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Co-producing usable knowledge for climate change adaptation: the New York City flood vulnerability index

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ABSTRACT

Co-producing climate services has been proposed as a way to make climate services more usable by aligning scientific analysis with decision contexts, institutional needs, and practitioner knowledge. Yet the benefits of co-production are often assumed rather than evaluated, particularly in relation to how process design shapes the final product. This paper examines the co-production of New York City's first Flood Vulnerability Index (NYC FVI), developed by researchers and city agency stakeholders to support flood adaptation planning. Through a structured co-reflection with members of the NYC FVI core team, we identify how co-production process principles and product characteristics shaped the NYC FVI's development and perceived usability. Results show how participants perceived that the principles of flexibility, collaboration, and decision orientation helped the team negotiate methodological choices and improve the tool's institutional fit. At the same time, participants identified trade-offs related to timeliness, inclusiveness, continuity, and post-release learning. Rather than treating co-production as a guarantee of uptake, this study shows how a structured co-reflection can make visible the choices, constraints, and stewardship needs that shape the usability of co-produced urban adaptation climate services.

1. Introduction

As extreme weather events continue to increase in intensity and frequency (IPCC, 2012, 2022), urban planners and decision-makers face the urgent challenge of mitigating climate risks through climate adaptation planning (Olazabal et al., 2019; Sainz de Murieta et al., 2021;

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Sillmann et al., 2024; Solecki & Friedman, 2021). Given the spatial heterogeneity of climate risks (Chang et al., 2021) and their disproportionate impacts exerted on vulnerable communities (Reckien et al., 2018; Yang et al., 2021), climate adaptation planning requires spatially explicit and justice-informed risk and vulnerability assessments to avoid maldistributing interventions and perpetuating uneven exposures (Anguelovski et al., 2016; Araos et al., 2021; Chu & Cannon, 2021; Juhola et al., 2022; Meerow & Newell, 2019).

Risk and vulnerability mapping has made significant scientific advances in the last few decades, making the aggregation of exposure and vulnerability indicators into spatially explicit indices or rankings a common practice in research (Bukvic et al., 2020; de Sherbinin et al., 2019; Li et al., 2022; Moreira et al., 2021a, 2021b; Preston et al., 2011; Sajjad et al., 2021). Risk reduction approaches have also advanced to provide optimization frameworks that aim to support decision-makers in selecting interventions, such as Nature-based Solutions (Cen et al., 2025; Herreros-Cantis & McPhearson, 2021; Khromova et al., 2025). However, local climate adaptation planning continues to under-rely on spatial risk science, failing to consider the uneven distributions of climate hazards and the implications of unequal exposures and vulnerabilities (Anderson & Logan, 2026).

Climate services, tools that "provide people and organizations with timely, tailored climate-related knowledge and information that they can use to reduce climate-related losses and enhance benefits, including the protection of lives, livelihoods, and property" (Vaughan & Dessai, 2014, p. 588) have emerged as a promising avenue for translating scientific knowledge into usable information. Climate services are considered more usable when developed under co-production settings, where co-production is defined as "an iterative, collaborative process in which knowledge is produced and integrated through the involvement of a variety of participants (scientists, civil society, policy-makers, etc.)" (Herreros-Cantis et al., 2024, p. 2). Climate services co-production is considered useful to narrow the "usability gap" by bringing together climate service producers and users (Ernst et al., 2019; Lemos et al., 2012). In climate services research, co-production tends to be conceptualized as an iterative interaction between scientists (producers) and non-scientists (users) (Bremer & Meisch, 2017) that enables the construction of credible, salient, and legitimate knowledge (Cash et al., 2003), where credibility refers to the degree to which information is trustable, authoritative, and believable; salience refers to the degree to which information is perceived as relevant and its timely delivery; legitimacy refers to the fairness of the knowledge co-production process and its capacity to account for diverse views, values, and perspectives. Approaching climate services through co-production rejects the traditional "drop-in" model of knowledge generation, where researchers hand over scientific knowledge without considering the needs or constraints of policy-makers (Dilling & Lemos, 2011; Roux et al., 2006; Vincent et al., 2018). In the context of urban adaptation, Foshag et al. (2020) similarly argue that effective and feasible adaptation measures require transdisciplinary collaboration capable of integrating physical climate information, practical planning requirements, and stakeholder perspectives across disciplinary and institutional boundaries.

Despite growing interest in co-production for climate adaptation, robust evidence of how co-production improves adaptation processes remains limited, making it hard to justify and improve the mobilization of resources it requires (Olazabal et al., 2025; Witinok-Huber et al., 2025). This gap is further apparent in climate services, where evaluation frameworks are only recently being advanced and applied in practice and tend to focus on the final product (Boon et al., 2022; Boon & Biesbroek, 2025; Tall et al., 2018; Visman et al., 2022). While climate services ultimately result from a series of methodological steps (e.g., selecting indicators, processing data, etc.), the impacts of co-production are intrinsically linked to the process through which it unfolds (Chambers et al., 2021), overlooking potential tensions and trade-offs that unfold in knowledge co-production processes (Englund et al., 2025). However, climate-service co-production initiatives vary in how deeply they engage with co-production theory and principles, creating a disconnect between rhetoric and practice. Addressing this gap requires a framework that distinguishes between principles that guide the co-production process and characteristics of the resulting climate service, making it possible to examine how co-production shapes both the development of a tool and its perceived usability as an output (Vincent et al., 2018).

To address this gap, we examine the development of New York City's first Flood Vulnerability Index (NYC FVI), a climate service scoped to inform climate adaptation planning decisions made by city agencies and co-produced through an inter- and transdisciplinary research setup. We ask: how did the co-production process shape the development, perceived usability, and institutional fit of the NYC FVI, and what trade-offs and improvement needs were identified by participants? To answer this question, we use a structured reflection among researchers and city agency stakeholders involved in the NYC FVI's development. We descriptively refer to this joint reflective exercise as "co-reflection", understood as a way to embed evaluation into co-production itself and to support social learning, mutual expectations, and relational capital among co-producers (Collins & Ison, 2009; Kalsnes et al., 2023). Previous work has shown that self-assessment processes can support urban climate resilience not only by generating comparative results, but also by creating spaces for exchange, mutual learning, and awareness-building among participating practitioners (Özerol et al., 2020). Building on this process-oriented assessment, our study seeks to enable co-producers to reflect on the development and perceived usability of an urban flood vulnerability climate service, providing an insider account of how co-production influenced the process and identifying trade-offs that should inform future co-production cycles.

2. Methodology

This study focuses on understanding how co-producing the NYC FVI shaped the process and the final product, supporting perceptions on the usability of a climate adaptation planning tool. While some methodological choices directly linked to the construction of the NYC FVI may be referenced as examples, the technical development of the NYC FVI is beyond the scope of this paper. For further methodological details and justifications on technical aspects of the NYC FVI, readers are referred to the project report (McPhearson, Towers, et al., 2024).

2.1. Co-production setup

The co-production of the NYC FVI was scoped within the broader project "NYC Climate Vulnerability, Impact, Adaptation and Analysis" (VIA), a research project focused on expanding knowledge on the socio-impacts of future extreme weather events (McPhearson, Towers, et al., 2024). The VIA project was commissioned by the Mayor's Office of Climate and Environmental Justice (MOCEJ, formerly named Mayor's Office of Climate Resiliency). As a transdisciplinary collaboration between city agencies and researchers, the funding of the project was possible through the NYC's Town+Gown initiative, a city-wide university-community partnership program promoted by the city's government. Since 2009, the Town+Gown initiative supports transdisciplinary research partnerships between researchers and practitioners, with a focus on supporting practice and policy change based on research results (NYC Department of Design & Construction, 2026).

The NYC FVI was scoped as a specific output of the VIA project. From the start, the NYC FVI was envisioned as a single spatially explicit tool to "help the City to identify and better direct resources to those communities exposed to this compounding risk" (NYC Department of Citywide Administrative Services & NYC Mayor's Office of Climate Resilience, 2021, p. 12).

As a tool intended to guide adaptation planning efforts led by NYC agencies, the co-production setup focused on including a diverse range of city agency stakeholders to ensure the tool's usability and uptake. City

agency stakeholders were recruited from the Interagency Climate Assessment Team (ICAT) - a group of city staff members from multiple departments tasked with identifying actionable climate-related knowledge gaps, steer research agendas, provide feedback to research inquiries, and incorporate research outputs into their department policies (NYC Mayor's Office of Climate & Environmental Justice, 2022a). In the scoping and starting stages of the project, ICAT members were invited to self-enroll and/or assign other agency members to the project. As a result, a core group of 12 city agency stakeholders became actively involved in the development of the NYC FVI (McPhearson, Towers, et al., 2024), representing five city government agencies: MOCEJ, NYC Emergency Management (NYCEM), NYC Parks, the Department of Health and Mental Hygiene (DOHMH), and the Department of Environmental Protection (DEP). The core group was completed with three researchers who co-led the NYC FVI development and who were in charge of data processing and analysis.

In addition to the core group, an advisory group composed of experts familiar with different aspects of NYC's flood risks was established to provide technical guidance on the NYC FVI's methodology, data selection, and potential use cases. This advisory group was composed of 8 members, representing academic researchers, federal institutions developing place-based research, and consultants involved in flood hazard mapping (e.g., contributors to NPCC reports and local flood resilience plans).

The co-production process of the NYC FVI took place during the timeline of the VIA project, which spanned from August 2022 to January 2024. At the kick-off stage, the core team agreed on the co-production's meeting cadence, setting up monthly check-ins in order to enable sustained feedback exchanges. When needed, additional bilateral meetings were organized to discuss specific dimensions of the NYC FVI development with particular collaborators (e.g., discussing the trade-offs of selecting specific flood hazard datasets to evaluate flood exposure). More than 20 team-wide, 1-hour long online meetings took place over the course of developing the NYC FVI. In addition to monthly team meetings, the team's researchers met systematically in the interim. Additionally, three all-hands meetings were conducted throughout the project in order to share updates across teams and to align the NYC FVI with other tasks being developed in parallel under the VIA project.

2.2. Co-reflecting the co-production's process and product

In order to structure our co-reflection on how the co-production process shaped the development of the NYC FVI, we rely on the principles and characteristics proposed by Vincent et al. (2018) in their framework for informing co-production cycles of climate services (Fig. 1). The framework distinguishes between the *process* principles that guide a co-production cycle (flexibility, collaboration, and inclusiveness) and the *product* characteristics (decision-driven, timeliness, process-based) expected to be produced through the cycle (Table 1). We consider the distinction between process and product highly useful, as the value of co-production lies in the relational processes it triggers in addition to the final product in itself. Consequently, we rely on this framework to examine how the process principles and product characteristics guiding co-production cycles shaped the development of the NYC FVI and perceptions of its usability.

The co-reflection exercise was proposed and coordinated by the first author, one of the three researchers involved in the NYC FVI core team. All the active members of the core team who co-produced the NYC FVI (12 city agency stakeholders and 3 researchers) were invited to participate in the co-reflection exercise. City agency stakeholders were first contacted by the first author in February 2025 to assess their interest in contributing to a publication reflecting on the co-production of the NYC FVI. Team members who agreed to participate were subsequently sent an open-ended questionnaire on 19 September 2025. Participants provided written input between 19 September and 13 October 2025.

The questionnaire shared with participants follows Vincent et al's (2018) framework's structure, with different sets of questions focusing on each of the six process and product principles (for the complete questionnaire shared with participants, see Supplementary Materials SM1). For each principle, we asked participants to what extent and how it supported the development of the NYC FVI, as well as how the future iterations of the NYC FVI may improve its application. For example, for evaluating flexibility throughout the process, the questionnaire asks *"According to your experience producing the NYC FVI, were there situations that required shifting from the original plans of how the final product would be developed and/or look? Did the way in which the FVI development was set up facilitate the incorporation of these changes?"* and *"What aspects do you*

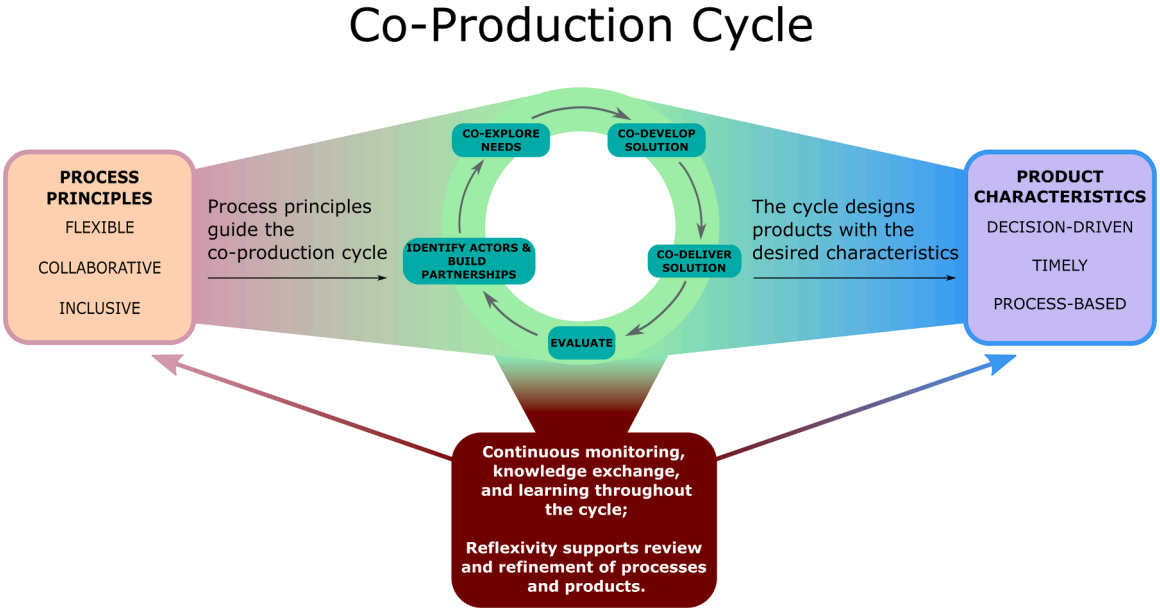


Fig. 1. Co-production cycle and its guiding process principles and product characteristics. Throughout the whole cycle, monitoring, learning, and reflexivity support the refinement and the revision of the way in which the process and product principles are being implemented. We frame this co-reflection paper as part of the reflexivity efforts to support learning and inform future iterations of the co-production cycle both within and beyond the case study area. Adapted from Vincent et al. (2018).

Table 1
Process principles and product characteristics proposed by Vincent et al. (2018) to inform climate service co-production cycles.

Principle / Characteristic	Description
Process: Flexibility	Capacity to reshape and adapt the goals of a process to unexpected or unplanned situations, needs, and lessons learned. Requires space for collectively making decisions within the co-production process, as well as for identifying and navigating knowledge gaps, and different understandings that may emerge from the diverse perspectives involved (Dilling & Lemos, 2011; Fazey et al., 2014; Wall et al., 2017).
Process: Collaboration	Practices within the process that enable the fostering and nurturing of relationships, trust building, integration of the knowledge held by diverse actors, and the development of shared understandings and ownership of the final products (Cook et al., 2013; Dilling & Lemos, 2011). Requires trust, credibility, and legitimacy, which may rely on previous interactions sustained through time.
Process: Inclusiveness	Inclusion of diverse agents, including end-users and those who may be affected by the outcome of the co-production process through meaningful participation opportunities (Daly & Dessai, 2018; Robinson & Tansey, 2006; Steynor et al., 2016).
Product: Decision-driven	Capacity to support real decision-making processes (Dilling & Lemos, 2011; Lemos et al., 2012).
Product: Timeliness	Capacity to provide information in time for ongoing decisions or policies (Easterling & Mjelde, 1987).
Product: Process-based	The role of climate services as not only the products themselves, but also the long-term processes that lead to their production, and how policy and decision makers use the services (Cvitanovic et al., 2015). The "process-based" characteristic also allows to investigate how the NYC FVI interacts with previous decisions and outputs (i.e., before the NYC FVI co-production cycle began) that enabled the development of the tool, and how it relies on post-release activities to remain relevant, such as monitoring, evaluation, and learning (MEL) cycles, dissemination, maintenance, and updates.

think should be considered in future iterations to make the process more adaptable to identified needs and/or limitations?" In addition to collecting authors' input through the questionnaire, we rely on project outputs such as interim and final reports, meeting notes, version logs, and emails to document whether and to what extent the process and the product aligned with the principles.

The questionnaire served both as a structured reflection instrument and as a mechanism for eliciting co-author input into the manuscript. Because respondents were co-producers of the NYC FVI and many are co-authors of this paper, their responses are not treated as anonymous independent testimony. Rather, they are interpreted as situated reflections from participants directly involved in the process. This design provides insight into perceived benefits, trade-offs, institutional constraints, and process mechanisms, while bounding the scope of the study's claims to co-producer perspectives and documented project evidence.

All participants who contributed to the co-reflection and manuscript development are listed as co-authors. Out of 15 active participants that engaged with the NYC FVI co-production, a total of 12 people (80%) joined the co-reflection process, providing input through the questionnaire and reviewing this manuscript. The pool of respondents includes the team's researchers (3) and staff members affiliated with MOCEJ (4), DOHMH (2), NYCEM (2), and NYC Parks (1).

2.3. Statement of positionality

This study relies on a structured co-reflection among researchers and city agency stakeholders directly involved in the development of the NYC FVI. Respondents are therefore not external evaluators of the project, but co-producers of the tool and co-authors of this manuscript. As such, the findings should be interpreted as a situated account of the co-production process and of participants' perceptions of the resulting climate service, rather than as an independent evaluation of the NYC FVI's impacts.

This positionality provides direct insight into how co-production is perceived to have interacted with the design choices, institutional constraints, perceived benefits, and trade-offs that guided the NYC FVI's development. At the same time, it bounds the scope of the study's claims: the reflections presented here represent the perspectives of participating researchers and city agency stakeholders. Non-participating city agencies, community-based organizations, external users, and flood-affected communities may assess the NYC FVI's credibility, salience, legitimacy, and usability differently. We therefore interpret our findings as evidence of perceived usability and institutional fit within the interagency co-production process, while recognizing that broader assessments of community legitimacy, public use, and downstream policy impacts require additional evaluation beyond the scope of this study.

3. Results

Table 2 presents a summary of the benefits and opportunities for improvement that were identified by participants in the co-reflection of the NYC FVI co-production process. In the sections below, we elaborate on these insights by relating the inputs provided by participants to practical examples through which each of the principles guiding this co-reflection played out and shaped the co-production process. For each principle, we report i) how participants in this co-reflection perceive that the principle benefited the process and product, and ii) specific examples of how the principle influenced the process itself and the final product, considering both setups within the co-production cycle itself as well as enabling circumstances that were identified in making the principle's application possible.

We present the findings as a qualitative synthesis of recurrent mechanisms, perceived benefits and trade-offs, with the aim of supporting future co-production cycles within the NYC context and beyond. Given the small purposive sample, the non-anonymous co-authoring process, and the fact that the manuscript itself synthesizes responses from co-producers together with project facts, response counts risk creating a misleading sense of quantitative precision or implying that absence of a theme in an individual response may represent disagreement.

3.1. Process

3.1.1. Flexibility

Participants report that the flexibility of the approach was especially useful to align expectations and assumptions behind the NYC FVI, as well as to react to unscoped needs that were identified as the process evolved.

Regarding the alignment of expectations and assumptions, flexibility was designed into the co-production process by setting a phased, iterative approach in which end-users and researchers exchanged feedback and expressed their needs and expectations throughout the process (Herreros-Cantis et al., 2024). Consequently, the process was organized around a succession of decision windows in which participating researchers, city agency stakeholders, and advisors discussed, defined, tested, and resolved methodological questions that had been intentionally left open in the project's scope (Fig. SM1). Examples of questions open to collective deliberation included (1) the underlying definition of vulnerability guiding the construction of the NYC FVI, (2) the selection of indicators used to measure vulnerability, (3) the methods used to aggregate indicators into an index, (4) the resolution of the analysis, and (5) the types of flooding to consider.

The first step to jointly tackle these questions was a literature review focused on providing alternative responses to each of the unscoped decisions. For instance, the literature review identified and proposed

Table 2
Summary of co-production benefits and aspects for improvement identified by participants in the co-reflection of the NYC FVI's co-production process.

Principle / Characteristic	Benefits identified	Improvement aspect
Process: Flexible	a. Allocating time to discussion and testing of methodological questions enabled the alignment of expectations and assumptions across the team. b. The co-production process allowed for the identification of previously unconsidered end-user needs, as well as for updating the project's scope in response to them.	1. Flexible approaches required significant amounts of time to discuss and weigh options. The project's timeline required moving forward at times making participants wish there was more time available.
Process: Collaborative	c. Collaborative setups such as the regularity of check-ins and the clarity of the roles within the team allowed for the process to move forward and develop new relationships between city staff and across city staff and researchers. d. Upstream collaborations prior to the project, as well as local spaces of knowledge exchange were key enablers through relationships and trust that were there from the beginning.	2. Increasing options for longer, in-person collaboration would help move the process forward faster. 3. While the process was helpful to build relationships with other city staff, some of those relationships were not actively maintained after the completion of the process due to a lack of a goal to work towards.
Process: Inclusive	e. The diversity of city agencies participating in the process enabled the integration of complementary perspectives, enriching choices around data selection, methods, and expectations held for the final product.	4. Stakeholder diversity required additional time to establish common understandings throughout the process. 5. Staff turnover in the city offices challenged the continuity and participation of some offices. Designating alternate participants for each office would reduce the risk of disruption. 6. The role of the advisory team and the expectations for its outputs may be better defined to increase their level of involvement throughout the process. 7. Some government offices with potential to benefit from the NYC FVI were unrepresented (e.g., Department of Housing Preservation and Development, Department of City Planning, Office of Management and Budget). Interim open-door sessions focused on presenting preliminary results may help enrich sources of feedback and facilitate early buy-ins from government officials without the bandwidth to co-produce. 8. Community perspectives from communities affected by flooding were not directly included, mainly because bottom-up co-production requires a much higher investment in relationship and trust building. Future iterations may, however, explore ways of including non-profit organizations who support flood resilience initiatives and/or community groups with the first iteration of the NYC FVI as a conversation starter.
Product: Decision-driven	f. Scoping the NYC FVI as a decision-support tool guided the process by checking methodological decisions against their impact on the tool's interpretability and usability. g. Co-producing the NYC FVI with a focus on usability led to early use cases shortly after the tool's release.	9. The NYC FVI is currently capable of mapping vulnerability under specific flood hazard scenarios that exclude pluvial flooding. As pluvial flooding data becomes more reliable, a specific set of NYC FVIs may be prepared for this specific flooding type. Similarly, compound flooding events may be represented in the future as novel modeling outputs emerge. 10. The provision of the NYC FVI may be enriched by including data and preliminary analyses informing the indicators driving local vulnerability, in order to guide context-specific interventions.
Product: Timely	h. Aligning the release of the NYC FVI with the reporting process of the New York Panel on Climate Change helped leveraging the tool throughout additional channels.	11. In its current version, the NYC FVI provides a series of static metrics (maps) under specific flooding types (storm surge or tidal flooding) and time horizons (current, 2050s, and 2080s). The NYC FVI's capacity to support short-term emergency responses under other types of events may be limited as the tool does not incorporate real-time flooding forecast data.
Product: Process-based	i. The NYC FVI was enabled by the outputs of previous reports and plans, including city-led exercises and collaborations in the science-policy interface. j. Post-release dissemination has kept the NYC FVI present through presentations of the tool to wider research, governance, and civic groups.	12. Feedback capture was limited during and shortly after the co-production process due to the lack of an embedded Monitoring, Evaluation, and Learning (MEL) framework. Future co-production processes may include tools to facilitate collective learning as part of the process.

potential definitions of vulnerability, built a database of commonly used and empirically verified flood vulnerability indicators, collected advantages and disadvantages of different aggregation methods, and provided an inventory of flood hazard types in NYC and the available geospatial data for each of them. The development of the literature review allowed participants to react and exchange their expectations for the NYC FVI, including what it should measure, what kinds of decisions it should support, and which methodological choices required further testing before making a final decision. In response to the literature review's results, the team concluded that key decisions such as the selection of aggregation methods, flood hazard layers, and the approach to assessing flood exposure required additional testing before final decisions could be made. In this sense, flexibility allowed the tool's development to respond to the needs and constraints identified by its end-users throughout the process.

In addition to the flexibility designed into the process, participants highlight the capacity of the process to adapt to unexpected and unscoped needs that emerged throughout the co-production process. The clearest example was the shift from a single data layer to a set of

scenario-based vulnerability outputs. In the original scope the NYC FVI was scoped as a single, stand-alone map (NYC Department of Citywide Administrative Services & NYC Mayor's Office of Climate Resilience, 2021), the co-production process identified a need for providing several NYC FVI maps in order to increase the tool's usability under more diverse flooding scenarios. First, the hazard layers depicting the flood hazard types selected (tidal and storm surge flooding) were only available separately, raising the need for assessing exposure separately for either tidal flooding or storm surge scenarios. Second, the interest in assessing future flooding in addition to current conditions led to selecting two future flooding scenarios for each flooding type (2050s and 2080s). Thus, a total of six NYC FVI maps combining vulnerability indicators with scenario-specific exposures were finally produced. In addition to the different exposure scenarios, participants identified a need for an exposure-less, generalized index based on the aggregated vulnerability indicators. This type of index was identified as useful in cases in which exposure data may be missing (e.g. for less explored flooding types). As a result, the team also developed the Flood Susceptibility to Harm and Capacity to Recover Index (FSHRI), which measures susceptibility to harm and capacity to recover from flooding regardless of exposure.

Participants also noted how navigating co-production with flexibility required substantial time, which at times became limited due to the project's timeline. Keeping methodological choices open allowed the team to compare alternatives, incorporate feedback, and identify areas requiring deeper inquiry. However, the project timeline also required some decisions to move toward closure. In these cases, the team prioritized the best available tested alternative, even when participants felt that additional time for research and testing would have been valuable. Methodological choices identified as candidates for future refinement were therefore included in the project report's "Future directions" section (McPhearson, Towers, et al., 2024). These methodological considerations, which include refinements to flood hazard coverage, exposure assumptions, structural vulnerability, and empirical indicator validation, were flagged in order to inform future funding cycles of the NYC FVI development.

3.1.2. Collaboration

Participants identified two levels at which collaborative practices played out and supported the NYC FVI development: collaborative practices within the project's timeline and preceding collaboration practices that enabled the NYC FVI's co-production approach.

Regarding project-level collaboration, participants relate the process' approach to its capacity of incorporating the operational rules under which city staff work, directly shaping data choices. During the focused monthly meetings, both researchers and policy makers confronted data gaps, access limits, and questions of validity when selecting vulnerability indicators and flood hazard layers. Several meetings focused on whether candidate flood layers met agencies' requirements for validity and certainty. The result was a shared rule of practice by which only interpretable and sufficiently validated data is usable in policy. Potential datasets that risked reducing the NYC FVI's conciseness and interpretability were thus discarded. These monthly exchanges were supported by the interim sub-meetings, which provided researchers with a critical checkpoint to assess progress, troubleshoot issues identified in the previous meeting, prepare for the next full-team discussion, and arrange bilateral meetings when needed.

Participants also report the clear definition of roles within the team as an additional collaboration-specific driver of progress. As the brokering agency and final data owner, MOCEJ provided formal sign-off after deliberation with partners, ensuring methods met policy and implementation requirements. This role, clearly established ex-ante, helped solving key junctures with policy and governance implications whenever they emerged.

Finally, participants point to the VIA project setup as an innovative way of securing research funding. Previous interactions in the science-policy interface such as New York Panel on Climate Change (NPCC) reports had required researchers and other partners to volunteer their time. By partnering with the City's Town+Gown initiative, the VIA project became one of the first transdisciplinary collaborations able to provide financial support to non-city partners, as well as to provide direct support to city officials who were encouraged and allowed to dedicate their time to the process.

Regarding enabling circumstances, participants consider the broader science-policy interface in NYC to have played a key role in enabling the co-production of the NYC FVI. Key examples brought up by participants include the city's Heat Vulnerability Index (HVI), which was also co-produced between city agency stakeholders and researchers (Madrigano et al., 2015). Participants indicate that this precedent co-production cycle provided a baseline for the NYC FVI, giving policy makers a clear sense of potential use cases and acceptable levels of complexity and interpretability. Consequently, policy makers were able to articulate their needs and constraints early on (e.g., how to apply and explain scores, discussing and selecting spatial analysis methods such as indicators and resolution, documentation and reporting needs). In addition to the HVI, city agency stakeholders mention the impact of previous experiences working together in complex climate adaptation programs, such as the Cool Neighborhoods Program, an initiative, led by the New York City Mayor's Office of Recovery and Resiliency (later folded into MOCEJ) that brought together other departments such as NYC Parks, DOHMH, the Department of Small Business Services (SBS), and NYCEM.

Beyond collaboration examples rooted in specific previous projects, participants point to additional enabling circumstances through NYC's history of nurturing collaborations and exchanges across different sectors, including researchers and community organizations, to support climate adaptation planning. The City maintains the NPCC, a multidisciplinary team of researchers established in 2009 that works to advance and synthesize the state of knowledge on the impacts of climate change to the city (NYC Mayor's Office of Climate & Environmental Justice, 2022b). The NPCC's outputs have effectively informed climate adaptation planning in NYC, informing the city's major adaptation plans since 2013 (City of New York, 2013; City of New York Office of the Mayor, 2023; New York City, 2019). NPCC outputs also directly inform climate budgeting, individual agency resilience plans such as the Metropolitan Transportation Authority's climate resilience roadmap (NYC Metropolitan Transportation Authority, 2024), NYCEM's Hazard Mitigation Plan (NYC Emergency Management, 2026), and work within the Environmental Justice NYC initiative (NYC Mayor's Office of Climate & Environmental Justice, 2025). Additional spaces where inter- and transdisciplinary exchanges are nurtured in the city include ICAT - which played a role in the recruitment of city agency stakeholders for developing the NYC FVI (see *Section 2.1.*), and the Climate Knowledge Exchange (CKE) initiative, a city-led process created in 2020 designed to provide a space for city officials to identify research needs by iteratively engaging with researchers, community organizations, and federal institutions (Bridges et al., 2024). The previous existence of inter- and transdisciplinary knowledge sharing spaces such as the NPCC, ICAT, and CKE enabled the generation of trust and relationships, facilitating interactions in the NYC FVI development.

Regarding trade-offs of the process, participants mentioned two main aspects related to collaboration. First, some participants point out that the setup and duration of the majority of the project meetings (online, 1-hour check-ins) would have benefitted from scoping longer, in-person sessions allowing for dedicated attention and discussion to specific decision points. Second, while participants acknowledged the project's contribution to nurturing relationships across city agencies and researchers, some also noted that newly established relationships were not always sustained after the project ended, particularly when there were no shared follow-up goals or institutional mechanisms through which to continue collaboration.

3.1.3. Inclusiveness

Participants relate the inclusiveness of the process to the integration of otherwise siloed insights from different city agencies, preventing design errors and increasing the validity of the final tool. For example, at the early stages of selecting flood hazard data, members of MOCEJ cautioned against combining two flood hazard layers without modelling their interactions, which would falsely imply compound flooding. Similarly, the participation of city agency staff involved in developing the city's first pluvial flood hazard maps informed the decision not to develop a pluvial-flooding version of the NYC FVI. This decision was motivated by the fact that the newly released pluvial flood hazard data by the DEP were under revision at the time (NYC Mayor's Office of Resiliency, 2021). Consequently, the team agreed to postpone the development of a pluvial NYC FVI to subsequent cycles as the data's uncertainty is reduced.

In addition to integrating specialized knowledge, participants point out that the inclusiveness of the process within NYC government offices enabled the integration of complementary missions and jurisdictions. For example, members of the NYC Parks expressed their interest in ensuring that the city's parks were properly represented, without falling into the common assumption that parks are floodable, pervious areas unworthy of prioritization.

Reflections on inclusiveness generated the most diverse responses regarding aspects for strengthening future iterations of the NYC FVI. Suggestions addressed both the composition of the co-production team and the conditions needed to sustain meaningful participation over time. For instance, the inclusion of diverse participants implied a need for additional time to establish a common understanding. This was most explicit during the process of jointly defining vulnerability at the early stages of the project. Participants' different epistemic traditions surfaced tensions between risk and vulnerability-oriented framings. The main difference between both fields is in the conceptual placement of exposure and hazard - while risk-based framings consider exposure to be external to vulnerability and dependent on specific hazard scenarios, vulnerability scholarship considers exposure as an inherent component to vulnerability (Cutter et al., 2009), irrespective of specific events that moderate hazard magnitudes (Sharma & Ravindranath, 2019). The flexibility of the process provided time to surface these differences, as well as the space to collectively agree to a definition of vulnerability that, while considering exposure as an intrinsic factor, accounted for different scenario-specific measurements of exposure.

Additional aspects identified by participants include the importance of clarifying the roles and responsibilities of advisory group members, developing mechanisms to address staff turnover, broadening the range of participating decision-makers and stakeholders, and exploring ways to involve community groups and non-profit organizations engaged in flood resilience efforts. These suggestions indicate that inclusiveness was not understood only as the number or diversity of participants involved, but also as the capacity of the process to sustain participation, maintain continuity, and incorporate forms of knowledge relevant to future uses of the NYC FVI.

3.2. Product

3.2.1. Decision-driven

City agency stakeholders co-leading the process reported that ensuring the tool's applicability was critical in order to avoid the product from going unused. The NYC FVI was scoped as a decision-driven climate service aiming to support the planning and design of climate adaptation interventions. Consequently, ensuring the tool's interpretability and usability acted as a guardrail against over-engineering by pursuing methods or data insights that, while interesting, would not have been immediately relevant. By over-engineering, we refer to the introduction of methodological complexity that may be technically defensible but reduces the transparency, interpretability, or practical usability of a climate service for its intended decision context. Leading the co-production process through a decision-driven lens shaped how the team negotiated trade-offs between technical complexity and usability.

Potential trade-offs related to the simplification of complex, dynamic interactions between flooding and vulnerability were continuously discussed throughout the process, supported by the flexibility designed into the whole process. For example, vulnerability indicators were considered appropriate only when perceived to have a clear and traceable relationship with potential socioeconomic outcomes under the flooding scenarios considered. Similarly, the decision to aggregate indicators using a geometric average resulted from discussions in which participants prioritized interpretability and comparability across NYC FVI iterations over more complex methods, such as Principal Components Analysis, that would have reduced the transparency of the final product. There were cases in which decision relevance did not imply methodological simplification. For instance, after testing alternative spatial resolutions, participants agreed to use tax lots (the finest resolution possible) as the unit of analysis for exposure because this level of spatial detail was considered necessary for the NYC FVI to be usable in NYC's dense and spatially complex urban setting. For details on the comparisons of different exposure methods and the justification for specific indicators selected, see the project report (McPhearson, Towers, et al., 2024).

3.2.2. Timely

The team explicitly scoped the development and release of the NYC FVI on a schedule that allowed the tool to be included in the NPCC's 4th assessment report (Rosenzweig et al., 2024), on which NYC agencies rely to inform climate resilience planning and implementation. Participants indicated that aligning the release of the NYC FVI with the NPCC reporting time-frames provided visibility among the broader ICAT and the city's offices, enabling the NYC FVI's integration into planning and policy-making workflows.

Among the limitations of the NYC FVI, short-term flood risk mapping based on weather forecasts may be a key aspect for potential improvement. In its current format, the NYC FVI provides a series of static flood exposure scenarios based on climate projections. However, emergency preparedness requires the incorporation of high temporal and spatial resolution data in order to anticipate risks related to incoming extreme events. Future iterations may explore integrating the NYC FVI with real-time anticipated exposures, increasing the tool's cadence and applicability.

3.2.3. Process-based

As summarized in the previous sections, the NYC FVI was developed through an iterative, collaborative process. In addition, the development of the tool is part of a long-term, ongoing process to manage climate risks in NYC in several specific ways. It responds directly to needs identified during previous collaborations between researchers and policy makers, and is being used in several efforts to advance flood resilience. Here, we focus on additional aspects raised by participants that define the NYC FVI as a living tool by outlining antecedents leading to the scoping of the NYC FVI, and post-release routines that keep the NYC FVI active.

In addition to the collaboration-relevant context addressed in *Section 3.1.2.*, specific outputs resulting from previous transdisciplinary interactions paved the way for the scoping of the NYC FVI. For instance, city agency participants identified the NPCC as an important antecedent process that helped create demand for the NYC FVI. Successive NPCC assessments had already framed climate adaptation through a risk management lens coupling hazard, exposure, and vulnerability (Ghosh et al., 2022; Yohe & Leichenko, 2010), while also increasingly foregrounding the environmental justice dimensions of climate impacts (S. Foster et al., 2019; S. R. Foster et al., 2024; Rosenzweig et al., 2024). The NYC FVI is therefore understood as building on an existing institutional trajectory. More directly, two governmental reports released in 2021

laid out the institutional demand for the NYC FVI. First, the NYC Stormwater Resiliency Plan scopes initiatives to "Build maps into interactive online platform showing citywide flood vulnerability from rain, coastal storms, and sea level rise", and "Establish criteria for tiering neighborhoods based on flood vulnerability and risk" (NYC Mayor's Office of Resiliency, 2021, p. 15). Second, post-Ida reports demanded the development of a Coastal Flood Vulnerability Index (Wolfe et al., 2021). The report referenced the HVI as a critical tool for resource allocation and called for a similar tool focused on flood risk management. Finally, participants pointed at informal exchanges within the CKE initiative in which the need for a flood vulnerability index was raised.

The process-based character of the NYC FVI also depends on post-release practices that keep the tool visible, accessible, and interpretable. Since its release, city staff involved in the development process have disseminated information about the NYC FVI and supported capacity-building for its use. The tool was made available for visualization through the city's Environmental Justice Mapping Tool, hosted by MOCEJ (NYC Mayor's Office of Climate & Environmental Justice, 2024a), through the data portal of the DOHMH (NYC Department of Health and Mental Hygiene, 2024a), and through the city's open data portal (NYC Mayor's Office of Climate & Environmental Justice, 2024c). The NYC FVI has also been featured for general dissemination purposes in a data story by the DOHMH (NYC Department of Health and Mental Hygiene, 2024b), and in the city's 2024 Open Data Report (NYC Office of Technology and Innovation, 2024). In addition, city agencies such as MOCEJ and researchers that co-led the development of the NYC FVI have sustained their interactions through on-demand presentations of the tool to specific working groups and offices as part of an effort to build awareness of the tool, discuss future updates, and address doubts regarding the tool's interpretation. For instance, the index was presented at "Adapting to Multiple and Cascading Climate Change Hazards and Risks", a workshop that convened practitioners from the public sector, academics, and civic organizations (McPhearson, Uriarte, et al., 2024).

The post-release activities reported, however, do not yet amount to a formal mechanism for monitoring and evaluating the NYC FVI and its development process. Participants noted the absence of established routines for collecting feedback on the NYC FVI's use, either within city agencies or from external users. As a result, the NYC FVI's continued use and interpretation currently depend on a combination of public data availability, agency dissemination, ongoing relationships among co-producers, and ad hoc opportunities to present or discuss the tool. We interpret this as a potential gap for sustaining the FVI as a living tool, particularly because continued relevance and future updates would benefit from mechanisms that track use, incorporate feedback, update data and methods, and document lessons learned.

4. Discussion

This study reflects on the perceived benefits and tradeoffs of using a co-production approach to develop New York City's first Flood Vulnerability Index. We rely on the principles proposed by Vincent et al. (2018) to provide a structured ex-post account of how the process and the final product benefitted from the approach taken.

Knowledge co-production has been extensively praised in the context of climate change adaptation, yet it remains unclear what type of evidence is needed to justify the commitment of funding, time, and resources implied in such an intensive approach (Olazabal et al., 2025). A key emerging argument in favor of transdisciplinary climate change adaptation points at the "relational turn" that re-imagines adaptation as a shared learning process that relies on cultivating and strengthening relationships among people and nature (Goodwin et al., 2025). In addition, recent scholarship calls for embracing transparency around tensions and trade-offs that emerge during knowledge co-production processes, as they are inherent to such approaches and only by reflecting on them can they be navigated in subsequent iterations (Englund et al., 2025). By framing this study as a co-reflection that brings together the experiences of the researchers and practitioners who co-produced the NYC FVI, we anchor this study to the facilitation of shared learning and maintaining feedback loops that strengthen the relationships nurtured throughout the process (Collins & Ison, 2009).

4.1. Transferable lessons & cross-cutting factors identified

The results of this co-reflection show that each of the principles interacts with each other substantially. For instance, the flexibility designed into the process was only made possible thanks to the collaborative setup of the project, whose frequent meeting cadence enabled timely exchanges and incorporations of feedback. Plus, the inclusion of multiple sectoral government offices in the process benefited from the flexibility designed into the project (e.g., setting clear decision windows for participants to provide input and feedback to specific aspects). The project's inclusiveness also required specific collaboration setups within the project, such as recurrent meetings and information flows capable of incorporating multiple inputs, and a clear distribution of roles within the multiple participating city agencies to ensure the project's steady progress (e.g., having MOCEJ as the project's main steward, with sign-off capacities).

The benefits and trade-offs of co-producing the NYC FVI may be contextualized through the principles of credibility, salience, and legitimacy, which anchor the production of usable, useful, and used knowledge (Cash et al., 2003; Crimmins et al., 2025). The results of the study's co-reflection show how participants in the NYC FVI's co-production perceive that the credibility of the NYC FVI benefited from the choices made collectively throughout the process (e.g., indicator selection, testing of alternative aggregation methods...). Participants viewed the initial literature review, the iterative methodological testing of alternatives, and the reporting of the process in a final report as supporting transparency. Participants also associated the tool's salience with its decision-driven scoping and the iterative inputs provided by intended institutional end-users. Finally, perceptions on the legitimacy of the NYC FVI rely on seeking the input from multiple government agencies through ICAT, facilitating a flexible process with space for deliberation and discussion, ensuring accessibility to both the tool and its documentation, and by this facilitated co-reflection paper that integrates the experiences and perceptions of its co-producers.

Tensions arose between the product's timeliness and the process' flexibility and inclusiveness. In order to align with the NPCC release, and to meet timelines required by stakeholders set to achieve the ultimate goal of providing a usable climate service, deliberation time was constrained to the project's scope, generating trade-offs between the salience linked to a timely product and the legitimacy and credibility of expanded deliberation. These observed interactions illustrate the critical need of accounting for the trade-offs that emerge across the six co-production principles and balancing them within the team and project's capabilities.

It is important to note, however, that credibility, salience, and legitimacy are based on the subjective perception of different potential users, and may vary across city agencies and non-governmental actors. Assessing perceptions on the tool beyond the co-producers that engaged with the NYC FVI development stems beyond this study's scope, but should be considered in future climate services evaluations (Vincent et al., 2018).

The results of this co-reflection illustrate how co-production does not happen in a vacuum. In NYC, upstream collaboration processes (e.g., the nurturing of a science-policy interface through NPCC, ICAT, and other cross sectoral forums) are key enablers of the trust and knowledge dissemination channels needed for the viability of the NYC FVI as a co-production effort. In addition to collaboration aspects, previous specific project outputs, reports, and decisions had explicitly called for a flood vulnerability index. Project antecedents and post-release routines

illustrate how the NYC FVI sits in an ongoing cycle of knowledge transfer and retention across agencies and within the science-policy interface. This context, specific to NYC, should be considered by agents seeking to replicate the co-production of climate services for climate adaptation planning. Cases with missing or under-developed institutional support, trusted boundary actors, data infrastructure, staff capacity, or shared problem definitions, may struggle to sustain co-production cycles. In these cases, initial steps may focus on setting up cross-agency and science-policy relationships. Such contexts may be nurtured through other forms of co-production than those used in the NYC FVI (Chambers et al., 2021).

Finally, the reflections elicited in this study connect to ongoing scientific discourses calling for co-production to be framed as a recurrent cycle rather than as a linear, single project with a limited lifespan (Kirchhoff et al., 2013; New et al., 2022). When co-production remains limited to a single project-based application (and its budgeted commitments), the organicity and flexibility required for collaborative knowledge generation is reduced (Chilvers & Kearnes, 2016; Harvey et al., 2017). These aspects also illustrate the fundamental shifts identified as necessary in the conception and operationalization of partnerships to achieve effective and equitable adaptation (Bhanye, 2025). Relationships and trust need to be built and maintained beyond the life-span and budgets of single projects (Albert-Fonseca et al., 2025; Howarth et al., 2022), and token consultation needs to shift towards shared powers in decision-making (Galende-Sánchez & Sorman, 2021). Formal and informal spaces for knowledge exchange (e.g., communities of practice, interagency coordination groups, citizen-inclusive forums), arise as crucial sources for supporting relationships and sharing knowledge beyond specific projects and identifying policy-relevant knowledge gaps (Bridges et al., 2024; Cornell et al., 2013; Cvitanovic et al., 2015; Muccione et al., 2019; Temby et al., 2017).

4.2. Future risk knowledge co-production iterations: pathways for improvement and evolution

The stewardship gap identified in the co-reflection points to the importance of incorporating monitoring, evaluation, and learning (MEL) practices into future NYC FVI co-production cycles. Furthermore, participants noted that they would have liked to engage in explicit co-reflection earlier after the project's completion. While the additional costs in time, resources, and engagement must be recognized, designing MEL tasks during and after the completion of the process would open explicit avenues for feedback-driven updates and improvements (Visman et al., 2022). Given that success criteria vary across stakeholders and through time, incorporating MEL practices would further support knowledge exchanges that improve collaboration, social learning, and an examination of how different actors perceive the credibility, salience, and legitimacy of co-produced climate services (Boon et al., 2025; Boon & Biesbroek, 2025).

Improvement points related to inclusiveness identified in the co-reflection highlight that broadening participation in future NYC FVI cycles is not only a matter of inviting additional actors, but also of designing the conditions through which diverse participants can remain engaged and meaningfully shape the process. The range of suggestions captures the multiple angles of what inclusiveness entails in practice. First, practical points related to staff mid-process turnover and the need for laying out clear, specific responsibilities for the advisory group illustrate how inclusiveness is dependent on collaboration design (Hegger et al., 2012). The impact of staff turnover can be especially harmful to collaboration setups when it applies to boundary actors, defined as agents that operate within climate science-policy networks (Howarth et al., 2022). In cases where these stakeholders sustain the interactions between specific organizations, their departure can leave a gap that slows down coordination or even resets trust and relationships. Future collaboration setups may include continuity tools (e.g., defining replacement actors, developing onboarding documentation).

Second, broadening the diversity of participating decision-makers and stakeholders relates to the need to critically reflect on the diversity of the knowledge represented throughout a co-production cycle. Knowledge diversity requires conciliating diverse problematizations (i.e. for different stakeholders, flooding in NYC may be linked to different impacts or causes). Recent exercises using systems-based approaches to integrate diverse perspectives have shown promising results in the context of climate adaptation (Olazabal et al., 2018; Tepes & Neumann, 2020). These methods enable reflections on the different ways in which the system is perceived, supporting the identification of knowledge gaps, biases, and recurrent narratives that are poised to steer co-production in specific directions (e.g., by prioritizing indicators related to specific themes) (Herreros-Cantis et al., 2025; Schwermer et al., 2021). Future co-production cycles, thus, would benefit from assessing knowledge diversity from an early stage to identify potential knowledge gaps calling for the addition of participants with expertise in specific sectors.

Third, suggestions to involve local communities in future co-production cycles raise important considerations on the type of knowledge systems that are invited to participate in climate services development for climate adaptation planning (Feagan et al., 2019; Herreros-Cantis et al., 2024). The NYC FVI was scoped as a tool to help city officials prioritize and design climate adaptation interventions. Consequently, the process deliberately engaged with the intended end-users within the city government in order to incorporate their formal and informal (i.e., experiential, uncoded knowledge) professional expertise. While the funding scheme of the project enabled a collaborative, transdisciplinary approach to developing a climate service aligned with city agency decision contexts, the recruitment of participants focused on institutional actors responsible for applying the tool within adaptation planning and implementation processes.

While perceived as highly valuable, the co-production process presented does not seek to replace the experiential knowledge of communities affected by flooding. Residents, grassroots organizations, and community-based groups hold knowledge about lived exposure, social vulnerability, coping capacity, infrastructure performance, and the everyday consequences of flood events that cannot be inferred from agency participation alone (Kotsila et al., 2026). Follow-up ongoing research in NYC is building on the development of the NYC FVI by integrating community expertise into a validation of vulnerability indicators through focus group discussions and household surveys in several NYC neighborhoods. The results of this research are expected to inform how the city navigates climate adaptation planning, and they may thus enrich the way in which the NYC FVI is constructed (e.g. the selection of indicators in future iterations of the NYC FVI) as well as how and for what it may be used in order to support equitable adaptation decisions. The tensions identified point towards a need for experimenting with novel funding schemes that tackle potential equity and inclusion challenges inherent to the funding of co-production (Arnott et al., 2020).

Broadening participation to include community groups and non-profit organizations that support flood resilience efforts is critical to enrich the understanding of vulnerability to flooding, and the applicability of the NYC FVI for both agencies and communities. Ultimately, co-production serves best when conceptualized as a multi-stage, iterative practice capable of delivering focused outputs while critically engaging with guiding principles (Vincent et al., 2018) to enable continuous learning and adjustment.

4.3. Early signs of uptake: implications of the NYC FVI in local climate adaptation planning

Although it is too early to assess the downstream policy impacts of the NYC FVI, the use cases reported by city agency stakeholders suggest that the tool has begun to circulate beyond its initial release as a technical report or dataset. This is relevant given persistent concerns that spatial risk and vulnerability assessments often remain underused in

local adaptation planning, despite their potential to inform more targeted and equitable interventions (Anderson & Logan, 2026). In this sense, the NYC FVI provides an example of a co-produced climate service showing early signs of circulation across policy, research, and civic contexts.

MOCEJ and collaborators relied on the NYC FVI to identify neighborhoods in the Climate Strong Communities Program, an engagement initiative to implement equitable resiliency projects by focusing on NYC's disproportionately affected areas (NYC Mayor's Office of Climate & Environmental Justice, 2024b, 2025). In addition, the NYC FVI's FSHRI was included in the flood risk report of the NPCC's 4th assessment both to highlight key vulnerable areas and to develop recommendations for future research efforts (Rosenzweig et al., 2024). In future processes, the NYC FVI is also expected to support coastal resilience planning processes. In addition to city officials, the NYC FVI has supported follow-up research projects and advocacy organizations. For example, preliminary results were discussed and provided to researchers leading FloodNet, a collaborative initiative to deploy real-time flood sensors throughout the city (McPhearson, Towers, et al., 2024; Silverman et al., 2022). FloodNet has used the NYC FVI to inform the prioritization of flood sensor installations (in combination with location requests from city agencies and community members). In addition, the civic organization Guardians of Flushing Bay relied on the NYC FVI to appeal against the Queens Future project, a large-scale development project planned on public parkland, during the project's Environmental Quality Review (VHB, Inc., 2025). As a result of this experience, participants affiliated with the city agency NYC Parks reported its usability for documenting the vulnerability to flooding that parks and surrounding communities experience.

These early use pathways suggest that the NYC FVI has not remained a static or isolated technical output. Instead, its circulation across city programs, scientific assessment, research initiatives, and civic advocacy suggests that the tool has begun to circulate within existing decision and knowledge networks. However, these examples remain early signals of uptake rather than evidence of long-term policy impact, underscoring the need for future monitoring and evaluation of how the NYC FVI is used, interpreted, and updated over time.

5. Conclusions

Climate services and knowledge co-production approaches are emerging as promising pathways to link scientific knowledge with decision-makers. However, there is little evidence about the ways in which co-production shapes the development of risk-focused knowledge. In this study, we bridged co-production theory and evaluation practices to assess the benefits and trade-offs emerging from taking a co-production approach to developing the New York City Flood Vulnerability Index.

Through a structured, ex-post co-reflection, we assessed how participating co-producers perceived the ways in which co-production shaped the process, the resulting tool, and the trade-offs and improvement needs that emerged during its development.

The presented co-reflection suggests that participants consider that the NYC FVI's salience, credibility, and legitimacy benefitted from the process and product principles that guide co-production cycles. Participants linked credibility to the collective testing and documentation of methodological choices, salience to the tool's decision-driven scoping and alignment with city agency needs, and institutional legitimacy to interagency participation, deliberation across methodological decision points, and public access to the tool and its documentation.

At the same time, the study highlights trade-offs that should inform future co-production cycles. Flexibility supported methodological adjustment and alignment with user needs, but also required time and had to be balanced against project timeliness. Inclusiveness benefited from interagency participation, but remained bounded by the focus on supporting government-level decisions. Timeliness helped align the NYC FVI with relevant planning and assessment windows, but limited the extent of deliberation and testing possible within the project scope. These trade-offs indicate that co-production principles interact in practice, and must be actively balanced according to project goals, capacities, and institutional conditions. Future co-production cycles looking to inform climate adaptation planning through climate services should account for the trade-offs implied between co-production principles and their impact on the credibility, salience, and legitimacy of the information produced.

While this study relied on the NYC FVI as a place-specific case study, the co-production process and the co-reflection methods presented are relevant for researchers and planners looking to inform adaptation planning through the development of climate services. Actors seeking to embrace co-production across the science-policy arena should account for the role of enabling circumstances such as long-term collaboration and exchange spaces beyond project life-cycles. In order to catalyze long-term collaboration and learning, future co-production cycles in NYC and elsewhere would benefit from explicitly incorporating monitoring, evaluation, and learning to support feedback-driven refinement of the process and its products. These practices can strengthen collaboration across future iterations and help assess how different users perceive and apply co-produced climate services over time.

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Supplementary materials

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Data availability

Data will be made available on request.

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