

Harnessing AI for Flood Risk Management: Integrating People, Data, and Action

A Summary Report Based on the 7th Assembly of the Gilbert F. White National
Flood Policy Forum

Washington, D.C. 2025



This report is the result of a robust Human-AI collaboration, harnessing both a well of expert human knowledge and advancing AI technology. AI tools played a critical role in efficiently summarizing extensive notes taken throughout the Forum, conducting targeted research, and identifying real-world use cases for concepts brought forward by participants. These initial drafts and findings provided a strong foundation, upon which the primary author—a seasoned floodplain manager who recently earned a professional certification in AI governance—built a comprehensive narrative tailored to the unique needs and complexities of floodplain management. The draft report then underwent an extensive review process, engaging technical editors, the Forum planning team, the ASFPM AI Subcommittee, and the ASFPM Foundation leadership. Each layer of human oversight was vital in refining the draft, bringing creativity, contextual understanding, and nuanced judgment to the fore. Ultimately, while AI expedited and enriched the initial stages, it was human expertise, insight, and discernment that shaped the report into a trustworthy and impactful resource for the field. This approach underscores the essential role of human decision-making in ensuring that new technologies are applied responsibly and effectively within floodplain management.

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Dedication to Jenni Evans, PhD

We dedicate this report to the memory of Jenni Evans, PhD, Emeritus Director and Faculty Associate of the Institute for Computational and Data Sciences at Pennsylvania State University. As an internationally respected meteorologist and educator, Dr. Evans brought an extraordinary depth of expertise to the intersection of artificial intelligence, advanced computation, and societal resilience. Her pioneering research—ranging from high-performance simulations of hurricane evolution to the integration of AI and machine learning for improved forecasting—helped redefine the boundaries of hazard science and inspired new standards for ethical innovation in floodplain management.

As a panelist at the 7th Gilbert F. White National Flood Policy Forum, Dr. Evans shared her visionary insights and unwavering commitment to public safety, leaving an indelible mark on ASFPM and the floodplain management community. Her passion for interdisciplinary collaboration, her dedication to mentorship, and her advocacy for responsible science continue to guide us as we embrace both the promise and the challenges of a data-driven future. Jenni Evans' legacy endures in the work and the values of all who strive for excellence in floodplain management.



Jenni Evans, PhD

Foreword from the ASFPM Foundation President

In recent years, the world has witnessed an unprecedented acceleration in the development and deployment of artificial intelligence (AI) technologies. From the bustling innovation hubs of Europe and South Korea to the dynamic technology sectors of Brazil and the United States, AI is reshaping economies, societies, and the future of public policy. As nations and private enterprises race to unlock the transformative potential of machine learning and Big Data, there is a growing recognition that the advancement of technology is often outpacing the evolution of governance and ethical oversight—especially in fields as critical as floodplain management.

Within the United States, the rapid proliferation of AI systems stands at the intersection of opportunity and challenge. Federal agencies and state governments are exploring frameworks to address the complex regulatory, legal, and social dimensions of AI. Local governments are experimenting with different AI applications and considering how it might be used. Internationally, efforts are underway to harmonize standards and codes of conduct, yet a consistent global approach remains elusive. The private sector continues to break new ground in technical capability, while policy and governance gaps can leave communities vulnerable to unintended consequences or new forms of risk.

Floodplain management depends on transparent, defensible flood risk data that can withstand technical, professional, and legal scrutiny, given the direct implications for public safety, financial risk, and property rights. AI offers important opportunities to enhance this work, particularly through automation and administrative support that improve efficiency while preserving scientific rigor. However, in a regulatory environment, AI must complement rather than replace explainable, reproducible methods grounded in hydrologic, hydraulic, and coastal science.

As practitioners in floodplain management, we are beginning to see AI technologies emerge in many areas but are uncertain of the promises and perils inherent in the adoption of AI. These technologies hold the potential to revolutionize our ability to predict, prepare for, and mitigate the impacts of catastrophic flooding. Enhanced modeling, real-time data analysis, and precision planning offer tools to improve public safety and resilience. Yet, the very speed and complexity of AI development also raise pressing questions: How do we ensure that our algorithms are transparent and accountable? What safeguards are necessary to protect public safety, privacy, and equity? How can we uphold the highest standards of professional responsibility, even as the boundaries of our discipline are being redefined?

The risks and ethical concerns associated with AI are not merely theoretical: they are present and urgent. Issues of bias, explainability, repeatability, and unintended consequences must be confronted head-on if we are to build systems that are truly trustworthy. The Association of State Floodplain Managers (ASFPM) Foundation recognizes that our community's codes of ethics and professional standards are foundational to this endeavor. It is our responsibility to engage, educate, and lead in identifying best practices for integrating AI into floodplain management, always with a commitment to the public good.

It is with this sense of urgency and opportunity that the ASFPM Foundation convened the 7th Gilbert F. White National Flood Policy Forum, "Floodplain Management in the Era of Big Data and Artificial Intelligence," in Washington, DC on March 5 and 6, 2025. This report captures the insights and recommendations of approximately 90 leading experts who met to discuss AI and its challenges and opportunities in floodplain management in light of charting a path forward. Together, we have begun the essential dialogue on harnessing AI for trustworthy, ethical, and effective floodplain management.

The ASFPM Foundation is proud to initiate and support this work. We believe that only through collaboration, rigorous inquiry, and unwavering commitment to ethical principles can we ensure that AI serves as a force for positive transformation.

Dale Lehman, PE, CFM

ASFPM Foundation President



Forum Summary

The rapid and extensive rise in the use of artificial intelligence (AI) has captured national and international attention. Floodplain management practitioners and policymakers are currently developing an understanding on how best to apply AI technologies—including the use of Big Data and machine learning—to enhance public safety and floodplain management activities across the United States. Importantly, the intentional and smart use of AI can lead to effective management of flood risk and reduction of the negative impacts associated with catastrophic flooding.

Floodplain management relies on reliable, defensible flood risk data to support regulatory, planning, and design decisions that directly affect public safety, financial risk, and property rights. Because these decisions must withstand professional, technical, and legal scrutiny, the methods used to generate flood hazard information must be transparent, well documented, and repeatable, allowing results to be recreated, traced, and challenged when necessary.

AI offers meaningful opportunities to improve floodplain management, particularly through automation and administrative support such as data retrieval, document processing, and regulatory compliance screening. These applications align well with existing professional practice by enhancing efficiency without displacing the physical science foundations of flood risk analysis. By contrast, opaque “black box” AI approaches that produce hazard outputs without clear grounding in hydrologic, hydraulic, and coastal processes raise significant concerns in a regulatory context, where explainability and defensibility are essential. In this domain, AI is most valuable when it strengthens transparency and professional judgment rather than replacing them.



Artificial Intelligence (AI)

Referred to collectively as AI for simplicity, AI includes the use of Big Data, machine learning, and related tools and techniques.

The Association of State Floodplain Managers (ASFPM) Foundation hosted the 7th Assembly of the Gilbert F. White National Flood Policy Forum, “*Floodplain Management in the Era of Big Data and Artificial Intelligence*,” at the George Washington University’s Student Center in Washington, DC. on March 5–6, 2025. The two-day Forum brought together approximately 90 leading experts in floodplain management and AI to catalyze discussion and action on these topics of critical national importance and set out ideas for addressing them.

This Forum addressed a topic that is both novel and evolving within the floodplain management sector. Unlike previous Forums, which focused on subjects closely related to the daily responsibilities and expertise of floodplain managers—facilitating detailed discussions and actionable policy recommendations—the 2025 event focused on a broader perspective. Participants examined AI at a conceptual level, emphasizing key definitions, overarching principles, and a wide range of use cases. Some of the use cases, as presented in this report, extend beyond the traditional scope of floodplain management but may hold future significance for the discipline. The Forum’s discussions and this report were not focused on providing prescriptive or exhaustive policy guidance

because the technological and regulatory frameworks for AI are rapidly developing and changing. The priority of the Forum was rather to promote heightened awareness, encourage proactive monitoring of ongoing advancements, and help participants begin identifying opportunities to integrate established AI solutions as they become available. This report aims to equip floodplain professionals with fundamental knowledge of AI and its potential strengths and weaknesses in floodplain management, thereby providing floodplain managers with the adaptability needed to respond effectively to emerging applications of AI within their field. Another purpose of the Forum and this report is to provide policymakers, including legislators and government agencies, with a clear starting point for understanding the key issues, tradeoffs, and considerations that should inform the development of national policy on the use of AI in flood risk management.

As illustrated below, the Forum’s agenda was designed to achieve three specific **outcomes** that cut across five **facets** of floodplain management. The Forum included three panel discussions and 12 breakout sessions, three each for floodplain management facets 1, 2, and 3, and three for combined floodplain management facets 4 and 5 to discuss the three outcomes. The 2-day discourse culminated in a collective agreement about three **key takeaways** that crosscut all facets of floodplain management and 11 specific **recommendations** for subsequent review and implementation.



Forum’s Three Discussion Panels

Panel 1 – Prime the Pump: Understanding Big Data and AI

Panel 2 – Drilling Down: The Role of Big Data and AI in Floodplain Management

Panel 3 – Policy Landscape



Forum Outcomes



Awareness

Build awareness and understanding of impacts and implications for all facets of floodplain management



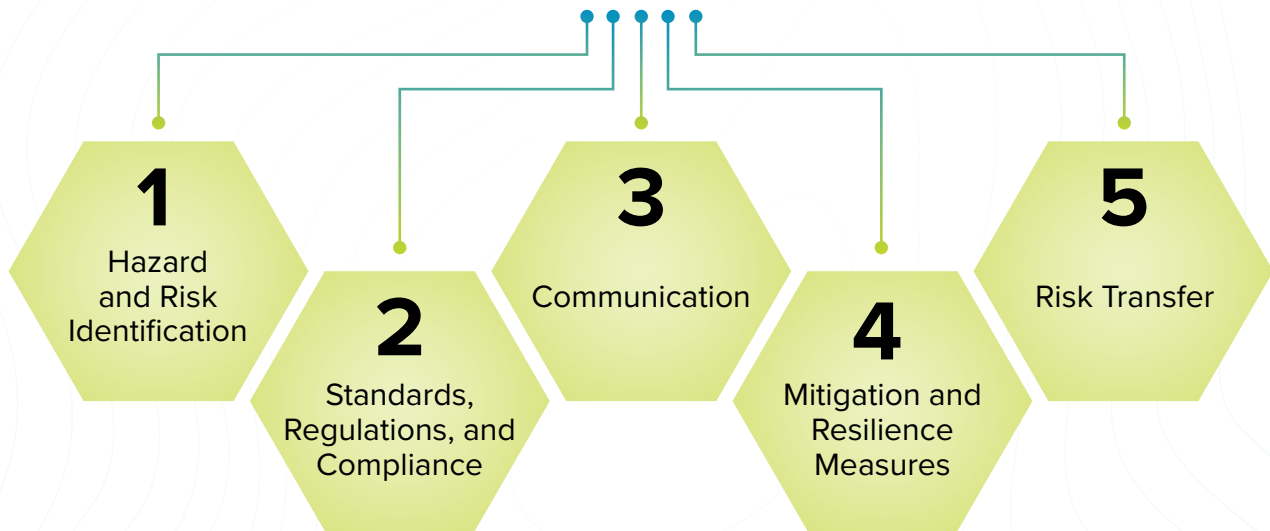
Safeguards

Identify and explore areas in need of standards, best practice, or other policy safeguards



Opportunities

Explore and envision as-yet-untapped opportunities to harness the power of AI within floodplain management



Five Facets of Floodplain Management

Forum Key Takeaways on AI:

It's About Data

The effectiveness of AI depends fundamentally on the quality and quantity of data used to train its models. Data serves as the foundation for AI's pattern recognition, prediction, and decision-making capabilities.

AI as a Tool—Humans Remain Essential

While AI can dramatically enhance decision-making and productivity, it is ultimately a tool designed to augment, not replace, human expertise and judgment. Human insight, creativity, and ethical reasoning are irreplaceable in guiding AI's application.

Potential with Guardrails

AI's transformative potential is vast, but harnessing its benefits requires the implementation of robust guardrails. Responsible development and oversight ensure that AI operates safely, ethically, and in alignment with organizational and societal values.

Summary of Recommendations*

- Recommendation **1** Organize a series of webinars and discussion forums on AI and floodplain management
- Recommendation **2** Compile and publish AI use cases
- Recommendation **3** Establish AI governance and policy framework for AI usage
- Recommendation **4** Review AI accreditation process and professional standards
- Recommendation **5** Institutionalize professional oversight for public safety
- Recommendation **6** Promote data quality and transparency and accountability of AI development and deployment
- Recommendation **7** Upskill the existing workforce and incentivize knowledge exchange
- Recommendation **8** Foster collaboration and co-development
- Recommendation **9** Collaborate on providing best practices and technical support
- Recommendation **10** Conduct an AI pilot project focusing on communication applications
- Recommendation **11** Explore the regulatory sandbox concept

Forum Outcome

-  Awareness
-  Awareness
-  Safeguards
-  Opportunities
-  Safeguards
-  Safeguards
-  Safeguards
-  Opportunities
-  Awareness
-  Opportunities
-  Safeguards
-  Opportunities
-  Awareness
-  Opportunities
-  Opportunities
-  Safeguards
-  Opportunities

*An explanation of each recommendation and a crosswalk with each outcome, facet, and audience is provided at the end of this report.



Basics of Artificial Intelligence

Artificial intelligence (AI) is a technology that allows computers and machines to emulate human cognitive functions, including pattern identification, text, image, and speech recognition, and data-driven decision making based on available and very large datasets. AI systems can learn from experience, adapt to new inputs, and perform tasks that typically require human cognition. For instance, AI-powered virtual assistants such as Siri and Alexa can understand and respond to voice commands, providing information or performing actions based on user requests.

How AI Works

AI systems operate using complex algorithms that enable them to learn, adapt, and make decisions. The process can be broken down into several key steps:

- **Data Collection:** AI systems require vast amounts of data to learn from. This data can come from various sources such as images, text, audio, and sensor readings. Collecting high-quality data is key to an effective and unbiased AI system.
- **Training:** During the training phase, AI models are fed data to learn patterns and relationships.
 - Machine learning, a subset of AI, uses techniques such as supervised learning, in which the model is trained on labeled data, or unsupervised learning, in which it finds patterns in unlabeled data.
- **Model Building:** The AI system builds a model based on the training data. This model is essentially a set of rules and parameters that the AI uses to make predictions or decisions.
- **Evaluation:** The model is tested on new data to evaluate its accuracy and performance. Adjustments are made to improve the model.
- **Deployment:** Once the model is refined, it is deployed operationally to perform tasks in real-world scenarios, continuously learning and adapting to new data.



Ethics, Bias, and Privacy

Ethical considerations play a vital role in the governance of AI systems. Ensuring that AI systems operate transparently, accountably, and responsibly is crucial. Bias in AI systems can lead to unfair and discriminatory outcomes and must be carefully monitored and mitigated. Ethical AI frameworks, such as the European Union (EU) AI Act and various state-level policies, provide guidelines for the ethical deployment of AI technologies.

To ensure data privacy, organizations can follow or employ existing regulations as guidelines. Examples include EU's General Data Protection Regulation (GDPR) and the California Consumer Privacy Act (CCPA). AI continues to evolve; adhering to these principles will be essential for building trustworthy and effective AI systems.

(Sources: <https://artificialintelligenceact.eu/>; <https://gdpr-info.eu/>; https://leginfo.ca.gov/faces/codes_displayText.xhtml?division=3.&part=4.&lawCode=CIV&title=1.81.5)



AI vs Automation and Coding

Automation. Automation refers to the use of machinery and technology to perform repetitive tasks without human intervention, typically based on pre-defined rules and processes. An example of automation is a conveyor belt system in a manufacturing plant that automatically moves products from one station to the next.

The key difference between AI and automation lies in the associated flexibility and adaptability. Automation is fixed and operates within set parameters, whereas AI is dynamic, capable of learning and improving over time.

Coding. Coding, also known as programming, is the process of writing instructions for computers to execute. These instructions are written in programming languages such as Python, Java, or C++. Coding involves creating algorithms that define specific steps a computer must take to perform a task. Traditional coding relies on predefined rules and logic that the computer follows strictly.

Coding involves writing explicit instructions for a computer, whereas AI uses algorithms to learn from data and derive its own instructions or logic, often adapting and improving over time.

(Source: <https://www.stanfordlawreview.org/print/article/speech-certainty-algorithmic-speech-and-the-limits-of-the-first-amendment/>)



Common AI Models: Neural Networks

The most commonly used AI models are neural networks. Put simply, a neural network is a computer system modeled on the way the human brain works. Imagine thousands or even millions of tiny, interconnected units—digital “neurons”—working together to recognize patterns, make predictions, or sort information. These networks are especially good at handling tasks that seem simple for people but are complex for computers, such as understanding speech, translating languages, or recognizing faces in photographs.

One of the most impressive types of neural networks is the large language model (LLM). LLMs are the models behind AI chatbots and virtual assistants. They are trained on huge amounts of written text and learn the patterns of language, grammar, and meaning. When you ask an LLM a question, it responds by predicting the most appropriate answer using what it has learned, much like how someone might respond in a conversation. For example, LLMs can help write articles, answer questions, summarize documents, and even translate languages—all by analyzing the context and details of text inputs.

Other neural network models can recognize images (for example sorting photographs of different animals), convert speech to text, or even help doctors analyze medical scans. By learning from lots of examples—sometimes millions—these AI models get better at their tasks, demonstrating just how powerful and flexible neural networks have become in everyday technology.



Generative AI vs Agentic AI

Generative AI is reactive and responds to prompts to create content, while agentic AI is proactive and makes decisions and acts autonomously toward goals.

Generative AI. Generative AI creates original content—text, images, video, audio, or code—based on user prompts.

Key Features:

- **Content Creation:** Excels at generating essays, answers, code, and designs.
- **Data Analysis:** Identifies patterns and trends in large datasets.
- **Adaptability:** Refines outputs based on user feedback.
- **Personalization:** Offers tailored recommendations and experiences.

Agentic AI. Agentic AI refers to autonomous systems that make decisions and act independently to achieve complex goals with minimal human supervision.

Key Features:

- **Decision-Making:** Assesses situations and chooses actions without human input.
- **Problem-Solving:** Uses a cycle of perceive, reason, act, and learn.
- **Autonomy:** Operates independently and adapts to changing environments.
- **Interactivity:** Engages with real-world data in real-time.
- **Planning:** Executes multi-step strategies toward goals.

(Source: <https://www.ibm.com/think/topics/agentic-ai-vs-generative-ai>)

Summary of Big Data and AI Concepts

The effectiveness and fairness of AI systems hinge on the quality, quantity, and governance of the data (Big Data) used to train them. Training data is the foundation upon which AI systems are built. It consists of examples, patterns, and information that an AI model uses to learn and make decisions. The quality and relevance of this data directly influence the performance of the AI system. Key concepts are summarized below.

Data Collection and Quality

Relevant data can be gathered from various sources such as sensors, databases, websites, and user interactions. Ensuring the comprehensiveness and diversity of data is crucial for the model to understand different scenarios and make accurate predictions.

High-quality data is essential for the success of AI systems. Data quality refers to the accuracy, completeness, consistency, and reliability of data. Poor-quality data can lead to incorrect predictions and biased decisions.

Data Quantity and Management

Data quantity refers to the amount of data that exists within an organization. It is a key characteristic of Big Data. Once the data is collected, it must be managed effectively. Data management involves organizing, storing, and maintaining the data to ensure it is easily accessible and secure. This broad discipline becomes more important as the quantity of data grows, helping to make sense of—and extract value from—vast amounts of information.

Data Governance

Data governance refers to the overall management of data availability, usability, integrity, and security in an organization. A robust data governance framework ensures that data is handled ethically and in compliance with regulations. For example, privacy risk management involves identifying and mitigating risks related to the privacy of individuals whose data is used in AI systems. Techniques such as data anonymization, differential privacy, and encryption are employed to protect sensitive information.

Data Cleaning and Annotation

Data cleaning is the process of identifying and correcting errors in the data. This includes removing duplicates, correcting inaccuracies, and filling in missing values. Techniques such as data imputation and outlier detection are commonly used in this process.

Data annotation involves labeling data to provide context to the AI model. For instance, in image recognition, annotating images with relevant tags helps the model understand and classify objects accurately. This step is crucial for supervised learning, where the model learns from labeled examples.

Data Training

The process of training data for AI systems involves meticulous data collection, management, and quality assurance. Implementing a robust data governance framework ensures that AI systems operate ethically, transparently, and without biases.

Bias mitigation involves identifying and addressing biases in the training data and the AI model. Techniques such as bias auditing, fairness-aware machine learning, and algorithmic transparency are used to ensure that AI systems make fair and unbiased decisions.

Benchmarking

Benchmark datasets are foundational to advancing AI systems, ensuring reproducibility, fostering community collaboration, and improving both model accuracy and interoperability across platforms. The establishment and use of standardized, openly accessible datasets are critical for scientific progress in AI deployment in many fields.

Use Cases Demonstrating the Importance of Benchmark Datasets for Reproducible, Community-Oriented Flood Forecasting and AI-Driven Decision Support

Benchmark datasets are foundational to advancing flood forecasting models, ensuring reproducibility, fostering community collaboration, and improving both model accuracy and interoperability across platforms.

- **WaterBench-Iowa dataset.** Recent efforts, such as the development of the WaterBench-Iowa dataset, underscore the value of adhering to FAIR (Findable, Accessible, Interoperable, Reusable) data principles for streamflow forecasting research (Demir et al., 2022). WaterBench-Iowa brings together high-resolution data from multiple federal and state agencies, enabling robust comparison of deep learning and machine learning models, and providing a gold-standard for evaluating new methodological advances. Similarly, the IowaRain dataset supplies a comprehensive archive of rain events derived from advanced weather radar products, offering a reliable reference for both predictive and prescriptive modeling aimed at disaster monitoring and rapid response (Sit et al., 2021).
- **EarthObsNet benchmark.** Another notable contribution is the EarthObsNet benchmark, which integrates satellite imagery and hydrological variables captured during the 2019 flooding in the central United States, thus supporting fast prototyping and comparison of earth observation and flood mapping tools (Li et al., 2025). Such interoperable resources facilitate collaboration between researchers, practitioners, and policymakers, enabling transparent model evaluation and accelerating the translation of research insights into operational solutions.
- **Hydrology-specific benchmarks.** The introduction of hydrology-specific benchmarks for LLMs, such as the HydroLLM dataset, further highlights the growing importance of domain-specific AI assessment (Kizilkaya et al., 2025). By rigorously testing LLMs' ability to reason about hydrologic phenomena, the community can better integrate advanced communication, knowledge graph construction, and automated decision-support capabilities within floodplain management systems.

Sources:

Demir, I., Xiang, Z., Demiray, B., & Sit, M. (2022). Waterbench: a large-scale benchmark dataset for data-driven streamflow forecasting. *Earth System Science Data Discussions*, 2022, 1-19.

Kizilkaya, D., Sajja, R., Sermet, Y., & Demir, I. (2025). Toward HydroLLM: a benchmark dataset for hydrology-specific knowledge assessment for large language models. *Environmental Data Science*, 4, e31.

Li, Z., Sermet, Y., & Demir, I. (2025). EarthObsNet: A comprehensive Benchmark dataset for data-driven earth observation image synthesis. *Environmental Modelling & Software*, 185, 106292.

Sit, M., Seo, B. C., & Demir, I. (2021). Iowarain: A statewide rain event dataset based on weather radars and quantitative precipitation estimation. *arXiv preprint arXiv:2107.03432*.



Use of AI in Floodplain Management

Floodplain management is fundamentally dependent on the availability of reliable, defensible flood risk data, including flood elevations, floodplain boundaries, and floodways, which underpin planning, development, and regulatory decisions made by floodplain managers, engineers, planners, lenders, insurers, and homeowners. In the United States, this work is most commonly governed by standards established under the National Flood Insurance Program (NFIP), with additional requirements sometimes imposed by state or local regulations. Flood hazard data are typically produced by licensed professional engineers using hydrologic, hydraulic, and coastal models grounded in physical science and historical observations. Because these data directly influence public safety, financial risk, insurance obligations, and property rights, the models and methods used to generate them must support transparency, documentation, and repeatability, allowing affected parties to recreate, trace, and challenge results through established technical and legal processes.

Within this context, AI has significant potential to enhance floodplain management, but not all applications are equally compatible with current professional and regulatory practice. In the near term, AI uses that emphasize automation and administrative support, such as intelligent data querying, document processing, map interpretation, or automated screening of development proposals for regulatory compliance, are more naturally aligned with existing workflows. These applications augment professional judgment without replacing the underlying scientific basis of flood risk determinations. In contrast, “black box” data science approaches that generate flood hazard outputs without clear linkage to watershed and floodplain physiography, hydrologic and hydraulic processes, or coastal dynamics pose greater challenges. While

such methods may offer computational efficiency or novel insights, their opacity and limited explainability conflict with the need for defensible, reproducible analyses in a regulatory environment where decisions must withstand technical scrutiny, professional liability, and legal challenge. As a result, the most effective role for AI in floodplain management is likely to be one that strengthens, rather than obscures, the physical science foundations and procedural rigor on which the discipline is built.

The Forum explored the current applications of AI, examined concerns and challenges about the use of AI, and took a look ahead at possible future directions of AI with respect to floodplain management. These topics were discussed in breakout sessions that spanned the following five facets of floodplain management:

- **Hazard and risk identification:** AI models could be used to analyze large datasets to predict flooding events with unprecedented accuracy, though challenges in data quality and integration remain.
- **Standards, regulations, and compliance:** AI could help automate and streamline adherence to regulations but requires continuous updates to reflect evolving standards and regulations.
- **Communication:** AI can enable more personalized, timely, and data-driven interactions, though privacy issues, biases, trust, and explainability are concerns.
- **Mitigation and resilience measures:** AI-driven simulations aid in proactive planning and response strategies; however, using accurate and comprehensive datasets is important.
- **Risk transfer:** AI could support risk transfer by providing precise risk assessments for insurance purposes, though bias and transparency issues need addressing.

Hazard and Risk Identification

The following subsections outline the current state of hazard and risk identification related to AI, concerns about the use of AI specific to hazard and risk identification, and a discussion looking forward.

Current State

AI is transforming flood hazard and risk identification through various innovative applications and use cases. AI models expedite results by rapidly analyzing vast datasets to predict flooding events with unprecedented accuracy. This advancement is exemplified by the use of surrogate modeling, which simplifies complex simulations to provide quicker insights without compromising the quality of the predictions. AI is also being used for data development and verification. AI-driven data development enhances the collection and processing of large amounts of information from diverse sources, creating a more robust foundation for accurate predictions. Data verification ensures the reliability and integrity of the input data, which is crucial for making precise flood forecasts.

Floodplain managers who work on AI development have the ability to fine-tune foundation models. Fine-tuning AI models is an ongoing process that involves continuously refining algorithms to enhance their predictive capabilities further. This iterative process ensures that the AI models remain adaptive and responsive to new data and emerging patterns.

Collectively, these advancements have the potential to significantly enhance floodplain management, particularly hazard and risk identification, offering more accurate, efficient, and proactive solutions. The combination of expedited results, surrogate modeling, robust data development and verification, and continuous model fine-tuning enable AI applications in flood hazard and risk identification to potentially be reliable, effective, and aligned with current standards and regulations.



Foundation Models

Foundation models are large, general-purpose AI models trained on vast amounts of diverse data that can be adapted to perform a wide range of tasks, such as text generation, image creation, and code writing. They serve as a versatile starting point for AI developers to build specific AI applications, eliminating the need to train specialized models from scratch.

Examples of foundation models include OpenAI's GPT and DALL-E, Meta AI's Llama models, and Stability AI's Stable Diffusion model.

(Source: <https://www.ibm.com/think/topics/foundation-models>)

Local Level Implementation

Real-world examples, such as FloodMapp, showcase the local-level implementation of AI, in which real-time data integration plays a pivotal role in producing detailed and timely flood forecasts. The City of Norfolk's use of FloodMapp demonstrates how data quality, quantity, and human oversight can contribute to successful outcomes in the operational deployment of AI for managing flood risk. Outcomes included enhanced public safety, reduced damage to vehicles, and reduced insurance premiums.

NowCast in Virginia:

AI Application Helps City of Norfolk, VA Adapt to Climate Change

Flooding has been a part of most people's lives in Norfolk, Virginia, for the last century, but in more recent years, flooding has presented risks to public safety, damaged property, and caused significant disruptions to public and private transport. Although the City of Norfolk has had readily accessible flood information, including flood sensors and static flood studies, the speed and scale of unfolding flood events required timely, accurate, and targeted information to alert drivers of flood hazards in real time.

The City of Norfolk selected FloodMapp in 2020, through the RISE Resilience Innovations' Urban Mobility Resilience Challenge, to solve this challenge. The effort, which integrated FloodMapp's AI-driven flood forecasting technology with the navigation app Waze, was made possible by funding from RISE, a first-of-its-kind resilience innovation hub developed using a National Disaster Resilience Competition award from the U.S. Department of Housing and Urban Development. FloodMapp deployed NowCast Enterprise operational flood modeling service, with a "RoadSafe" impact analytics solution, to simulate pluvial, fluvial, and coastal inundation and identify impacted roadways across the City in real time. Leveraging the power of NowCast's real-time capability, FloodMapp was able to obtain the data needed to meet the required speed, accuracy, and granularity required.

The resulting solution delivers information about impacted roadways to Norfolk's existing GIS platforms, allowing users to view live road closures and road hazard segments, which update dynamically as a flood unfolds:

- NowCast was implemented to run and refresh results every 15 minutes as new tidal, riverine, and rainfall observations are ingested, producing 1-meter resolution flood inundation models that are accurate within inches.
- City road data was used in RoadSafe impact analytics, a powerful analytics service that predicts which roads will flood based on NowCast inundation data.
- Flood depth thresholds, developed in collaboration with the City emergency and resilience staff, are used to define road hazards and road closures, respectively, based on the depth of flooding over each road segment.

The resulting flood intelligence is delivered and rendered as a City-wide common operating picture and single point of truth via Esri's ArcGIS Online and ArcGIS Pro systems, providing the City of Norfolk staff and Emergency Operations Center (EOC) with hyper-local flood impact intelligence in real time.

Further, citizens can access FloodMapp NowCast flood hazard information via their Waze app, which quickly alerts them to flood hazards in real-time and enables safe route planning to navigate away from delays or danger.

Prior to approval for public launch, flood extent and depth models were calibrated and validated by qualified engineers and scientists. The road impact hazard and closure functionality in Waze was tested extensively by an independent system acceptance committee that included engineers, scientists, and certified floodplain managers to ensure that the software was functioning as intended.

Following a successful proof of concept and pilot with internal city stakeholders, the system launched to residents in October 2021. Since that date, the system has successfully helped millions of drivers navigate safety around flooded roads, keeping people and cars out of floodwaters. Waze users have confirmed more than 18,103 flooded roads accurately predicted by FloodMapp NowCast and drivers have provided over 42,683 thumbs-ups to validate these predictions (an average of 2.36 and a maximum of 72 confirmations per hazard) (data as of September 2025).

The City of Norfolk has reduced insurance premiums for its community by including FloodMapp's real-time flood intelligence in its Program for Public Information. The use of FloodMapp data has improved the City's Federal Emergency Management Agency (FEMA) Community Rating System (CRS) Class Rating from a seven to a five, which has reduced National Flood Insurance Program (NFIP) premiums by 10%, saving all policyholders \$1.9M annually (an average saving of \$273 annually per home located within the FEMA's Special Flood Hazard Areas).

(Source: <https://www.floodmapp.com/nowcast-in-va>)

Concerns

Despite the significant advancements AI brings to flood hazard and risk identification, concerns must be addressed to ensure its effective and ethical application. While applicable to other facets, the following concerns are the most commonly raised when using AI for flood hazard and risk identification.

Bias: Bias in AI models and its training data can lead to inaccuracies and unfair outcomes, undermining trust and reliability. Two types of AI bias are relevant to AI uses in flood hazard and risk identification. Temporal bias is that in which an AI model is trained and functions properly at one time but may not work as intended at a future time, requiring new training to address the evolving data. Overfitting bias is that in which an AI model learns the training data too well but does not work for new or unseen data because it is so fitted to the training data.

For some applications, it may be appropriate to build statistical bias into a model to provide safeguard measures. For example, when using machine learning for flood forecasting, an engineer may include a bias toward predicting the peak earlier (rather than too late) and over predicting flood height (rather than under predicting). This type of AI or machine learning model bias can be considered similar to a conservative parameter estimate when using a physical hydrology model (i.e., selecting a lower initial loss parameter to understand a worst-case scenario) or a factor of safety built into a spillway to convey more than the design discharge.

Transparency and explainability: The lack of transparency and explainability in AI decision-making processes complicates trust in AI systems and leads to biased and unethical outcomes, making it hard to assign accountability for AI mistakes. Stakeholders may find it challenging to understand how flood hazard and risk conclusions are reached. When an AI system hallucinates, makes a mistake, or causes harm, it is difficult to determine who is responsible without understanding how the output or decision was made.



AI Hallucination

AI hallucination is when an AI system, such as a chatbot or computer program, confidently gives an answer or information that sounds reasonable but is false, made up, or incorrect. In these cases, the AI isn't intentionally lying; instead, it mistakenly creates or guesses details that are reasonable but aren't true. This can happen when the AI system doesn't fully understand the real world and generates responses based on patterns in the data it has seen, not on facts.

AI system hallucination makes clear the importance of double-checking information provided by an AI, especially when accuracy matters.

(Source: <https://www.ibm.com/think/topics/ai-hallucinations>)

Business risk: AI technologies bring business risk to an organization that produces flood hazard and risk identification. AI can automate tasks and jobs, not just manual jobs but also processes. If there is bad quality training data or a lack of effective data labeling practices, the organization that develops and deploys the AI system may be subject to bias and discrimination challenges. Another concern is the potential infringement of intellectual property developed by practitioners for identifying hazard and risk identification; infringement related to copyright, patents, and trademarks may occur when AI scrapes information from the internet to generate output or makes a decision, claiming the output as its own.

Looking Forward

To address concerns in the development and deployment of AI systems, particularly related to flood hazard and risk identification, design and engineering professionals must pay attention to their professional standard of care when using AI. Organizations may look to govern the use of AI responsibly by applying a fit-for-purpose structure or framework and jointly developing AI and its standards with regulatory partners under the name of “Regulatory Sandbox.”

Standard of care. Like lawyers, doctors, and accountants, engineers provide professional services that are not required to be perfect. Instead, their professional services are measured against others practicing in the same profession, in the same locality, and under the same circumstances. This is called standard of care. While AI is a tool to enhance efficiency and productivity, automate routine tasks, and generate initial design ideas, AI does not follow engineering methods. Professional engineers remain ultimately responsible for the accuracy, compliance, and quality of the final work product, even when using AI. Professional engineers must perform due diligence on AI tools, verifying their reliability, limitations, and potential biases. AI outputs must be critically reviewed; AI cannot replace human judgment, ethical decision-making,

or creative originality. The standard of care is not changing to include AI as a new peer; it is still based on the prudent professional who uses AI responsibly as a tool while retaining accountability for the final deliverable. Similarly, government officials making life safety type decisions or investments should also verify that an appropriate standard of care is used in developing the information on which they are making their decisions consistent with applicable federal, state, and local requirements.

Fit-for-purpose. Fit-for-purpose is a term used informally to describe a process, configuration item, or service that is capable of meeting independently established objectives or service levels. Being fit-for-purpose requires suitable design, implementation, control, and maintenance. Being identified as fit-for-purpose implies that the item in question meets the necessary standards and requirements for its intended use. For an AI model, fit-for-purpose means the model is designed and performs its intended tasks effectively and reliably, meeting specific requirements and achieving desired outcomes. For example, a flood forecast model designed for the purpose of predicting water levels in advance (e.g., to support emergency preparedness and evacuations), would look different than a model designed for the purposes of estimating long-term future coastal flood risk due to sea level rise (e.g., to support development planning).



Applying a Fit-for-Purpose Framework to FEMA's National Flood Mapping Program

On July 8, 2025, ASFPM submitted comments to the FEMA Review Council addressing among other comments how a fit-for-purpose framework is applied to the FEMA's National Flood Mapping Program. Below are the comments that were submitted to FEMA.

Flood hazard and risk datasets should not be judged as simply “good” or “bad,” but rather evaluated based on their fit-for-purpose. A national-scale algorithmic model or an AI model may be fit for raising public awareness or informing regional or state planning, while a detailed engineering study is fit for the purpose of site-specific regulation and development decisions. The principles of transparency, reproducibility, public availability, accountability, collaboration, and due process are hallmarks of good governance.

Transparency. FEMA's NFIP mapping process actively incorporates local knowledge through its regional offices, contractor support, and Cooperating Technical Partners (CTPs), with transparent public meetings and community review of models and data. This collaborative method encourages stakeholder engagement, including participation in map determination appeals—and leads to more accurate, widely adopted flood risk products. Unlike private proprietary models, which often lack transparency and coordination with local officials, FEMA's participatory approach leverages decades of local expertise to develop comprehensive and reliable datasets.

Reproducibility. FEMA updates its publicly available flood map guidelines (Guidelines and Specifications) twice yearly to ensure reproducible and consistent data, which aids in effective flood risk management and reliable comparisons across regions and time. Regional staff use this data to answer questions about floodplain activities and assess risks to people and structures, while transparent, freely accessible information reduces costs and complications for property owners. Professionals nationwide rely on these standardized maps and data to evaluate and communicate changes efficiently.

Availability. FEMA makes all flood maps and supporting data freely available to the public, requiring participating communities to maintain public repositories. The Flood Map Service Center provides easy online access for anyone to download regulatory floodplain maps and data, supporting open innovation for academics, businesses, and governments. In contrast, proprietary models are often costly and restrict access, as companies need to recover expenses from extensive data collection. While inexpensive data may suffice in many markets, high-quality information is crucial for flood risk, especially for homeowners needing reliable science to protect their property. Public, unrestricted FEMA data

supports broad innovation, while paywalled private data can limit use and create inequities. FEMA's approach helps ensure equitable access and fosters greater risk awareness.

Accountability. The certification of flood hazard data by a Professional Engineer (PE) is the bedrock of accountability in the NFIP. When a PE affixes their seal to a study, they are attesting that a legally recognized standard of care was met using established and defensible scientific principles. An algorithm, no matter how sophisticated, cannot be held to a professional standard of care. There is no ethical board for an algorithm and no individual license to revoke if its proprietary process leads to a flawed outcome that causes harm. This professional accountability is non-negotiable in a system that directly impacts the financial and physical safety of the public. This accountability extends to the public through due process. Under 42 USC 4101b(d), the NFIP must allow individuals to challenge map errors through a transparent process, a right not provided by proprietary models like First Street Foundation's or opaque systems like FEMA's Risk Rating 2.0. The lack of due process and transparency in such “black box” systems can erode public trust and invite legal scrutiny.

Collaboration. FEMA's mapping standards are shaped by a collaborative process, formalized through the CTP program. This partnership leverages state, local, and regional expertise to align with national goals and maximize public funding. In fiscal year 2023, over 300 CTPs contributed \$5.8 million in resources and helped leverage an additional \$120 million for mapping efforts, supplementing FEMA's \$85 million investment.

Due Process. Due process requirements in flood map development are clearly defined by law, and Congress has closely monitored this to ensure transparency. Public notices, certified mail, meetings, and open houses offer property owners a scientific way to challenge map data if needed. This right is crucial because flood maps carry regulatory and financial impacts. States and communities can also add superior data that meets FEMA's standards. In contrast, proprietary models lack these due process protections, making them unsuitable for regulation.

(Source: Department of Homeland Security. (2025). “Comments of the Association of State Floodplain Managers.” Docket No. DHS-2025-0026, <https://www.regulations.gov/comment/DHS-2025-0026-0029>.)

Regulatory sandbox. Due to a lack of regulatory guidance on AI development, particularly in the United States, practitioners and policy makers are exploring a collaborative approach to jointly develop, test, and deploy innovative or new technologies such as AI, namely using a regulatory sandbox. A regulatory sandbox is a controlled environment created by a regulator in which businesses can test innovative products, services, or business models in a live setting, but with regulatory requirements relaxed or modified for a limited time. It is designed to foster innovation while still ensuring consumer protection and managing risks.

Regulatory sandboxes, such as those established under the European Union (EU) AI Act, provide controlled environments in which EU members can test and validate AI applications. These sandboxes ensure that AI systems comply with current standards, regulations, and evolving policies, thereby fostering innovation while maintaining accountability and transparency.

Another example of a regulatory sandbox is the Texas AI regulatory sandbox, established by the Texas Responsible Artificial Intelligence Governance Act in June 2025. This Act allows organizations to test innovative AI systems in a controlled environment for up to 36 months with temporary relief from certain state licensing requirements. Administered by the Texas Department of Information Resources and overseen by the Texas Artificial Intelligence Council, the sandbox program promotes AI innovation by providing a pathway to experiment without immediate enforcement penalties, though core prohibitions against manipulative, discriminatory, or unlawful AI uses still apply. Participants must submit quarterly reports on performance and risk, with the collected data informing future legislative reforms.

Summary of AI Regulatory Sandboxes under Articles 57-59 of the EU AI Act

- AI regulatory sandboxes are frameworks for testing AI systems in controlled environments that foster innovation and facilitate development, training, testing, and validation before market entry.
- Sandboxes aim to improve legal certainty, support sharing of best practices, foster innovation, contribute to evidence-based regulatory learning, and facilitate market access, particularly for subject matter experts (SMEs) and startups. Providers may use documentation from participating in a sandbox to demonstrate their compliance with the EU AI Act.
- Each Member State must establish at least one AI regulatory sandbox by 2 August 2026. The national sandbox may also be done jointly with other Member States.
- National competent authorities provide guidance, supervision, and support to identify risks and ensure compliance with the AI Act and other relevant legislation.
- Providers participating in sandboxes remain liable under applicable liability laws but are protected from administrative fines if they follow sandbox guidelines in good faith.
- Providers may process personal data in sandboxes for projects serving the public interest if the data is necessary, kept secure, not shared externally, and deleted after use. They must manage risks, document activities, and publish a summary unless sensitive law enforcement data is involved.
- National competent authorities must coordinate their activities through the AI Board and submit annual reports on sandbox implementation.
- SMEs and startups can access AI sandboxes free of charge, though national authorities may recover fair and proportionate exceptional costs.

(Source: <https://artificialintelligenceact.eu/ai-regulatory-sandbox-approaches-eu-member-state-overview/>)

Standards, Regulations, and Compliance

The following outlines the current state of standards, regulations, and compliance related to AI, concerns about the use of AI specific to standards, regulations, and compliance, and a discussion looking forward.

Current State

Although AI applications for floodplain standards, regulations, and compliance are not widely used today, there is significant interest and experimentation with using AI to improve compliance and permitting. Within the public sector, the adoption of AI in general remains limited, with some government entities even prohibiting the use of such technologies within the agency or by contractors and vendors. The application of AI for implementing standards, regulations, and compliance in floodplain management by the private sector is particularly underdeveloped. Nonetheless, there are promising opportunities for AI to enhance compliance processes and facilitate the collection of data to support standard setting and regulatory activities. It is imperative for practitioners to continuously monitor and track relevant laws, regulations, and standards as they evolve to inform decision-making.

As related to hazard and risk identification (Facet 1), the current NFIP regulations governing the use of computer models for determining flood elevations were developed in the 1980s, at a time when deterministic, rule-based hydrologic and hydraulic software was the industry standard. These regulations emphasize characteristics such as explicit documentation, accessible source code, and the ability for agencies and stakeholders to review and reproduce model results, which don't align with many modern AI and machine learning approaches. As a result, while AI offers powerful new capabilities for analyzing large and complex datasets, existing NFIP regulatory frameworks are not well suited to accommodate learning-based or probabilistic models and would require thoughtful modernization to enable their use while preserving transparency, repeatability, and due process.

Non-governmental organization use. AI is increasingly being leveraged to support regulatory compliance by interpreting local floodplain maps and ordinances, streamlining compliance paths, and enhancing training through analysis of best practices. By applying Big Data and machine learning techniques, AI can standardize complex input data and provide insights even in areas lacking traditional flood risk assessments. Automated tools can draft and summarize damage reports, while also clarifying regulatory terminology for community members. AI serves as both an informational resource and an efficiency driver, enabling communities to better understand flood risks and adhere to evolving standards and regulations.

Many organizations create AI governance frameworks and tools to build trust in AI, close knowledge gaps, and build awareness particularly in the public sector. AI technologies are also used for regulatory compliance by the private sector. The IBM governance platform is an example of how AI could be used for regulatory compliance, in this case with an AI risk management framework.



IBM Governance Compliance Platform

IBM's watsonx.governance is an example of a governance framework designed to help an organization manage, monitor, and ensure the responsible use of AI and machine learning models. It supports both traditional machine learning and generative AI systems.

Its core capabilities include:

1. **Model Lifecycle Tracking:** Tracks AI models and prompt templates from development to deployment.
2. **Compliance and Risk Management:** Ensures models meet regulatory and ethical standards, including fairness, transparency, and explainability.
3. **Monitoring and Retraining:** Automates the monitoring of deployed models for performance, bias, and drift, and supports retraining workflows.
4. **AI Factsheets:** Provides detailed documentation for each AI asset, including evaluation metrics, fairness indicators, and lifecycle status.

Key Use Cases

- **Governance and Compliance:** Track and document the full history of AI models and ensure transparency and accountability for regulatory audits.
- **Responsible AI:** Monitor deployed models for fairness, accuracy, and explainability, and detect and mitigate bias or model drift.
- **Model Lifecycle Management:** Automate the building, testing, deployment, and monitoring of AI models, and simplify retraining processes based on production feedback.
- **Enterprise Integration:** Integrate with tools such as Watson Studio, Watson Machine Learning, Watson OpenScale, and IBM OpenPages for a unified AI governance ecosystem.

(Sources: <https://www.ibm.com/products/watsonx-governance>; <https://www.ibm.com/docs/en/watsonx/saas?topic=cases-watsonxgovernance-use-case>)

Concerns

Although not specifically related to floodplain regulations, concerns arose in the general Forum discussion that have relevance to floodplain regulations as AI is increasingly applied across floodplain management. Consideration of these concerns is critical when applying the use of AI in developing floodplain regulations, setting standards, and ensuring compliance. The key takeaway is that AI should serve as a tool to support—not replace—human decision-making.

Knowledge gap. One major issue is the knowledge gap: if policymakers lack a clear understanding of AI processes, they may not fully comprehend implemented changes, emphasizing the need for thorough explanation and education.

Regulatory authority. State and local governments face unique challenges, particularly relative to state rights and authority, when integrating AI technologies into public services. Moreover, the rapid pace of AI development far outstrips the slower evolution of policy and regulatory frameworks, leaving gaps in oversight and governance.

Appropriateness and bias. Appropriateness is another concern, particularly regarding the ethical implications of AI and machine learning source data. Utilizing inappropriate or unrepresentative data can result in biased outcomes. Financial motivations, such as prioritizing profit over scientific integrity, may further complicate decision-making. Issues of accessibility, usability, and equity often depend on the availability of resources and existing constraints.

Organization harms. Other laws and regulations, such as privacy and competition or antitrust laws, may apply to AI although there is currently no comprehensive AI law in the United States. Breach of legal and regulatory requirements can lead to sanctions, fines, and an order to stop processing. Given the nature of AI's continued evolution, it can be difficult to anticipate what new risks may occur. Consequentially, if something goes wrong with AI, there will be costs of internal resources and remediation and litigation costs, in addition to the organization's reputation.

Human-AI Teaming: State-of-the-Art and Research Needs (2022)

Human-AI teaming underscores the critical need for human supervision to ensure the effective and ethical use of AI tools. Without human oversight, AI systems risk perpetuating biases, making erroneous decisions, and lacking transparency.

- For instance, in sectors such as healthcare, AI can assist in diagnosing diseases by analyzing vast datasets, but the final conclusion should always involve a human clinician to consider nuanced patient factors.
- In the realm of public participation, AI-driven tools can efficiently gather and analyze public opinions, but the interpretation and action upon these insights should be guided by human judgment to avoid misrepresentations.
- In floodplain management, AI tools can streamline workflows in flood modeling, automating and accelerating tasks traditionally done manually in HEC-RAS and other floodplain management software. Despite AI capabilities, licensed professionals remain responsible for verifying data and exercising direct control over engineering decisions and solutions.

This synergy between human expertise and AI capabilities not only enhances decision-making processes but also ensures that the implementation of AI remains grounded in human values and ethics.

(Source: National Academies of Sciences, Engineering, and Medicine. (2022). Human-AI Teaming: State-of-the-Art and Research Needs. Washington, DC: The National Academies Press. <https://doi.org/10.17226/26355>.)

Looking Forward

As AI continues to develop within a free market environment, it frequently tests the limits of what is permissible. Legal actions, particularly those addressing copyright infringement, will likely initiate the process of defining regulatory boundaries; however, the outcomes will ultimately hinge upon political resolve and judicial interpretation. Notably, the European Union is progressing further along the governance pathway. Engagement and collaboration with EU agency representatives is recommended and reviewing the upcoming EU AI Code of Practice and Trust Framework, scheduled for release in April 2025, should be prioritized.

Human oversight. Human oversight of AI development and deployment is a best practice, and sometimes a legal requirement. How much oversight is needed may be determined by data type and sensitivity, applications, and the jurisdiction governing the AI systems; such oversight is needed to minimize human biases being introduced in the process. Human oversight in AI refers to the important practice of involving human judgment and intervention in AI systems, ensuring they operate ethically, responsibly, and effectively. This oversight is essential to mitigate risks associated with bias, errors, and unintended consequences, particularly in high-risk applications.

Human-AI teaming. The human-AI teaming concept centers on the harmonious collaboration between human expertise and AI, where each complements the other's strengths and compensates for respective limitations. Rather than framing AI as a replacement for human judgment, this approach leverages technology to augment decision-making, improve efficiency, and support more nuanced outcomes. In this dynamic partnership, humans provide ethical reasoning, contextual awareness, and interpretative insight, while AI contributes analytical power, speed, and the capacity to process vast and varied datasets. Together, they can achieve results unattainable by either working alone, helping to foster resilient systems that are adaptable to complex and evolving challenges— such as those encountered in flood risk management— where both technological innovation and human stewardship are vital. The key takeaway is that AI should serve as a tool to support—not replace—human decision-making.

The following outlines the current state of floodplain communication relative to AI, concerns about the use of AI-specific to communication, and a discussion looking forward.

Current State

AI is revolutionizing communications and stakeholder engagement in flood risk management by enabling more personalized, timely, and data-driven interactions, such as drafting articles and generating podcasts. Advanced AI tools that use LLMs assist agencies and organizations in crafting clear, accessible messages about flood risks, while visualization platforms help translate complex data into easily understood graphics and materials. Innovative systems use natural language processing and disaster ontologies to deliver real-time information via various digital channels. In related sectors, AI is also being applied to enhance environmental risk awareness and communication. These advancements not only improve public understanding but also empower stakeholders to make well-informed decisions in the face of escalating climate challenges.

AI applications in communications are robust because of the groundbreaking LLMs. Using AI in flood risk communications and stakeholder engagement offers several key benefits:

- **Personalization and accessibility:** AI tools such as ChatGPT and Microsoft Copilot tailor messages to different audiences—residents, policymakers, or developers—providing that complex flood risk data is communicated in clear, relatable terms.
- **Real-time information delivery:** AI systems process and disseminate real-time flood alerts and updates through chatbots, voice assistants, or automated emails, helping communities respond quickly to emergencies.
- **Data integration and visualization:** Platforms such as Canva and Google’s AI tools turn raw flood data into compelling visuals, maps, and infographics, making it easier for stakeholders to understand risk levels and mitigation strategies.
- **Enhanced decision-making:** AI systems analyze large datasets to identify flood-prone areas, predict future risks, and support planning decisions. For example, Realtor.com and Zillow use AI to integrate flood risk scores into property listings, helping buyers make informed choices.
- **Scalability and efficiency:** AI automates repetitive tasks such as generating reports, answering frequently asked questions (FAQs), or summarizing risk assessments, freeing up human experts to focus on strategic engagement and planning.
- **Stakeholder engagement at scale:** Sentiment analysis tools use AI and natural language processing to automatically determine the emotional tone or sentiment expressed in the text. These tools are used to analyze customer feedback, social media posts, reviews, and more to understand how people feel about a brand, product, or topic.

Concerns

Although not specific to communication about floodplain risk and management issues, concerns arose in the general Forum discussion that are relevant when using AI in communicating floodplain issues or when discussing AI and its outcomes in public-facing communication products. While AI has the potential to be transformative in flood risk communications, significant concerns and challenges persist.

Data validation. A key question centers on the validation of data. Stakeholders often ask who has vetted the information that AI systems process and disseminate, raising issues about credibility and trustworthiness. Concerns over data credibility persist, emphasizing the need for robust data sourcing and verification.

Transparency and explainability. Articulating the role of AI and machine learning in decision-making processes presents a significant challenge, as transparency is essential for fostering public trust and comprehension. Without adequate transparency and disclosure regarding the development and deployment of AI systems, users cannot fully understand when they are interacting with AI or effectively contest outcomes resulting from such interactions. Any use of AI-generated information, content, data, or conclusions should be clearly disclosed.

Accountability. Accountability represents a critical concern in the use of AI-powered tools for flood risk communication, especially when incorporating sentiment analysis systems. As these tools increasingly shape how authorities interpret public opinion and prioritize engagement strategies, questions arise about who is ultimately responsible for the outcomes generated by automated sentiment assessments. The opaque nature of many machine learning models can make it difficult for communities to challenge or understand decisions that affect them, particularly if misclassifications or biases in sentiment analysis lead to misguided resource allocation or overlooked needs. Ensuring there are clear channels for recourse, oversight, and explanation is essential so that stakeholders can trust not only the results but also the processes behind them. Without robust accountability mechanisms, the deployment of sentiment analysis tools risks deepening mistrust and eroding the legitimacy of flood risk communication initiatives.



What is AI Governance?

AI governance is an organization's approach to using laws, policies, frameworks, practices, and processes at international, national, and organizational levels. It is also intended to help stakeholders in implementing, managing, overseeing, and regulating the use of AI technology.

AI governance is used to manage associated risks to ensure AI aligns with stakeholders' objectives, is developed and used responsibly and ethically, and complies with applicable requirements.

Using the guardrails that AI governance provides can help to address potential issues such as bias, privacy impacts, and misuse, while also helping to increase innovation and trust.

(Source: <https://iapp.org/>)



Looking Forward

As the integration of AI into flood risk communications accelerates, it is essential to adopt a measured and strategic approach to ensure these technologies achieve their intended benefits while addressing critical challenges. Establishing robust AI governance within organizations and pursuing credible education and training in AI are fundamental steps toward building reliable, effective, and purpose-driven AI systems that genuinely meet the needs of diverse communities.

While effective AI solutions offer considerable potential for improving communication, ongoing vigilance is necessary to prevent misuse by malicious actors. Maintaining credibility must remain a core principle in all related initiatives.

AI governance. Robust governance structures are crucial, with an emphasis on transparency and accountability in alignment with the EU AI Act. Each AI development and use project should have a clearly articulated purpose, ensuring that all efforts are directed toward defined objectives and remain fit-for-purpose. Active participation by ASFPM in national and state and local government AI policy development is necessary. Policies must foster innovation while simultaneously safeguarding the public interest.

AI certification. The development of advanced visualization tools can assist homeowners in evaluating mitigation strategies. It is essential that those providing these tools are credible and possess substantial expertise.

IAPP AIGP Certification

The IAPP Artificial Intelligence Governance Professional (AIGP) certification is a vital credential for AI developers and deployers seeking to ensure responsible and ethical AI practices. As AI technologies become increasingly integrated into critical systems, the AIGP certification equips professionals with the knowledge to navigate complex legal, ethical, and operational challenges. It validates expertise in AI governance foundations, applicable laws and standards, and best practices for managing AI throughout its lifecycle—from design and development to deployment and ongoing monitoring. By earning the AIGP, professionals demonstrate their commitment to building trustworthy AI systems that align with organizational values and regulatory expectations, making them valuable assets in any AI-driven enterprise.

(Source: <https://iapp.org/certify/aigp/>)



4

Mitigation and Resilience Measures

The following outlines the current state of mitigation and resilience measures relative to AI, concerns about the use of AI specific to mitigation and resilience measures, and a discussion looking forward.

Current State

The current state of using AI in flood mitigation and resilience planning and implementation is marked by innovative collaborations and the adoption of advanced technologies, yet it remains in a formative stage:

- Federal agencies such as the National Oceanic and Atmospheric Administration (NOAA) are exploring AI-driven modeling to anticipate future climate and flood conditions, which is pivotal for identifying critical data gaps—as demonstrated by recent initiatives in California.
- AI is increasingly leveraged to personalize flood risk communication, for example by integrating data from platforms such as Google Maps, to provide individuals with tailored visualizations of their own risk profiles and actionable mitigation options, sometimes showcased interactively at community open houses.
- Three-dimensional renderings and simulation tools, already available, further enhance public understanding by making complex scenarios tangible; however, visual storytelling is most effective when grounded in reliable, evidence-backed imagery.
- Rather than focusing solely on traditional infrastructure projects, efforts now emphasize AI's role in informing policy guidance, updating planning codes, and communicating risk to diverse stakeholders.
- Importantly, AI serves as a valuable starting point for devising solutions, offering a foundational baseline to guide strategic interventions and foster more informed, adaptive decision-making in the face of evolving flood hazards.

Monmouth County, New Jersey, offers an example of the use of AI in mitigation planning. Monmouth County took a proactive approach to flood mitigation by participating in a pilot project that integrates AI into hazard mitigation planning. Through FEMA's Planning Assistant for Resilient Communities (PARC) program, the county's Planning Division staff tested generative AI tools designed to enhance the effectiveness of disaster preparedness and streamline recovery efforts. The pilot was conducted using three targeted sessions and concluded that while AI has strong potential for use as a planning assistant, the tools are not yet reliable as autonomous decision-makers.

FEMA Program: Planning Assistant for Resilient Communities

FEMA's Planning Assistant for Resilient Communities (PARC) program is a generative AI pilot program developed to support local governments in enhancing hazard mitigation planning efforts. The program is designed to streamline and improve planning process efficiency by leveraging AI to assist with data analysis, plan development, and compliance with federal guidelines. The program—while currently not active—helps communities better understand their risks and develop more effective strategies for disaster resilience by automating complex tasks and providing tailored insights.

(Source: <https://www.dhs.gov/ai/use-case-inventory/fema>)

AI Pilot Project – Monmouth County, NJ

Monmouth County, NJ, was selected to participate in FEMA Region 2's PARC Pilot Project, a national effort to assess how generative AI could support the development of local Hazard Mitigation Plans (HMPs). Monmouth was chosen based on its active CRS program, proven planning expertise, openness to innovation, and willingness to participate on previous FEMA initiatives. This initiative complemented the county's broader flood resilience strategy, which includes a \$300,000 FEMA Flood Mitigation Assistance grant and partnerships with 16 municipalities using Forerunner, a floodplain management software platform.

The pilot was structured as a series of three targeted sessions, each designed to test distinct applications of AI in hazard mitigation planning:

- **Session 1 – FEMA's Generative AI Tool: Use Case Testing**

Participants used FEMA's AI prototype—preloaded with FEMA mitigation documents and sandbox data—to evaluate how well the tool could respond to planning prompts. Monmouth County posed real-world questions related to climate change, flooding vulnerability, and community exposure. While the AI could generate responses, they were often too generic or missed obvious local vulnerabilities (e.g., omitting known flood-prone towns). The session revealed that refined prompts were essential to get specific, actionable results, and that AI performance varied depending on how questions were framed.

- **Session 2 – Document Integration via ChatGPT**

The County uploaded over 30 local and regional planning documents into a controlled AI environment to explore how hazard mitigation could be more explicitly integrated into existing plans. ChatGPT was prompted to identify integration points, suggest language improvements, and prioritize mitigation activities under budget constraints. The AI returned structured ideas and cost breakdowns, but again, only when the prompts were specific and layered. This session demonstrated that AI can accelerate crosswalk analysis and support resource allocation conversations—but only with expert oversight and clear guidance.

- **Session 3 – User Experience and Interface Testing**

In one-on-one sessions with FEMA's Digital Customer Experience team, participants explored how future planners might interact with AI platforms. This test focused on end-user interface expectations, response clarity, and the system's ability to deliver trusted, verifiable outputs. It highlighted the importance of source transparency, limitations around AI-generated assumptions ("hallucinations"), and the continued need for human validation and professional judgment.

Across all three sessions, the pilot affirmed that AI has strong potential as a planning assistant—able to help draft content, surface connections between plans, and improve community outreach. However, the tools are not yet reliable as autonomous decision-makers and must be carefully guided and reviewed by content experts. Prompt structure, data context, and professional judgment were repeatedly shown to be critical to producing useful outputs.

As floodplain management evolves, AI will likely play a growing role in supporting planning functions—but it must be integrated thoughtfully, with an emphasis on accountability, transparency, and local knowledge.

(Source: Monmouth County Division of Planning (2024). 204 Year-in-Review Highlights. https://www.co.monmouth.nj.us/documents/24/Planning_2024_YIR_Presentation.pdf)

Concerns

Despite the promise AI holds for advancing flood mitigation and resilience measures, several significant concerns and challenges remain. While these concerns and challenges are not specific to mitigation and resilience measures, these concerns arose in the general Forum discussion as being particularly pertinent to this topic area.

Lack of precedent. Notably, there has yet to be a truly successful example demonstrating the effectiveness of AI in this domain, which fuels skepticism about its practical utility. This lack of established precedent presents several challenges for practitioners, policymakers, and the communities they serve. Without concrete, well-documented use cases, there is uncertainty about which AI approaches will yield meaningful results, and stakeholders may be hesitant to invest in or adopt these emerging tools. The absence of proven models also complicates efforts to benchmark success or learn from past missteps, increasing the risk of inefficiencies or unforeseen outcomes in project delivery. Furthermore, communities may face difficulties in securing funding or regulatory approvals for AI-driven initiatives if they cannot point to successful analogs elsewhere.

Data quality. Data quality represents a concern when deploying AI in flood mitigation and resilience planning. The reliability of AI models is fundamentally dependent on the currency, completeness, and granularity of the data they process. Outdated or incomplete information can lead to inaccurate risk assessments and misguided recommendations, while a lack of detail—such as not having street-level specificity—may render AI-generated insights less actionable or even misleading for local stakeholders. Inconsistent data sources, errors in collection, and insufficient validation further undermine the credibility of AI outputs. AI analysis of data appears to be prone to producing results as valid without proper statistical bounds and domain expertise. Whereas a human statistician might group the same results as correlation without causality understanding that the patterns suggested by the data do not necessarily reflect reality. Without rigorous standards to ensure data integrity, the promise of AI to enhance resilience planning is significantly diminished, potentially exacerbating vulnerabilities rather than reducing them.

Organization harm. The integration of AI into flood mitigation and resilience planning carries the risk of substantial harm to organizations if not carefully managed. One critical concern is the potential for non-compliance with established regulations, federal guidelines, and industry standards. When AI tools are deployed without oversight, they may inadvertently produce recommendations or automate decisions that conflict with statutory requirements or local ordinances, exposing agencies and project implementers to legal liabilities and reputational damage. This is especially significant when projects are funded by federal or state grants, as non-compliance can jeopardize current and future funding, result in costly audits, or even force the repayment of grant awards. Furthermore, organizations may face difficulties in demonstrating adherence to grant compliance and reporting obligations, particularly if the AI system's operations lack transparency or fail to document decision-making processes effectively.

Looking Forward

As the integration of AI into flood mitigation and resilience planning and project implementation continues to evolve, several forward-looking guardrails are emerging. By harnessing the analytical power of AI, agencies and organizations are beginning to envision systems that can centralize data, track real-world impacts, and provide tailored guidance for AI risk mitigation. The following points highlight some of the innovative directions and practical uses being considered to further enhance the effectiveness and reach of AI in this critical field.

Professional responsibility. AI can enhance efficiency and innovation, but it is a tool, not a substitute for professional judgment. AI cannot be held accountable and lacks the training, experience, and ethical responsibility of a licensed professional. While AI has already contributed significantly to floodplain management, the pace of AI development is outstripping current laws and regulations. Governments and industries are working to understand and regulate AI applications. The primary focus must remain on public health, safety, and welfare, under the supervision of licensed professionals.

Professional code of ethics. As AI becomes increasingly integrated into professional workflows, it is essential for practitioners to align its use with established codes of ethics. AI tools offer powerful capabilities that can enhance decision-making, streamline operations, and generate insights—but they also introduce risks related to bias, transparency, and accountability. Professionals must ensure that AI applications uphold the core values of their discipline, including integrity, public trust, and responsibility. By grounding AI use in ethical standards, individuals can harness its benefits while safeguarding the interests of clients, communities, and society at large.

An example of a formal alignment of code of ethics principles is illustrated by the American Planning Association (APA), which translated principles of the American Institute of Certified Planners (AICP) Code of Ethics into practical guidance for the use of generative AI in planning.

American Society of Civil Engineers Policy Statement 573 Artificial Intelligence and Engineering Responsibility

The American Society of Civil Engineers (ASCE) adopted Policy Statement 573 on July 18, 2024, acknowledging the increasing role of AI in civil engineering. Despite AI's potential, licensed Professional Engineers must retain full responsibility for all aspects of civil engineering projects, including planning, design, construction, operations, maintenance, and protection of public health, safety, and welfare.

(Source: <https://www.asce.org/advocacy/policy-statements/ps573---artificial-intelligence-and-engineering-responsibility>)

AICP Code of Ethics and Generative AI: Practical Guidance for Planners Navigating Its Use Responsibly

Key Ethical Guidelines for Using AI in Planning

- Recognize Bias and Limitations
 - AI models can perpetuate societal biases.
 - Planners must critically analyze AI outputs and avoid delegating decision-making to AI.
- Verify Outputs and Disclose Use
 - AI tools are prone to errors and lack proper attribution.
 - Planners must validate outputs and disclose AI use to stakeholders.
- Educate Yourself and Others
 - Ongoing education in AI is essential for ethical practice.
 - Use frameworks like the National Institute of Standards and Technology (NIST) AI Risk Management Framework (RMF) and CLeAR (Comparable, Legible, Actionable, and Robust) documentation to guide responsible use.
- Protect Sensitive Information
 - Avoid sharing confidential data through unauthorized AI platforms.
 - Follow organizational policies and legal requirements.

(Source: <https://www.planning.org/blog/9295637/planning-ethics-and-generative-ai/>)

The following outlines the current state of risk transfer relative to AI, concerns about the use of AI specific to risk transfer, and a discussion looking forward.

Current State

The current state of AI use by insurers, particularly within the flood insurance sector, is best described as innovative yet formative, with significant potential to transform how risk is communicated and understood. Insurers and programs such as the NFIP recognize that motivating individuals to purchase insurance hinges on their awareness of risk—a goal that AI is positioned to advance by putting actionable knowledge directly into consumers' hands. Tools powered by AI can help homebuyers and property owners not only understand the true, long-term costs associated with purchasing a home in flood-prone areas but also make more informed decisions about mitigation and protection options.

Early initiatives, such as Flood Factor led by the First Street Foundation, represent promising starts by leveraging AI for risk mapping and communication, though these efforts have thus far lacked the granularity needed to fully capture nuanced, property-specific risks. While AI-driven solutions show clear promise in supporting personalized risk profiles and increasing transparency, a truly comprehensive and detailed application remains a work in progress, with the industry still seeking more precise and up-to-date data to unlock AI's full potential for both insurers and their customers.

AI Application after Hurricane Harvey: An Insurtech* Case Study

Hurricane Harvey made landfall near Rockport, Texas, on August 25, 2017, as a Category 4 hurricane, caused catastrophic flooding with over 50 inches of rain in some areas, and displaced 30,000 people. These residents were left vulnerable and in need of quick resolutions by their insurers. Speedy claims resolution is vital after natural disasters to support affected individuals and reduce insurer costs. Claims management is often overlooked in Insurtech innovation, despite being a critical part of the insurance experience.

One company addressing this challenge for insurers is Geospatial Insight. Geospatial Insight supported insurers after Hurricane Harvey by applying machine learning, drones, satellite imagery, and social media analysis to assess flood damage. Using these various data sources, the company produced detailed flood maps and identified affected properties with advanced imaging, allowing insurers to process claims expeditiously.

Key challenges addressed included estimating claim sizes, mapping damage to prevent fraud, and verifying disaster-caused damages. Flooding was exacerbated by reservoir overflows and emergency water releases in Houston, impacting uninsured residents the most. For those insured, rapid claims handling proved vital, showing how technology can deliver timely, actionable insights for the industry.

** Insurtech (a blend of "insurance" and "technology") refers to the innovative use of technology to disrupt and improve the insurance industry. It aims to make insurance more efficient, customer-friendly, and data-driven.*

(Sources: <https://www.insurancethoughtleadership.com/resilience-sustainability/hurricane-harvey-insurtech-case-study/>; <https://geospatial-insight.com/>)

Concerns

Forum discussions identified significant bias and privacy risks in applying AI to insurance and other forms of risk transfer. While AI has the potential to be transformative in supporting risk transfer, these concerns present challenges.

Accountability. There is broad recognition that AI is not a universal solution; it cannot address every nuance inherent to insurance and risk assessment. Additionally, the deployment of AI demands clear lines of accountability to ensure transparency in decision-making, data sources, and oversight.

Bias. Bias in AI systems can harm a person's civil liberties, rights, safety, and economic opportunity. Two types of bias are relevant to insurance applications. Implicit bias is discrimination or prejudice toward a particular group or individual. For example, implicit bias can manifest if an AI model trained to assess flood insurance risk inadvertently assigns higher premiums to neighborhoods with predominantly minority populations, not because of actual risk differences, but due to historical housing and lending practices reflected in the data. Sampling bias occurs when data gets skewed toward a subset of a group and therefore may favor that subset of a larger group. Sampling bias might occur if an insurance company's AI uses data primarily from urban areas, resulting in risk assessments that do not accurately reflect the unique flood risks faced by rural communities, thereby disadvantaging those policyholders. Of note, individuals developing the systems may also have bias, which should be addressed during the AI system development.

Privacy risks. Risks that endanger an individual's privacy are another concern. Several kinds of privacy risks can arise in relation to data handling:

- Data persistence refers to data that exists longer than the human subjects who created it, which should not happen. Data persistence may happen if an organization keeps the data beyond the lifespan of the data subject.
- Data spillover is a term for data that is collected on people who are not the target of the data collection (e.g., from surveillance).
- Data repurposing, similar to data spillover, refers to data being used beyond its originally specified purpose.

Looking Forward

There is the transformative potential for AI in the insurance sector, particularly in how risk is evaluated, communicated, and ultimately transferred. As AI technologies continue to evolve, their applications in insurance—from precise risk mapping to dynamic pricing—offer opportunities to enhance transparency and empower both insurers and consumers. However, these advancements also raise significant concerns about transparency, fairness, accountability, and bias within AI-driven decision-making processes. To address these challenges, the National Association of Insurance Commissioners (NAIC) has developed a Model Bulletin to guide the ethical and responsible use of AI by insurers. Since the adoption of the NAIC Model Bulletin, 24 states have adopted it, and other states have enacted regulations or promulgated other guidance addressing similar topics. Wider adoption of this Model Bulletin across more states is essential to promote consistent standards and safeguard consumer interests. It is imperative that insurance professionals not only stay informed about these evolving guidelines, but also rigorously adhere to the principles outlined in the Model Bulletin to ensure that AI is leveraged in a manner that upholds trust, equity, and integrity within the industry as we look to the future.

National Association of Insurance Commissioners Model Bulletin for AI Uses by Insurers

On December 4, 2023, the National Association of Insurance Commissioners (NAIC) adopted a model bulletin that sets forth regulatory expectations for insurers using AI. The bulletin requires insurers to adopt an AI governance and risk management framework and encourages them to test for unfair discrimination. It aims to mitigate AI-related risks such as discrimination, data vulnerability, and lack of transparency.

Key Elements of the Bulletin

- **Scope:** Applies to all insurers licensed to operate in a given jurisdiction.
- **AI Systems Definition:** Includes advanced analytical and computational technologies used in insurance processes.
- **Compliance Requirements:** Insurers must ensure AI-driven decisions comply with laws on unfair trade practices and discrimination.
- **AIS Program:** Insurers are required to implement a documented Artificial Intelligence System (AIS) Program that includes:
 - Governance frameworks
 - Risk management and internal controls
 - Auditing and oversight mechanisms
 - Vendor management protocols
- **Transparency and Fairness:** Emphasizes ethical AI use, accountability, and transparency.
- **Regulatory Oversight:** Insurers should expect inquiries into their AI governance and be prepared to provide documentation.

(Source: NAIC. (2023). "The Use of Artificial Intelligence Systems by Insurers." NAIC Model Bulletin. <https://content.naic.org/sites/default/files/cmtc-h-big-data-artificial-intelligence-wg-ai-model-bulletin.pdf>.)

Organisation for Economic Co-operation and Development (OECD) AI Principles. As foundational guidance for the responsible development and use of AI worldwide, the OECD AI Principles serve as an international benchmark for promoting trustworthy AI. Adopted by over 40 countries, these principles emphasize values such as transparency, accountability, robustness, security, and the protection of human rights. In practical terms, they guide governments and organizations in designing AI systems that respect ethical standards, foster innovation, and mitigate potential risks. Their widespread adoption reflects a shared global commitment to integrating ethical considerations into AI policy and practice, supporting both public- and private-sector efforts to develop AI technologies that benefit society as a whole.

OECD AI Principles

Adopted in May 2019, the OECD AI Principles are the first intergovernmental standard on AI. They aim to promote innovative and trustworthy AI that respects human rights and democratic values.

The OECD's five key principles for responsible AI are:

- **Inclusive Growth, Sustainable Development, and Well-being:** AI should benefit people and the planet by driving inclusive economic growth and sustainable development.
- **Human-Centered Values and Fairness:** AI systems must respect human rights, fairness, and democratic values, including privacy and non-discrimination.
- **Transparency and Explainability:** AI systems should be transparent and explainable to ensure accountability and trust.
- **Robustness, Security, and Safety:** AI should function reliably and securely throughout its lifecycle, minimizing risks and unintended consequences.
- **Accountability:** Organizations and individuals developing or deploying AI should be accountable for its proper functioning and outcomes.

(Source: <https://www.oecd.org/en/topics/sub-issues/ai-principles.html>)





Review of Current AI Policy and Governance Landscape

AI is revolutionizing various public industries across the globe, and its governance has become a pivotal concern for policymakers. In the United States, Europe, and many other areas around the world, both governments and the private sector are actively developing and implementing frameworks to ensure the ethical use of AI. While the AI policy and governance environment is rapidly changing at both government and private-sector levels, the following snapshot of different AI policies and governance structures in these regions and AI governance being implemented by private-sector entities provides an understanding of how the world is addressing the challenges and opportunities presented by AI technologies.

By examining these policy frameworks, we can appreciate the global efforts to create a safe, transparent, and ethical AI landscape. As floodplain managers, we are committed to leveraging the benefits of these emerging technologies, with the goal of ensuring the safety, transparency, and explainability of AI systems to effectively manage flood risks in the 21st century.

United States

In the United States, AI policy is shaped by both federal and state initiatives. At the federal level, significant changes have been introduced with Executive Order 14179, Removing Barriers to American Leadership in Artificial Intelligence (January 23, 2025), which emphasizes support for innovation while deemphasizing strict regulations. Despite the revocation of the Biden-Harris Administration's Executive Order 14110, Safe, Secure, and Trustworthy Artificial Intelligence (October 30, 2023), the focus remains on adopting AI solutions that are trustable, reliable, and explainable.

While there is no current comprehensive and specific AI legal framework outlined by the U.S. government, other entities within the United States are developing a variety of guidelines, frameworks, and policies, including the National Institute of Standards and Technology (NIST), the State of Colorado, and the State of Texas.

NIST AI Risk Management Framework

NIST—an agency of the U.S. Department of Commerce—developed the AI Risk Management Framework (AI RMF) in 2024 to help organizations manage risks associated with AI. The framework is structured around four core functions: Govern, Map, Measure, and Manage. These functions guide organizations in establishing governance structures, understanding AI systems and their contexts, assessing risks, and implementing risk management strategies.

The NIST AI RMF emphasizes trustworthiness, including aspects such as validity, reliability, safety, security, accountability, transparency, explainability, privacy, and fairness. Congress and various organizations are planning to use the AI RMF to enhance AI governance by integrating it into broader enterprise risk management strategies. This integration aims to address AI risks alongside other critical risks such as cybersecurity and privacy, promoting a more cohesive and efficient approach to risk management.

State AI Policies

State-level AI policies continue to evolve, with states such as Colorado and Texas taking notable steps toward robust AI governance.

Colorado. The Colorado Artificial Intelligence Act (CAIA), enacted on May 17, 2024, is the first comprehensive AI regulation in the United States. It focuses on high-risk AI systems that make consequential decisions affecting areas such as education, employment, financial services, housing, healthcare, and legal services. The CAIA focuses on ethical AI deployment, ensuring transparency and accountability in AI systems. The state's approach includes bias auditing and fairness-aware machine learning to mitigate discriminatory outcomes in AI applications. The CAIA mandates that developers and deployers of these systems implement risk management programs, conduct impact assessments, and ensure transparency and accountability to prevent algorithmic discrimination.

NIST AI Risk Management Framework Applications

Diverse organizations—from local governments to tech companies and academic institutions—are leveraging NIST's AI RMF to ensure responsible and trustworthy AI practices:

- **City of San Jose, CA:** The city has developed a playbook to guide the responsible use of AI in municipal services, ensuring that AI systems are trustworthy and beneficial to the community.
- **PEAT (Partnership on Employment & Accessible Technology):** Funded by the U.S. Department of Labor, PEAT uses the AI RMF to create frameworks for AI hiring practices that are inclusive and accessible.
- **Workday:** This company has integrated the AI RMF into its AI governance processes to enhance the trustworthiness and reliability of its AI-driven human resource solutions.
- **Google DeepMind:** DeepMind has developed templates based on the AI RMF to ensure its AI systems are designed and deployed responsibly.
- **University of Michigan-Dearborn:** The university uses the AI RMF to manage risks associated with autonomous vehicle technology, particularly in traffic sign recognition.

(Source: <https://www.nist.gov/itl/ai-risk-management-framework>)

Colorado CAIA Highlights

State agencies are leveraging the CAIA to foster responsible AI use and protect consumer rights:

- The Colorado Department of Health Care Policy and Financing uses the CAIA to guide AI applications in Medicaid services, ensuring equitable access and preventing bias.
- The Colorado Housing and Finance Authority employs the CAIA to manage AI-driven housing allocation processes, promoting fairness and transparency.

(Source: Rice, T., Lamont, K., Francis, J. (2024). The Colorado Artificial Intelligence Act. FPF Legislation Policy Brief, https://leg.colorado.gov/sites/default/files/images/fpf_legislation_policy_brief_the_colorado_ai_act_final.pdf.)

Texas. Texas enacted the Texas Responsible Artificial Intelligence Governance Act (TRAIGA) on June 22, 2025, which places restrictions on the development and deployment of AI systems. This makes Texas the second state, after Colorado, to enact comprehensive AI legislation. The law, which takes effect on January 1, 2026, prohibits certain AI uses by government entities and individuals developing or deploying AI systems. The law requires government agencies using AI to inform consumers whenever they are interacting with an AI system, introduces a regulatory sandbox program designed to allow testing and development of AI systems with relaxed regulatory constraints, and establishes the Texas AI Advisory Council.

Texas TRAIGA Highlights

- Texas has prioritized the integration of AI in various sectors, including healthcare and security, while establishing guidelines to safeguard data privacy and protect sensitive information.
- TRAIGA provides safe-harbor provisions to incentivize businesses to adopt proactive compliance measures.
- Compliance with recognized frameworks, such as the NIST's AI Risk Management Framework, can be a defense against allegations of misuse.
- The law encourages businesses to conduct adversarial testing to identify potential risks and preserve audit trails.

(Source: <https://capitol.texas.gov/tlodocs/89R/billtext/pdf/HB00149F.pdf>)

Around the World

The EU AI Act, considered the world's first comprehensive legal framework specifically designed to regulate AI, officially entered into force on August 1, 2024. Around the world, other countries are also recognizing the importance of non-governmental AI governance. Various organizations and consortia are developing standards and best practices to complement governmental regulations, ensuring a balanced approach to AI governance that includes diverse perspectives.

Europe

In Europe, the EU AI Act provides a comprehensive approach towards human-centric, resilient, and sustainable AI adoption. It aims to create a comprehensive unified regulatory framework for AI systems across member states, emphasizing the importance of ethical considerations in AI deployment. The EU AI Act mandates transparency, accountability, and the minimization of risks associated with AI technologies. This legislation was approved by the EU Parliament on March 13, 2024, and published in the Official Journal on July 12, 2024.

EU AI Act: Risk Levels

The EU AI Act categorizes AI systems based on risk levels, with stringent requirements for high-risk AI applications, including mandatory risk assessments, transparency measures, and accountability protocols. The Act classifies AI systems into four risk categories based on their potential impact on individuals and society. These categories help ensure that AI systems are used responsibly and ethically, with appropriate safeguards based on their risk level:

- **Prohibited AI:** These systems are banned due to their potential to cause significant harm. Examples include AI systems that manipulate human behavior through subliminal techniques or exploit vulnerabilities related to age, disability, or socio-economic circumstances.

- **High-Risk AI:** This category includes AI systems that could adversely affect health, safety, fundamental rights, or the environment. High-risk AI systems are subject to stringent requirements, including mandatory risk assessments, transparency measures, and accountability protocols. Examples include AI used in critical infrastructure, education, employment, and law enforcement.
- **Limited Risk AI:** This category includes AI systems that pose a lower risk and are subject to lighter transparency obligations. Developers and deployers must ensure that end-users are aware they are interacting with AI. Examples include AI used in chatbots and deepfakes.
- **Minimal Risk AI:** This category includes the majority of AI applications currently available. Minimal risk AI systems are largely unregulated. Examples include AI-enabled video games and spam filters.

EU AI Act: Phased Implementation

The implementation timeline for the EU AI Act is staggered, allowing organizations time to comply. General provisions and prohibitions on certain AI practices will apply from February 2, 2025, while other requirements will be phased in over the following years. For example, large-scale IT systems must comply by December 31, 2030. This phased approach aims to ensure a smooth transition and effective enforcement across diverse AI applications.

South Korea

In South Korea, the government has enacted comprehensive AI legislation aimed at fostering innovation while ensuring ethical standards. Its AI Framework Act, implemented in 2022, focuses on promoting responsible AI development, safeguarding user privacy, and preventing algorithmic bias. South Korea's approach includes the establishment of an AI ethics committee to oversee the deployment of AI technologies, ensuring transparency and accountability in AI systems. (Source: <https://iapp.org/news/a/analyzing-south-korea-s-framework-act-on-the-development-of-ai>)

Brazil

Brazil has taken significant steps toward AI governance through both strategic planning and legislative action. The country released a national AI Strategy focused on promoting ethical AI development, mitigating algorithmic bias, ensuring human oversight in high-risk automated decisions, and encouraging transparency and data sharing. A major legislative milestone is the Senate's approval of Bill 2338/2023, which establishes a comprehensive AI regulatory framework. This bill emphasizes human rights, prohibits certain high-risk AI systems, mandates civil liability for AI providers, and guarantees individual rights such as explanation, nondiscrimination, and due process. The bill is currently under review by the lower chamber. Brazil's data protection authority (Agência Nacional de Proteção de Dados or ANPD) has also issued a final opinion on the bill, reinforcing its role in AI oversight. (Source: https://iapp.org/media/pdf/resource_center/global_ai_law_policy_tracker.pdf)

Private Sector

It is not only governments that are active in AI governance: The private sector plays a crucial role in AI governance by implementing comprehensive risk frameworks, prioritizing privacy data protection, and enforcing robust data governance practices. While governments are likely to be slow in regulating AI, the private sector should establish AI governance to create trust. Companies that operate globally are actively developing standards to ensure the ethical deployment of AI technologies, addressing concerns related to algorithmic bias and transparency.

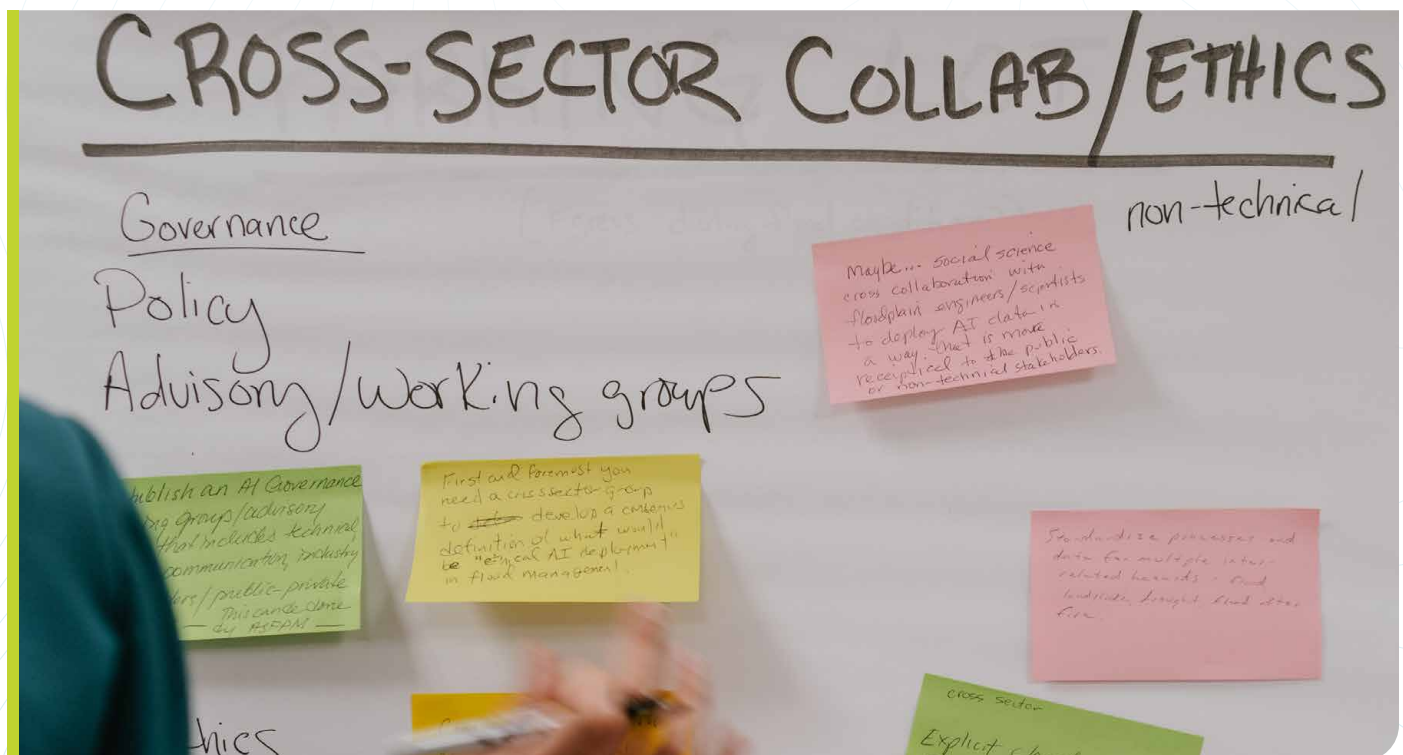
By leveraging existing risk frameworks, organizations can proactively manage potential AI-related threats, fostering innovation while safeguarding user interests:

- Privacy data protocols help protect sensitive information, ensuring compliance with regulations and maintaining public trust.
- Data governance strategies further enhance the reliability and accountability of AI systems, creating a balanced approach that harmonizes technological advancements with ethical considerations.

AI Governance in the Private Sector

- **Microsoft AETHER:** Microsoft has established an AI, Ethics, and Effects in Engineering and Research (AETHER) Committee to oversee AI ethics and governance. This committee ensures that AI systems are developed and deployed responsibly, focusing on fairness, reliability, safety, privacy, and inclusiveness.
- **Google AI Principles:** Google has implemented its AI Principles, which guide the ethical development and use of AI technologies. These principles emphasize social benefits, avoiding unfair bias, and ensuring accountability and transparency in AI systems.
- **IBM AI Ethics Board:** IBM has created an AI Ethics Board to provide guidance on the ethical implications of AI technologies. The board reviews AI projects to ensure they align with IBM's ethical standards and principles, focusing on trust and transparency.

(Sources: https://erichorvitz.com/Aether_Committee_Microsoft.htm; <https://ai.google/principles/>; <https://www.ibm.com/trust/responsible-ai>)





Synthesis of Recommendations/Findings

The Forum successfully achieved its anticipated outcomes by building awareness and understanding of the impacts and implications of the use of AI in floodplain management; identifying and exploring areas in need of standards, best practices, or other policy safeguards; and exploring and discussing as-yet-untapped opportunities to harness the power of AI within floodplain management.

Following the twelve breakout sessions, participants collectively agreed on the following three overarching key takeaways:

- **It's About Data:** The effectiveness of AI depends fundamentally on the quality and quantity of data used to train its models. Data serves as the foundation of AI's pattern recognition, prediction, and decision-making capabilities.
- **AI as a Tool—Humans Remain Essential:** While AI can dramatically enhance decision-making and productivity, it is ultimately a tool designed to augment, not replace, human expertise and judgment. Human insight, creativity, and ethical reasoning are irreplaceable in guiding AI's application.
- **Potential with Guardrails:** AI's transformative potential is vast, but harnessing its benefits requires the implementation of robust guardrails. Responsible development and oversight ensure that AI operates safely, ethically, and in alignment with organizational and societal values.

The Forum's discussions identified five topic areas that would benefit from additional exploration and 11 recommendations related to the use of AI by floodplain managers.

Future Considerations

The challenges addressed by the Forum are complex and require continued discussion beyond this report. Areas that may warrant further examination include evaluating the long-term effects of policy changes, reviewing resource allocation approaches, and analyzing stakeholder engagement methods. Specifically, the following issues were noted as needing follow-up exploration:

- **Consistency of AI Applications:** Addressing potential inconsistency of AI applications for NFIP.
- **Equal Access to AI:** Addressing equal access to AI and the importance of inclusivity in its use.
- **Monitoring for Effectiveness:** To maintain credibility, AI models and outcomes will require continual checking.
- **Funding:** Funding sources to enact the recommendations from this Forum and future actions that may be identified should be explored. Funding might include grants, public-private partnerships, or other funding mechanisms.
- **Cybersecurity:** Governance for AI must address cybersecurity.

Periodic discussions may help to identify and incorporate emerging issues into future policy recommendations. Examining these factors in more detail can contribute to a broader understanding of AI's role in floodplain management.

Forum Recommendations

The Forum focused on both the technical aspects of using AI as well as the policy landscape related to each of the five facets of floodplain management.

The recommendations presented here focus on promoting heightened awareness, encouraging proactive monitoring of ongoing advancements, and helping practitioners begin to identify opportunities to integrate established AI solutions as they become available. The recommendations are to equip floodplain professionals with fundamental knowledge of AI and its potential strengths and weaknesses to support effective response to emerging applications of AI within their field.

Recommendations do not include providing prescriptive or exhaustive policy guidance because the technological and regulatory frameworks for AI are rapidly developing and changing.

The recommendations presented here were developed with either practitioners or policy makers in mind. Practitioners include anyone involved in floodplain management, from community planning to engineering. Policy makers include government officials creating policy or official guidance. While the Forum did not address specifics about who will undertake the recommendations and how they could be funded, they include actions intended to be undertaken primarily by the ASFPM Foundation and ASFPM with support from its partners, such as members' organizations.

Five Facets of Floodplain Management



Recommendations of ASFPM Foundation 2025 Forum*

Recommendation

1

Organize a series of webinars and discussion forums on AI and floodplain management

Arrange a series of webinars and discussion forums focused on the intersection of AI and floodplain management, highlighting AI's capabilities and exploring its potential applications and associated considerations.

Establish the ASFPM AI Task Force by expanding the scope of the current ASFPM AI Subcommittee to allow for broader involvement within the organization in hosting AI-related events.

Partner with ASFPM chapters and other organizations to facilitate these forums during their annual conference and other convenings.

OUTCOME



Awareness

FACET



AUDIENCE



Practitioner

Recommendation

2

Compile and publish AI use cases

Gather AI use cases pertaining to the five facets of floodplain management, including those showcased at the ASFPM and its Chapter-hosted conferences, AI Subcommittee's webinar series, and other ASFPM-led events. The curated use cases will be organized and maintained within the AI Collection of the ASFPM online library.

OUTCOME



Awareness



Safeguards



Opportunities

FACET



AUDIENCE



Practitioner



Policymaker

*Refer to narrative for explanation of outcomes, facets, and audience.

Recommendation
3

Establish AI governance and policy framework for AI usage

Explore the development of detailed standards and guidelines for the use of AI in floodplain management, particularly hazard and risk identification. Gather AI usage policies from public and private organizations to encourage ethical and responsible implementation of AI among ASFPM member organizations and partners.

Develop an ASFPM policy on the use of AI with guiding principles such as standard of care, fit-for-purpose, human oversight, interdisciplinary inputs, source citation requirements, and advocating policy adoption.

Create (1) data governance standards to ensure appropriate application of data and (2) AI governance for AI tools in various settings, such as emergency response and insurance.

OUTCOME



Safeguards

FACET



AUDIENCE



Policymaker

Recommendation
4

Review AI accreditation process and professional standards

Evaluate relevant professional certifications, such as Professional Engineer and Certified Floodplain Manager (CFM), ensuring that AI development and deployment are aligned with ongoing annual recertification processes that incorporate recent advancements.

Promote comprehensive AI-focused education across the five facets of floodplain management, including structured training and the integration of standards within the CFM program or through Continuing Education Credits.

Explore development of a certification program or specialization within an existing certification, such as a “Certified Floodplain Manager-Artificial Intelligence Practitioner (CFM-AIP).”

OUTCOME



Safeguards

FACET



AUDIENCE



Practitioner



Policymaker

Recommendation
5

Institutionalize professional oversight for public safety

Draft a proposal to State Boards of Professional Engineers (PEs) requiring that flood hazard and risk data be developed by licensed PEs to protect public safety along with accountability measures to hold non-licensed individuals or organizations accountable for releasing flood hazard and risk data.

Support State Boards of professionals and other organizations that oversee professional certifications (PE and others) to review and update their professional responsibly and code of ethics to reflect the responsible and ethical uses of AI.

OUTCOME



Safeguards

FACET



AUDIENCE



Policymaker

Recommendation
6

Promote data quality and transparency and accountability of AI development and deployment

Make a commitment to training AI models that actively reduce biases and maintain rigorous standards of data quality, especially when producing hazard or risk flood data. This can be achieved by implementing robust data management practices—including data cleansing, data minimization, and comparative analyses with established traditional models—to ensure consistency and enhance confidence in AI-generated results.

Create data benchmarking and a standardized data dictionary with clear definitions, privacy standards, and ethical guidelines. Use simple disclosures and disclaimers, keep continuous chain-of-custody, clarify decision variables, track changes with audit trails and version control, and set up feedback for data correction to uphold AI integrity and reliability.

Establish ethical guidelines for both inputs and outputs and define processes for challenging AI decisions and seeking recourse.

OUTCOME



Opportunities

FACET



AUDIENCE



Practitioner

Recommendation
7

Upskill the existing workforce and incentivize knowledge exchange

Train the current workforce to develop new skills aligned with AI technologies. This can involve creating new career paths and providing continuous learning opportunities.

Incentivize and provide resources for employees to share, among ASFPM peers and partners, knowledge gained and lessons learned from AI development and AI applications in floodplain management.

OUTCOME



Awareness



Opportunities

FACET



AUDIENCE



Policymaker

Recommendation
8

Foster collaboration and co-development

Foster collaboration between AI researchers, policymakers, and community leaders to enhance the ethical development and deployment of AI systems. This can include co-developing standards, updating outdated regulations, and ensuring community input is considered in model optimization and decision-making processes.

Explore collaboration with other organizations such as the International Association of Privacy Professionals (IAPP), which is well established in AI governance and practices, and the American Society of Civil Engineers (ASCE) and American Planning Association (APA) for professional responsibility and certification alignments.

OUTCOME



Safeguards



Opportunities

FACET



AUDIENCE



Practitioner



Policymaker

Recommendation
9

Collaborate on providing best practices and technical support

Create an AI Practitioner Hub for AI practitioners and researchers to provide technical support and share best practices. This hub can serve as a central resource for AI-related knowledge and expertise.

Develop best practices templates that offer general templates, AI prompt guidance, and communication pieces verified by humans to deliver consistency and credibility in AI applications.

OUTCOME



Awareness



Opportunities

FACET



AUDIENCE



Practitioner

Recommendation
10

Conduct an AI pilot project focusing on communication applications

Collaborate among ASFPM members and other public and private partners to conduct an AI pilot project focused on promoting responsible, wide, and prudent use of AI in floodplain management, particularly in communications and stakeholder engagement.

OUTCOME



Opportunities

FACET



AUDIENCE



Practitioner

Explore the regulatory sandbox concept

Explore the concept of the regulatory sandbox to test and refine AI tools in a controlled environment. This approach allows for innovation while ensuring compliance with data privacy standards. The recently promulgated Texas AI law, which includes a regulatory sandbox program, could provide a framework for this initiative.

OUTCOME



Safeguards



Opportunities

FACET



AUDIENCE



Practitioner



Policymaker



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Panelists

Panel 1: Priming the Pump

Ibrahim Demir, PhD

Michael A. Fitts Presidential Chair in Environmental
Informatics and Artificial Intelligence,
Tulane University

Mary Lehman

Delegate – District 21, Maryland House
of Delegates

Panel 2: Drilling Down

George Gallagher

Senior Leader and Principal, Climate Risk and
Natural Hazard Solutions, CoreLogic

Jenni Evans, PhD

Emeritus Director and Faculty Associate,
Institute for Computational and Data Sciences,
Pennsylvania State University

Rowan Schmidt

Co-Founder & CEO, Radbridge

Panel 3: Policy Landscape

Johannes Bahrke

Counselor for Digital Policy, Delegation of the
European Union to the United States

Cobun Zweifel-Keegan, JD, CIPP/US, CIPM

Managing Director, International Association of
Privacy Professionals

Kathleen Birrane, JD

Litigation Practice Partner and U.S. Insurance
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Doug Plasencia, PE, CFM, Moffatt & Nichol

ASFPM Foundation Past President

Moderators

Panel 1: Priming the Pump

Suman Biswas, Niyam IT
ASFPM Foundation Associate

Panel 2: Drilling Down

Richard Passarelli, PE, CFM, PMP, AtkinsRéalis

Panel 3: Policy Landscape

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Forum Breakout Session Report-Outs

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Facet 1: Hazard/Risk Identification

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ASFPM Foundation Associate

Facet 2: Standards, Regulations, and Compliance

Becca Fricke-Croft, PMP, CFM, AtkinsRéalis
ASFPM Foundation Associate

Facet 3: Communication

Necolle Maccherone, CFM, AtkinsRéalis

Facet 4: Mitigation and Resilience Measures and Facet 5: Risk Transfer

Johanna Greenspan-Johnston, Dewberry

Notetakers

Facet 1: Hazard/Risk Identification

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Facet 2: Standards, Regulations, and Compliance

Joanna Wagschal, PMP, M.Ed., Bloomsburie
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Facet 3: Communication

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Facet 4: Mitigation and Resilience Measures and Facet 5: Risk Transfer

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List of Acronyms

AETHER	AI, Ethics, and Effects in Engineering and Research
AI	artificial intelligence
AICP	American Institute of Certified Planners
AIGP	Artificial Intelligence Governance Professional
AI RMF	AI Risk Management Framework
AIS	Artificial Intelligence System
APA	American Planning Association
ASCE	American Society of Civil Engineers
ASFPM	Association of State Floodplain Managers
CAIA	Colorado Artificial Intelligence Act
CCPA	California Consumer Privacy Act
CFM	Certified Floodplain Manager
CFM-AIP	Certified Floodplain Manager-Artificial Intelligence Practitioner
CLeAR	Comparable, Legible, Actionable, and Robust
CRS	Community Rating System
CTP	Cooperating Technical Partners
EOC	Emergency Operations Center
EU	European Union
FAIR	Findable, Accessible, Interoperable, Reusable
FAQs	frequently asked questions
FEMA	Federal Emergency Management Agency
GDPR	General Data Protection Regulation
GIS	geographic information system
HEC-RAS	Hydrologic Engineering Center's River Analysis System
HMP	Hazard Mitigation Plan
IAPP	International Association of Privacy Professionals
LLM	large language model
NAIC	National Association of Insurance Commissioners
NFIP	National Flood Insurance Program
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
PARC	Planning Assistant for Resilient Communities
PE	Professional Engineer
PEAT	Partnership on Employment & Accessible Technology
RMF	Risk Management Framework
SME	subject matter expert
TRAIGA	Texas Responsible Artificial Intelligence Governance Act

