterns, habitat preferences, and external factors such as human activity and environmental changes to predict where wildlife poaching is likely to occur.[16] The government of Sri Lanka has established an AI-enabled warning system that uses acoustic sensors to detect weapons fire and communicates its findings to park rangers via a mobile app. This alert allows the rangers to respond in real-time to emerging threats.[17]

Illegal timber transport, Romania

The government of Romania is using AI to crack down on illegal and unauthorised timber transiting through the country. Romania's government issues over 400,000 timber transportation permits each month. To receive a permit, four photographs of the load are required—adding up to 1.6 million photographs to be reviewed each month, too much for the country's 200 human reviewers to handle, and leaving opportunity for illegal timber movement. In collaboration with Google and a local IT company, the government established a new AI-based system that can review the photographs and documentation for 400,000 permits in three days.[18]

Waste dumping, Australia

The city of Melbourne, Australia, worked with the company Nokia to roll out AI that reduces "illegal and dangerous dumping of waste."[15] The programme uses cameras to monitor the city's trash compactors. An AI-powered algorithm reviews data from the cameras along with operational data on the compactor itself to create real-time alerts and reports. Object detection identifies potentially dangerous items and identifies unusual movements, such as illegal waste dumping at night. The information is intended to provide information to the city to act before the dumped items become a hazard and to allows city personnel to understand patterns of waste dumping activities so they can patrol more effectively.[15]

Illegal deforestation, South America

The NGO Rainforest Connection found an innovative way to use AI and old cellphones to identify illegal deforestation activities. The organisation uses the equipment (originally old cellphones but since updated to purpose-designed acoustic monitors) to capture the sounds of the forest. The recordings are uploaded to Google's TensorFlow, an AI machine learning framework that was trained to identify the sound of chainsaws in the forest. The information about chainsaw activity, along with the location, is sent automatically to forest managers.[19]

Methane emissions detection, global

In the past few years, over a dozen non-profit and commercial organisations have emerged that identify and quantify methane emissions from industrial facilities, based on satellite and aerial observation coupled with machine learning.[20] These organisations include GHGSat, MethaneSat, the Carbon Mapper Coalition and others. Many of these have been created either by national environmental agencies or with country governments providing financial support. The readings from these AI-enabled satellites help governments across the world to identify local sources of high emissions and to measure progress against the Global Methane Pledge and other national policy agreements. The technology is also being used to validate controlled methane releases.[21]

C. Disaster prediction, planning and response

Disaster prediction, planning and response involves:

- Identifying what potential events/disasters (wildfires, hurricanes, toxic spills, etc.) are most likely to occur, and what the extent and geographic scope are likely to be.
- Planning for how to respond effectively and where to target resources.
- Continuously monitoring for the development of emergency events.
- Real-time response—directing resources to mitigate impacts and communicating with the public at large.

There are a number of ways that AI can be helpful for these tasks. For example, AI-based predictive modelling can be used to assess the likelihood, location and extent of potential disasters. AI can be part of an early warning system. AI can support decision-making around resource allocation and coordinating response efforts.

Although both traditional risk modelling tools and AI can be used to model disaster risk, they take very different approaches and have different strengths. Traditional disaster risk modelling uses a variety of data sources (historical records, maps, field measurements, etc.) to create models that are based on how physical properties and dynamics operate in the real world. AI, by contrast, assembles data and then makes predictions based on patterns it finds in the data.[22] In our increasingly data-heavy world, this approach holds a lot of promise, as it allows far more data sources to be synthesised and incorporated. However, the AI models are not necessarily based in physical reality and are based only on relationships in the data. This makes it difficult for experts to check the results.[22]

Real-World Examples of AI used for disaster planning and response

Flood forecasting, India

India's Central Water Commission entered into an agreement with Google in 2018 to use AI to build flood forecast systems, improve management and disseminate flood-related information. The model uses a combination of rainfall records, terrain maps, river levels and machine learning to predict when and where a flood might occur, as well as the potential severity.[23] When there is a flood, the system also automatically sends alerts to smartphones in the affected area. Google has since broadened its system (Google Flood Hub) which covers 80 countries.

Preventing bushfires, Australia

AI helped streamline the resource-intensive process of preventing bushfires in Australia. AusNet, an Australian electric utility, partnered with Amazon Web Services (AWS) to automate the process of classifying LiDAR and other visual data to map out vegetation in relation to AusNet's electrical assets and identify areas that needed to be trimmed for safety. This was previously done using GIS, rules-based approaches and manual labor to classify images. The deep learning AI had around a 92% accuracy in detecting conductors and vegetation, increasing the speed of response and saving AusNet about $500,000 per year.[26]

Toxic chemical spill response, U.S

A failure at a chemical facility released 10,000 gallons of 4-methylcyclohexylmethanol into the Elk River, one of the main tributaries for drinking water in Ohio. A quick response by the water utility, who worked with the technology company Leidoswas, was able to stop the chemical from entering the city's drinking supply. The approach used AI to rapidly calculate the time of travel and concentration of contaminants based on the river's real-time flow and velocity.[28]

Earthquake rescue, Syria and Turkey

After a magnitude 7.8 earthquake in Syria and Turkey in 2023, AI was used to support ground rescue missions. AI analysed satellite images to help rescue workers find damaged areas that needed response.[24] In addition to mapping out damaged areas, the programme was able to help identify where safe temporary shelter sites could be placed.[25]

Building disaster-resilient infrastructure, Caribbean

The governments of Dominica and St. Lucia worked with the Global Facility for Disaster Reduction and Recovery (GFDRR) and the World Bank to map structures at risk of damage in disaster scenarios. The work brings together satellite-based earth observation data and AI to rapidly generate baseline geospatial data that will help the governments to identify and retrofit structures damaged in hurricanes or other natural disasters.[27]

Post-earthquake communications, Myanmar and China

After the March, 2025, earthquake in Myanmar, the Chinese government created an AI-based Chinese-Myanmar-English language translation system to assist in communicating and coordinating emergency rescue teams in real time.[29] The system was developed by the National Language Service Corps of China, an agency that provides language support during public emergencies.[30] It was created in just seven hours using China's DeepSeek AI platform.

D. Resource use planning

Public sector environmental departments are tasked with planning for optimal environmental resource use in a way that balances risks, benefits and the competing demands of different users and interests. This comes in numerous forms such as water take, forestry allowances, mining rights, oil and gas leases, or allowed CO_2 emissions.

Departments may need to:
- Determine the extent of resources to allocate, over what time period and with what level of intensity.
- Develop strategies for land and resource use.
- Evaluate proposed developments that seek permits or environmental approvals.
- Design or revise regulations and standards that address the environmental risks of resource exploitation.

Ultimately, resource planning is a values-driven decision with no single correct answer. It relies on human judgment. But underpinning good decision-making is the analysis of a large volume of data that provides evidence on current conditions and likely outcomes under different scenarios.

This is why this task is a good fit for AI assistance. AI can help by quickly digesting the large volumes of information and providing predictions about what would happen under different conditions. As a result, decision-makers may have more information about trade-offs. They may also have this information more quickly than by using other methods, which could contribute to, for example, shorter permitting processes.[31]

Real-World Examples of AI used for resource use planning

Balancing biodiversity and urban development, Canada

The city of Edmonton, Alberta has implemented a project called WildEdmonton to inform the city's future growth and development in a way that respects wildlife habitats and protects local biodiversity. The project uses AI to analyse images from remote cameras to identify the presence and location of animals and where interactions between humans and wildlife are likely to occur. The project was built on Microsoft's CameraTraps Megadetector but required extensive customisation to fit the city's context and the purpose of the project.[32]

Managing land use trade-offs, U.K.

The U.K. Geospatial Commission partnered with the Alan Turing Institute and Newcastle City Council to develop a new, AI-based approach to managing land use trade-offs.[33] The programme uses earth observation (satellite) imagery, AI processing, and a user-friendly tool called DemoLand that allows members of the public to explore different land use scenarios and interact with a chatbot. The DemoLand program has been made open source so that other organisations can learn from and make use of the work.

Water resource management, India

Over 121 urban local bodies in India have established digital twins for urban water management using Vassar Labs' aquaWISE platform. The platform uses AI models to integrate data from various sources such as sensors, satellites, databases and global forecast systems. The digital twin, which operates in real-time, is able to help the urban local body to anticipate and manage water-related assets, demand and strain on local water infrastructure.

Forest resource management, India

The heavily-forested state of Uttarakhand has implemented an AI-based programme that assists in preparing 10-year working plans that govern forest management. The project team states that the use of AI has provided analysis outputs that are useful in forming the working plans, as well as specific approaches for sustainable forest management and biodiversity conservation.[34]

Efficiency in environmental permitting, USA and Denmark

In 2024, the U.S. Department of Energy (DOE) announced initiatives to use AI as a way to help speed up the environmental permitting process. The DOE's Pacific Northwest National Laboratory developed a pilot "PolicyAI" program that can help federal regulators to find, extract and summarise information located across 28,212 documents from 2,917 different environmental assessment reviews. This is the first time these records are searchable in one location.[35]

As in the U.S. example above, Denmark's EA Hub is a digital platform that houses environmental assessments and environmental impact reports from across the country. AI-assisted search is available to help users locate relevant information. However, Denmark's Hub is able to be accessed not only by government authorities, but also consultants, researchers and the general public.[36]

E. Stakeholder engagement

Stakeholder engagement is ultimately about building trusted relationships—a process that cannot be replaced by any kind of technology.

However, there are several elements of stakeholder engagement that can be made simpler with AI assistance. These include:

- Transcribing audio or video recordings of stakeholder meetings. This is a process that can be automated with AI. At this point in time, AI is very good—but not perfect—at producing transcriptions. Human review is still required to ensure that the AI's results are accurate. However, the process of review is far less time-intensive than having people transcribe from scratch.

- Analysing feedback from stakeholders. Analysing feedback from stakeholders can be cumbersome, especially if stakeholder submissions number in the thousands. Although traditional tools (like NVivo) have been used for many years, AI is particularly good at working with unstructured data, which could include emails, letters, transcripts and even video recordings. AI is also increasingly capable of sentiment analysis, which can help distinguish tone and meaning. However, it is still far from perfect and requires substantial oversight to ensure that it has correctly interpreted meaning.[37]

- Developing stakeholder communication materials. Large language models (LLMs – a type of AI) can help simplify detailed or complex technical information and tailor it to different audiences. These models can also be used to test different communication materials before they are given to the public to show how those materials could be received or interpreted by different stakeholders. LLMs are also very good at translating documents between languages quickly and mostly accurately.

- Allowing stakeholders to engage with environmental risk information. Chatbots are a form of AI that mimic / simulate conversation with a human agent. Chatbots can be developed that enable stakeholders to ask questions and receive answers about a particular topic, project or set of information. The advantage of a chatbot over a fixed set of questions and answers (like an FAQ section on a website) is that the chatbot can accept any kind of wording (natural language), can provide answers about a greater range of things than an FAQ can contain, and can assemble responses from a greater range of information behind the scenes.[38] For example, a chatbot could be trained on a project description and Environmental Impact Statement, and the user can ask about any aspect of the project that interests them. The output is not infallible, but it can be helpful.

Using AI to assist stakeholder engagement is an area where particular attention needs to be paid to rights, security, privacy, transparency and fairness.[39]

Real-World Examples of AI used for stakeholder engagement

Chatbot for collecting community environmental concerns, U.S.

Personnel at the Texas A&M Superfund Center developed MyEcoReporter, a chatbot that helps community members report pollution and chemical release incidents via text message.[40] Users text concerns to the MyEcoReporter app, eng aging in conversation with the chatbot using natural language. The chatbot then packages that information and sends it to the right authorities.

Simplifying government correspondence, Netherlands

The Netherlands Enterprise Agency (RVO), part of the Dutch Ministry of Economic Affairs, collaborated with Utrecht University to explore the application of LLMs in simplifying official letters. The initiative aimed to rewrite complex correspondence into B1 language level—understood by 95% of the Dutch population—by utilising AI to reformulate sentences and suggest simpler alternatives. Although not related directly to environmental risk, this approach is an example of government using AI to make communications more accessible to citizens.[43]

Scraping social media to identify development issues, Philippines

In the Philippines, the government of the semi-autonomous Bangsamoro region collaborated with the Japan International Cooperation Agency (JICA) and the AI company Peloria. They created an AI approach that scanned social media and online news sources data in both Tagalog and English. Using this approach, the government identified critical development issues from the perspective of citizens, including finding variance across different communities, that traditional phone surveys had not detected.[41]

Air pollution community alerts, Spain

Spain's Ministry of Innovation, Industry, Trade, and Tourism is funding a project, in partnership with the Polytechnic University of Valencia and several private companies, called PREDATICS. The program will predict air pollution and poor air quality peaks and send alerts directly to vulnerable members of the public. The assessment is based on an analysis of local sensor data, satellite monitoring, and AI-based predictive modelling.[42]

Considerations for using AI for environmental risk tasks

What exactly is "AI"?

Artificial intelligence (AI) refers to a set of approaches that enable systems to analyse data, recognise patterns, and make predictions or decisions by learning from data rather than relying solely on explicitly programmed rules.

Many people are familiar with Large Language Models (LLMs) and other forms of generative AI, with well-known examples including ChatGPT, Claude, or Deepseek. However, LLMs are only a narrow subset of AI technologies, with a similarly narrow range of things that they are suitable for.

AI encompasses a broad range of methods beyond LLMs, including machine learning (ML), deep learning (DL), optimisation algorithms, computer vision, natural language processing (NLP), symbolic reasoning and probabilistic modeling. These methods enable tasks such as object detection, data analytics, forecasting and decision-making in complex and uncertain contexts.

Is AI really new and different?

For many decades, a variety of sophisticated tools and technologies have been employed to help professionals assess and manage environmental risk. These tools include GIS and other mapping programs, remote sensing networks, statistical models, and computer-based simulation programs.

Does AI represent a fundamental paradigm shift compared to these "traditional" approaches for managing environmental risk? Or is AI simply an extension of existing technologies that delivers improved efficiency?

The answer lies somewhere in the middle.

On the one hand, AI can be seen as an evolution and extension of traditional tools. The core principles and objectives for using technology to manage environmental risk remain the same. The need for human oversight and the nature of human decision-making have not changed. Like traditional approaches, AI is hindered by data gaps or poor quality data. And AI is being added to the back end of many traditional tools in a way that provides additional power. For example, AI capabilities are now available within programs such as SPSS, NVivo, ArcGIS, ERDAS IMAGINE, DHI MIKE, Aquaveo, MODFLOW and Stella. This positions AI as part of a continuum of development that has been going on for many decades.

However, another argument can be made that AI offers new capabilities that are revolutionary and that redefine what is possible in environmental risk management.

- AI can address problems at a speed, scale and complexity that traditional tools simply cannot handle. It can manage larger quantities of data, a greater range of data types (satellite imagery, sensor networks, videos, transcripts, historical datasets, street view images, social media data), and multi-dimensional data that has hundreds or thousands of different variables.

- AI can identify complex, non-linear relationships between environmental variables that traditional rule-based models often oversimplify. AI is also generally better at handling uncertainty arising from data gaps.

- It can learn from its data and increase the accuracy of its models in real time, something traditional tools cannot do.

- On the adverse side of "revolutionary," AI also introduces novel problems. It can be extremely difficult to identify why an AI generated particular outputs, decisions or predictions. This can make it difficult to verify the accuracy of the result, to confirm replicability, and to ensure that the approach does not perpetuate bias or create harm.

Even though AI can dramatically improve efficiency, predictive accuracy and real-time monitoring, it is not the best tool for every job. For many tasks, there are numerous alternatives to AI, and the tool that is selected should be the one (or ones) that best fits the task/activity to be done. The goal for using AI is not to play with a shiny new object for its own sake, but to empower humans to make better decisions.[44] AI should be used in a way that adds value while maintaining the rigor, transparency, and compliance standards provided by traditional approaches.

How can environmental agencies use AI?

The ways that organisations can use AI exist across a spectrum, ranging from simple productivity enhancement to full-scale transformational change. At this point in time, many organisations appear to be using AI primarily as a productivity booster to speed up repetitive tasks like summarising reports or sifting through large datasets. While AI is certainly valuable in this role, it doesn't reach its full potential in this way.

At the other end of the spectrum, AI can enable organisations to do things that were previously impossible—not just making existing processes faster, but fundamentally expanding what the organisation can achieve. However, reaching this level of transformation requires much more than just implementing a tool. It demands significant resources, organisational maturity, supportive leadership, supportive staff, and a clear strategic vision, among other critical factors. Making the leap from basic productivity gains to true transformation rarely happens all at once.

Once a government agency decides it wants to use AI to support environmental risk-related activities, where can it find the right AI tools?

Depending on the context and needs, an agency could build a custom AI solution; or it could purchase access to commercial software. Each approach has advantages and disadvantages, and in practice governments usually develop technology systems that are a mixture of commercial and custom parts.[45] The real-world use cases shown in the previous section included examples of both custom and commercial approaches.

Build a Custom AI

This means developing a tailored solution from scratch, designed to meet the agency's specific needs. This approach requires working with AI specialists who understand both AI development and the agency's mandate, workflows, technologies, and data requirements as well as laws and policies the agency must follow.[45] The AI specialist may be someone from within government itself, or may be an external vendor, either from the private sector or academia. Although building a custom AI helps to ensure that the tool fits the need, it can be very resource intensive and require a long time to develop.

Ready-to-use AI Tools

At the other end of the spectrum, many AI-powered applications are already available and can be used without programming expertise. These off-the-shelf tools are particularly well suited for tasks that include monitoring, detecting trends over time, and planning for natural disasters. A number of these applications are reviewed in the next section of this report.

Customised SaaS AI Solutions

A middle-ground approach is to work with companies that provide environmental AI software as a service (SaaS) and customise their tools to fit agency needs. This does not require building an AI from scratch, but rather adapting existing AI-powered services to support government activities. In the real-world examples presented in the previous section, AI companies that governments partnered with included Dendra Systems, Vassar Labs, Leidos, Peloria, Amazon AWS, Google, Microsoft and IBM.

Some cautions on using AI

AI comes with a number of limitations and problems that are extremely important to understand and manage. A brief review of some of the problems most relevant to the use of AI for environmental risk are reviewed below.

Your country may have guidelines on responsible AI that need to be followed

An increasing number of countries are developing national policies and guidelines to guide the responsible use of AI and other emerging technologies, especially for government agencies.[46] If you work in the public sector, you need to be aware of and follow your government's policies. In addition, consensus is starting to form around principles that should underpin the use of AI in environmental regulation more specifically.[47] Some of the issues that need to be managed include confidentiality, transparency, accountability, and justification for government decisions, especially when permits or legal liability is involved.

AI can be wrong

AI-generated results often appear definitive and convincing, but they can still be incorrect.[47] This can happen for several reasons.

- First, the data being fed into the AI may be of poor quality, containing errors or missing values that cause the analysis to be incorrect. The AI itself will not necessarily detect this problem.
- Object-based mapping methods miss objects that should be detected (errors of omission) or may falsely detect objects that do not really exist (errors of commission), particularly for rare features.[48]
- Generative AIs are prone to "hallucination" or generating plausible but factually incorrect outputs. Unfortunately, it has been demonstrated that the problem of hallucination can never be completely eliminated.[49]

This may have particular consequences in light of environmental agencies' statutory requirements and need to justify their decision-making. If, for example, the AI predicts that there has been a breach of environmental law that would trigger consequences for some party, there need to be accountability systems to ensure the prediction is correct before action is taken.[47] To mitigate this problem, a system needs to be built where results are confirmed using multiple complementary methods, including human verification.

AI raises privacy concerns

Environmental data can be highly sensitive, raising privacy and security risks.[52] AI needs to be used within robust governance frameworks for data ownership, control, access and protection to ensure that privacy and confidentiality are appropriately maintained. This is particularly important where Indigenous groups are affected[19] or in Fragility, Conflict andViolence (FCV) settings.[22] Mitigating against privacy violations requires understanding where data goes when it is fed into AI systems and protecting against security breaches that could allow data to be inappropriately viewed, used or stolen.

Using AI can intensify problems of bias, inequity and environmental justice.
AIs perpetuate any biases that are part of the data they were trained on—including gaps in the data they were trained on. This means that unless great care is taken, the use of AI can perpetuate or exacerbate existing disparities and undermine fair and equitable outcomes.[16, 22] This holds true for environmental outcomes as well as social and economic ones.[50, 51]

AI is energy intensive and has environmental costs
AI consumes significant amounts of energy, contributing to GHG emissions, and can use large volumes of water for cooling. This has led to extensive discussion on when the use of AI is or is not warranted.[53] A new and helpful development is the AI Energy Score, introduced in February, 2025. The Score acts as a benchmarking tool that represents an easy way to identify and compare the energy consumption of different AI models. At the time of the Score's introduction, there was an almost 20-fold difference in energy consumption between the top and bottom performing AI models.

AI cannot build trusted relationships.
As noted earlier, AI cannot replace using face-to-face methods to build relationships of trust with the public or key stakeholder groups.

Ready-to-use AI tools for environmental risk

This section highlights ready-to-use AI applications for understanding and managing environmental risk. Most run in the cloud and are accessed online rather than installed as software on a local computer or server. Almost all can be used by people who do not have programming expertise.

Many of the tools listed below cross over the five environmental risk categories used earlier in this report—for example, a single application may assist with both monitoring and natural disaster prediction, or with both violation detection and resource use planning.

There are several categories of helpful, ready-to-use AI tools that are not described in the tables below, because they apply to many different disciplines rather than being specific to environmental risk. These include AI applications that can help with tasks like project management, synthesizing research findings, communication, and stakeholder engagement; and Large Language Models (LLMs) and other generative AI applications (ChatGPT, Gemini, Deepseek, etc.) that can perform a wide variety of tasks.

Note: the landscape of AI services is changing rapidly. The following list does not attempt to be comprehensive and may become out of date quickly.

1. Planetary observation and analysis

Planetary observation and analysis AIs use satellites, computer vision and machine learning to visualise and analyse environmental conditions across the planet. These systems are extremely useful for environmental risk management, because they have broad geographic coverage, frequently updated data, high reliability, the ability to provide information about areas where on-the-ground monitoring is challenging, and the ability to manage huge amounts (petabytes) of data.

Some things that these tools can be used for:

- Monitoring the condition of air, water, soil, forests, biodiversity, land use, surface temperature, etc.
- Identifying methane emissions and carbon sinks
- Identifying unpermitted environmental encroachments (e.g. new roads, urban development, illegal mining sites, deforestation or fires)
- Monitoring facility-level compliance with environmental regulations
- Supporting environmental reporting regulations (e.g. for European Union Deforestation Regulation)
- Predicting damage in the event of a natural disaster

Many of these services provide similar capabilities. These include:

- The ability to visually explore geographic, ecological and man-made features
- The ability to identify anomalies and track changes over time
- The ability to output data in forms that are compatible with other environmental software programmes such as AutoCAD, ASV, DWG/DXF, SVG, ESRI shape files, ASCII X/Y/Z, etc.

Differences among these services arise from:

- Differences in ownership and organisational purpose (some are publicly funded for free access, while others operate as commercial services)
- Type, spatial resolution, and update frequency of the available data
- Cost
- The user interface, technical expertise required and the level of support available to the user.

The following table lists some major planetary observation AI services (though many more exist). For each service, a number of key elements are given that are relevant to the selection of which service to use.

It is important to note that the table does not attempt to rate the full suite of features or the performance of these services. For public sector environmental risk managers, selecting a service should be guided by specific needs—whether for flood preparedness, deforestation tracking, emissions monitoring, or another purpose.[54] In addition, the chosen tool must align with the required data type, resolution, and accuracy; must integrate with the user's existing systems; and must provide an appropriate level of user support.

Planetary observation and analysis AI services

Not-for-profit and government-owned services

Name (click for link)	Owner or developer	Pricing	Languages	Geography covered	Key environmental focus areas	Notes
Skytruth	Skytruth	Free	Hundreds of languages	Global	• Freshwater • Oceans • Biodiversity • Climate	
Global Forest Watch	World Resources Institute with Google, USAID and others	Free	English, Chinese, Indonesian, Portuguese, French, Spanish	Global	• Forests and tree cover	
Global Fishing Watch	Created by Oceana, Skytruth and Google	Free	English, Spanish	Global	• Ocean conditions • Marine biology • Human activity at sea	
Land & Carbon Lab	World Resources Institute and the Bezos Earth Fund	Free	English	Global	• Land cover, including global tree canopy height, land disturbance, cropland change. • Land-based GHG emissions and carbon stocks	Many of the services are still under development
Cyanobacteria Finder (CyFi)	Owned by NASA (U.S. government)	Free	English	Global	• Algae blooms in small water bodies	Some U.S. government websites are no longer available
Copernicus Data Space Ecosystem	The European Union	Free	13 European languages	Global	• Agriculture • Atmosphere • Air pollution • Floods • Droughts • Geology • Water • Vegetation and forestry • Fires • Volcanoes	
Dynamic World	Google and World Resources Institute	Free	English	Global	• Land cover	

Planetary observation and analysis AI services

For profit services

Name (click for link)	Owner or developer	Pricing	Languages	Geography covered	Key environmental focus areas	Notes
Google Earth Engine	Google	Paid for commercial use, free for academic and research use	Multiple	Global	• Land cover • Water resources • Ecological trends • Climate	
Satellite Imaging Corp.	Satellite Imaging Corp.	Paid	English	Global	• Land cover • Oceans and coral reefs • Forests • Wildlife and habitats	
Planet	Planet Labs	Paid	English	Global	• Land cover and use • Water • Climate • Forests • Agriculture • Soil • Natural disasters • Surface temperature	Still in private preview mode (not yet available to the general public) of April, 2025
Microsoft Planetary Computer	Microsoft	Free	Multiple	Global	• Land cover and use • Carbon stocks • Air quality • Climate • Fire • Water • Surface temperature	
EOSDA Land Viewer	EOS Data Analytics	Paid	English, Spanish, Portuguese Ukrainian, Russian, German	Global	• Land cover • Forests • Agriculture	

2. Methane (and GHG) emissions detection

Methane detection satellites and airborne sensors use infrared spectroscopy and hyperspectral imaging combined with AI technologies to detect and quantify total methane emissions (and other greenhouse gases). They can identify everything from major discharges over large regions down to small leaks at the facility level.[55] They are particularly useful for industrial regions, remote areas and other locations where ground-based information has been poor. Newer satellites with more sensitive detection thresholds have improved resolution and broadened geographic coverage. Despite these advancements, limitations remain. In particular, cloud cover and atmospheric conditions can interfere with detection. However, these systems provide a number of improvements over bottom-up quantification methods.

The services listed in the table below all provide tools to detect methane (and some other GHGs) as their primary focus. Several of the planetary observation services listed in the previous table also provide this capability, but as part of a larger suite of environmental information.

Name (click for link)	Owner or developer	Pricing	Languages	Geography covered	Notes
MethaneSAT	Non-profit. Developed by the Environmental Defense Fund and the government of New Zealand	Free	English	Global	Public launch planned for early 2025 but has been delayed
Carbon Mapper	Non-profit. Partnership with NASA and PlanetLabs	Free	English	Global	Owns the two satellites which produce the data
Methane Watch	Kayrros, a private company	Free	English	Global	
GHGSat	GHGSat, a private company	Paid	English	Global	Provides both satellite and airborne methane monitoring

3. Natural disaster prediction, planning and response

Some AI models have been designed specifically to aid with forecasting natural disasters and planning for response.

The products listed in the table on the next page are examples of AI-driven systems. As noted elsewhere in this report, AI is not always the best approach. There are many other software programmes that don't use AI (or that use it only in limited ways) but are still extremely helpful for predicting disasters, estimating exposure, and planning for response, such as OpenQuake, Ushahidi, CAPRA, and MapAction.

In 2024, the United Nations launched the Global Initiative on Resilience to Natural Hazards through AI Solutions. The initiative is not developing AI tools. However, it will develop AI use cases, provide expert guidance, and support research, innovation, and the development of standards for the use of AI in disaster management.

Careful - sometimes, it really is too good to be true.

As interest in AI continues to surge, so does the number of applications claiming to support environmental risk activities—particularly in areas like disaster prediction and emergency planning. Many of these tools promote themselves as intelligent, reliable solutions, but are in fact little more than simple wrappers around general-purpose Large Language Models (LLMs) like ChatGPT, with minimal customisation or added value.

The problem? These applications are often built by developers with limited understanding of the environmental systems and data they aim to support. As a result, the quality, relevance, and reliability of the outputs are highly questionable. What may appear to be a powerful, AI-driven insight can actually be a generic response, lacking scientific rigor and misaligned with the realities of environmental risk management.

Before adopting any AI tool for high-stakes applications, take the time to investigate how it's built, what data sources it uses, and whether its outputs have been validated by domain experts. When it comes to managing environmental risk, trustworthiness matters far more than trendiness.

Name (click for link)	Owner or developer	What it does	Price	Languages	Geography	Notes
Prediction, early warning and planning						
Google FloodHub	Google	Forecasts river floods up to 7 days in advance	Free	Over 15 languages	80 countries	Can be configured to send out alerts via SMS to people in affected areas
PDC Disaster Alert	Pacific Disaster Centre	Near real-time information and alerts on 28 types of natural and man-made hazards	Free	10 languages	Global	
Reask	Private company	Risk forecasting for extreme weather events, especially cyclones / hurricanes	Paid	English	Global	
Mediterranean and pan-European forecast and Early Warning System against natural hazards (MedEWSa)	Developed by the World Meteorological Association, funded by the E.U.	Provides tools to understand risks related to frequent extreme weather and climate events and take action to minimize their impact	Free	Multiple	Mediterranean and Europe	
Response						
Artificial Intelligence for Digital Response (AIDR)	Developed by the Qatar Computing Research Institute	Analyzes social media posts in real-time to detect distress signals, identify needs, and direct emergency responders.	Free	All languages	Global	Free open source software. Some coding knowledge needed.
xView2	U.S. Department of Defense	Assesses infrastructure and building damage following natural disasters	Free and paid tiers	English	Many locations but not full global coverage	
CrowdAI	Private company, owned by SAAB	Rapid assessment and mapping of disaster affected areas	Paid	English	Global	

4. AI-based analysis of local sensor networks

The tools below use AI to bring insight to data collected from local sensor networks, often augmented by satellite data for broader context. Many of these tools also allow users to upload additional datasets, such as historical information or supplementary map layers.

These tools are useful for:

- Assessing the quality of environmental media and identifying changes over time, particularly for localised areas.
- Using predictive analytics to estimate future change.
- Assessing facility-level compliance with environmental regulations.
- Identifying pollution sources.

Name (click for link)	Owner or developer	Purpose	Pricing	Languages	Notes
WildMe / Conservation X Labs	Conservation X Labs	Uses AI to monitor wildlife populations using camera trap images	Free	English	
Wildlife.ai	Wildlife.ai is a charitable trust	Local sensors and AI to identify and classify wildlife	Free	English	
SpeciesNet	Wildlabs.net	Animal species recognition from camera trap	Free	n/a (code only)	Requires programming knowledge
SurfPerch	Google Research and DeepMind	Coral reef acoustic environment and health indicators	Free, open-source	n/a (code only)	Requires programming knowledge

5. Other useful tools

The AI-based tools and services in the table below don't fit into any of the categories above, but are extremely useful nonetheless.

Name (click for link)	Owner	Purpose	Pricing
ARIES - ARtificial Intelligence for Environment & Sustainability	Non-profit	ARIES is an open-source AI platform that integrates data and modelling to support sustainable decision-making, by mapping ecosystem services, biodiversity, and environmental risks.	Free
WatsonX Environmental Intelligence	IBM	WatsonX Environmental intelligence is an AI platform that can monitor data, provide insights and create forecasts about a wide variety of environmental risk-related conditions based on live data feeds from satellites, weather stations, climate models and other sources.	Paid
Dendra Systems	Dendra Systems	Dendra provides AI insights (monitoring, forecasting and planning) for a wide range of environmental risk management conditions and across large ecosystems.	Paid

Conclusion

This report has provided some insight into how AI could be useful for identifying, understanding and managing environmental risk. We conclude with some high-level observations/messages.

1. AI is not always better than more traditional data approaches

AI can be of valuable assistance in helping manage large amounts of data and assemble different sources. However, it doesn't preclude the need for other systems of data collection and analysis to address specific needs. And critically, AI cannot substitute for human judgement, empathy, relationship building, expertise and context. Ultimately, you need to use the tool that is best suited for the specific job—whether AI, a more traditional software program, or a person.

2. Humans and AI working together is the most powerful and appropriate approach.

Humans and AI each bring their own set of strengths in organisational decision-making.[56] AI can be an amazing tool – but it does not have the deep expertise that professionals do.[57] It is a mistake to ignore the advantages that AI brings, but it is an equal mistake to assume that AI can replace the need for hands-on human involvement and professional expertise.

3. Garbage in, garbage out.

AI will provide its best attempt at answers, but if the data feeding the AI is of poor quality or if it is asked to use analysis methods that are not appropriate for the context, the outputs will be unreliable at best, or dangerously wrong at worst. Those people who set up and use AI for environmental risk must have a good understanding of the ways that AI analysis can go wrong, and must set up verification systems to counteract the potential problems.

4. A Community of Practice could boost learning on how to use AI for environmental risk responsibly, cheaply and well.

AI is still relatively new for most environmental risk professionals and agencies. It would be useful for a Community of Practice to be developed to allow experiences and knowledge to be documented and shared. This could be started by a university, a government agency or a not-for-profit organisation. In addition, such a community could be a platform for building a large foundation model for AI that has been specifically trained on environmental issues.

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About the Author

Marla Orenstein is a Visiting Fellow at the LRF Institute for the Public Understanding of Risk (IPUR) and recently finished a six-year tenure as Director of Resources, Environment and Economy at the Canada West Foundation, a public policy think tank based in Calgary, Canada. In this role, she focused on using policy to maximise sustainability and prosperity as the world transitions to cleaner forms of energy.

Marla is a leading expert on regulatory processes for major project approval. She has twice held the role of President of the International Association for Impact Assessment (IAIA), and has authored textbooks, book chapters, practice standards, journal articles, reports and op-eds on best practices in impact assessment and regulatory efficiency.

She founded and for 12 years led Habitat Health Impact Consulting, where she worked closely with governments, industry, international agencies, Indigenous groups and communities on the risks and impacts of resource and infrastructure development projects around the world.

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About IPUR

The LRF Institute for the Public Understanding of Risk (IPUR) is the premier institute focusing on public risk perception and communication in Asia, a region which faces acute and growing risks relating to public health, the environment, climate change and emerging technologies. We investigate what people are worried about, where the gaps are between the public's understanding of these issues and the experts' risk assessment, and what interventions can help to bridge these gaps.

Launched in 2017, IPUR was established through funding from the Lloyd's Register Foundation and the National University of Singapore. IPUR strives to shed light on some of the most pressing societal matters which are subject to uncertainty. By dedicating ourselves to transform the risk communication landscape and enhance the public understanding of risk, we seek to improve lives with maximum impact. Our research is multi-disciplinary and brings together social sciences – psychology, economics, public policy, communications, sociology – with marketing, science and engineering.

Our research spans three main risk domains: Data and Technology, Environment and Climate, and Health and Lifestyle. We partner with government, industry and academia to design and evaluate intervention measures, train professionals and students, develop resources, and organise outreach events, stakeholder workshops and conferences.