Co-Creating a Regional Sustainability Hub: Conversational AI, Community Engagement, and Local Data for Computing in Place

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Abstract

The Sustainability Hub is a community-driven digital infrastructure project that connects policymakers, researchers, and community members across Colorado through a shared platform for sustainability and well-being data. Grounded in a place-based computing approach, the Hub integrates conversational AI, open-source tools, and community asset mapping to support regional decision-making and resilience. This paper presents early-stage development and future directions. We introduce Bili, a natural language assistant that lowers technical barriers to data access and BiliCore, a framework for evaluating large language models in sustainability contexts. Another key component is the implementation of survey-informed Communities of Interest to support collaboration and engagement. We describe our co-design methodology, beta testing strategy, and participatory outreach efforts, offering a real-world case of computing in place that bridges technical innovation with social infrastructure.

CCS Concepts

• **Computing methodologies** → **Machine learning**; *Natural language processing*; • **Human-centered computing** → **Human computer interaction (HCI)**; • **Applied computing** → **Computing in government**; • **Information systems** → **Geographic information systems**; *Open source software.*

Keywords

sustainability, computing in place, community engagement, participatory design, conversational AI, large language models, retrieval-augmented generation, human-computer interaction, natural language processing, geographic information systems

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1 Introduction

As computing technologies become more embedded in social, environmental, and political contexts, sustainability research must consider how digital systems are governed and aligned with community needs. These questions are especially urgent as machine learning, data platforms, and automation are rapidly integrated into public-sector decision-making and environmental monitoring. Emerging work across geospatial AI, sustainability science, and citizen engagement has underscored the importance of designing computing systems that are attuned to place, enabling context-aware decision-making and grounded collaboration [18, 21, 26].

This late breaking work presents the early stage development of the Sustainability Hub, a regional digital infrastructure initiative in

Colorado. Our goal is to create a platform that bridges fragmented sustainability and well-being data while making information more accessible and actionable for three core groups: community members, researchers, and policymakers. Unlike tools that prioritize abstract modeling or generic policy indicators, the Hub is explicitly place-based and community-informed. It supports the discovery and use of data by those facing sustainability challenges.

The Sustainability Hub emerged from the convergence of local needs, technological advances, and institutional collaboration. In Colorado, rapid development and climate variability have exposed the limits of traditional data systems, particularly for rural communities and under-resourced municipalities. Advances in open-source tools, geospatial infrastructure, and natural language processing now offer opportunities to design more accessible, community-centered platforms.

In response, we are designing a modular system to address three challenges: fragmented local data, technical barriers to interpretation, and the lack of inclusive civic tools. Key components include Bili, a natural language interface for querying sustainability data, BiliCore [29], an evaluation framework for sustainability-focused LLMs, and Communities of Interest, which enables users to organize around place-or issue-based concerns.

2 Background and Motivation

Colorado is undergoing transformation driven by environmental, social, and technological pressures. Urbanization, climate variability, water scarcity, and demographic shifts have heightened the need for tools that support regionally grounded sustainability planning. Yet efforts to address these challenges remain fragmented across disconnected datasets, disciplinary silos, and uneven technological capacity. Studies show that civic data platforms often struggle with equitable access, particularly in rural or under-served areas [7, 27].

The Sustainability Hub responds by offering a unifying digital infrastructure grounded in community participation and AI-enhanced data accessibility. Drawing from geospatial AI and open data platform research [18, 21, 28], we emphasize that sustainability is inherently local and that data infrastructures must reflect regional context.

The Hub explores Large Language Models (LLMs), Retrieval-Augmented Generation (RAG), and geospatial indexing as methods for data democratization. This work draws from Human-Computer Interaction (HCI) and computing for sustainability, particularly approaches that examine the social and political dimensions of data systems. Scholars have shown that platforms are not neutral; they encode assumptions about what counts as knowledge, who gets to produce it, and how it is used [30, 34]. Technologies must be evaluated for both their function and the values and hierarchies they reinforce. As sustainability experts argue, digital systems must account for their material and environmental footprints, not just the outcomes they support [24]. In the context of AI and sustainability, systems that privilege institutional data or obscure provenance can unintentionally reproduce power imbalances and limit local relevance [27].

To resist this trend, we draw on "interface justice" and participatory design. Our co-design strategies, rooted in citizen science and public engagement literature [11, 13, 20], aim to position stakeholders as active co-authors of the platform. Rather than treating stakeholders as end-users, we build on participatory science models [11] that emphasize iterative co-creation and long-term stewardship.

This ethos informs key design principles:

- **Universal Usability**: Interfaces for non-experts, including mobile-first layouts and multilingual support.
- **Contextual Insight**: Metadata, provenance, and explanation to support interpretation.
- **Participatory Authorship**: Community-driven submission, annotation, and curation of datasets.

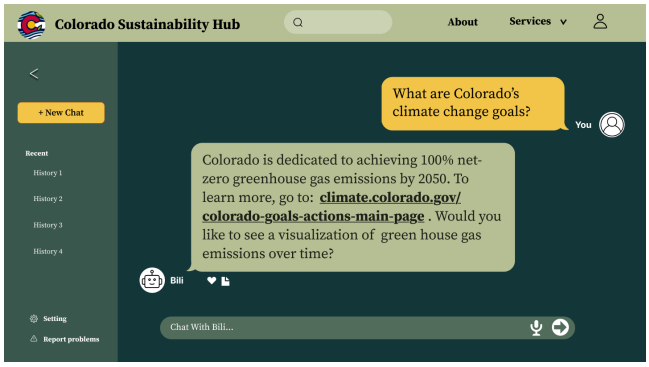

Figure 1: Bili chatbot prototype showing text-based responses to sustainability-related user queries

In parallel with community outreach, we are building technical infrastructure to support AI-powered research. This includes the Bili conversational agent and BiliCore [9], an open framework for evaluating LLMs in sustainability tasks using cloud and local models [31, 33, 35]. As shown in Figure 1, our goal is not just accuracy, but usability, transparency, and trust. Following critiques of civic AI governance and critical HCI [2, 31], we view LLMs not as autonomous decision-makers but as scaffolds for traceable, contextual inquiry. By embedding these tools within regional governance and geospatial data systems, the Hub operates at the intersection of civic needs and AI innovation, supporting sustainable futures that are co-created, accountable, and grounded in place.

3 Community Asset Mapping and Co-Design Process

In order to ensure that our planned in-person community engagement sessions are as meaningful and inclusive as possible, we began by cataloging organizations and communities across Colorado engaged with sustainability efforts across the three pillars of sustainability: Economic, Ecological, and Societal. This resulted in a catalog of more than 1,200 entities working in land and water management, environmental education, public health, and food systems. Data sources included CSU Extension consultation, public datasets, and community-science partnerships via CitSci.org.

An asset map, shown in Figure 2, was created to build a relational view of Colorado's sustainability infrastructure. Organizations were tagged by domain, geography, affiliation (e.g., tribal, municipal,

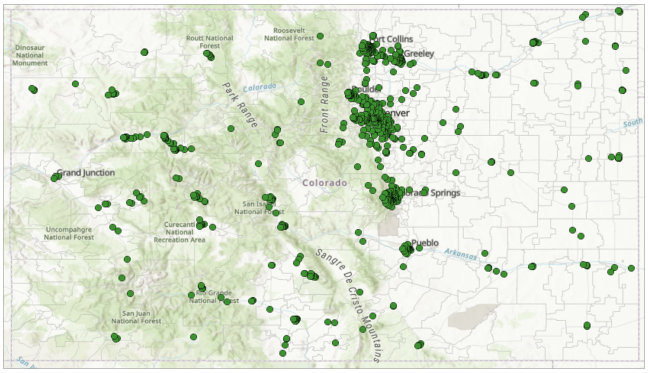

Figure 2: Community asset locations across Colorado from the initial mapping phase

nonprofit), and data holdings. The process revealed interoperability gaps, especially in rural areas, and highlighted clusters-such as watershed coalitions and air quality networks-that would benefit from better data-sharing tools.

To understand how these groups engage with data, we piloted a statewide survey with questions on data types, tools (e.g., ArcGIS, spreadsheets), staffing, sharing challenges, and infrastructure needs. We also explored attitudes toward AI and natural language interfaces to guide Bili's development. Distributed through regional partners, email campaigns, and planning meetings, the survey received over 130 responses. Preliminary findings include:

- Most organizations collect data, but lack the capacity to analyze it meaningfully.
- The demand for simplified discovery tools is high, especially with spatial filtering.
- Participants value tagging, curation, and storytelling, highlighting metadata and narrative framing.
- There is cautious optimism toward AI, contingent on transparency and user control.

These findings confirm the need for low-barrier interfaces, participatory workflows, and shared infrastructure to connect siloed efforts, consistent with observed patterns in participatory science research [11, 16, 23]. They are directly informing the Hub's beta prototype, guiding features like regional filters, data views, and early Communities of Interest.

To keep the Hub grounded in user needs, we are adopting a phased co-design process. In Summer 2025 we will employ field technicians to conduct in-person interviews and canvassing sessions to gather community feedback. In fall 2025, we will host listening sessions and co-design workshops with a cross-section of organizations identified in the asset mapping, those who participated in the survey, and community members with whom we connected in summer. These sessions will span urban, rural, and frontier contexts.

Participants will include representatives of governments, nonprofits, academic institutions, tribal groups, and local residents. In partnership with CSU Extension, sessions will use accessible language, hands-on exploration, and collaborative critique to:

- Identify regional priorities and data gaps.
- Evaluate Bili and CoI usability.
- Surface trust and representation concerns.
- Invite contributions of locally relevant data.

Workshops will be documented through field notes, consented recordings, and participatory rubrics. Feedback will be synthesized and used to refine the design. Drawing on participatory design practices [11, 13, 20], this process treats iteration not as user testing, but as civic capacity-building, strengthening relationships, data confidence, and local voice.

This phase extends our survey work into sustained partnerships. It will allow us to engage directly with organizations, build trust, and gather critical feedback to inform user interface design, data presentation and visualization approaches, and the overall structure of the platform. This reinforces our commitment to principles of HCI and community-driven design, ensuring that future iterations of the Hub are shaped by the real-world goals, constraints, and interpretive needs of those it is meant to serve.

4 Bili and BiliCore: A HCI-Informed Conversational AI Framework

A central feature of the Sustainability Hub is Bili, a conversational AI assistant designed to reduce technical barriers to accessing complex sustainability data. It connects users, ranging from rural planners to researchers, with structured and unstructured data through natural language.

Bili is grounded in Sustainable HCI, Participatory Design, and Critical HCI principles, which examine the social, epistemic, and environmental dimensions of digital systems [1, 8, 22]. Our approach, rooted in citizen science and civic informatics [13, 20], recognizes the need for participatory infrastructure attentive to power, representation, and inclusion.

We launched early interface prototyping and public-facing development through two HCI courses at the University of Denver. Student designs, shown in Figure 1 and Figure 3, were grounded in HCI best practices and inform wireframes and use cases for co-design workshops. A public website shares updates, user stories, and will phase in access to Bili and the Communities of Interest platform in 2025.

We are critically attentive to how language models may reproduce institutional biases or exclude underrepresented sources. Many community organizations hold valuable sustainability knowledge that lacks public infrastructure. The Hub will support direct data contributions, source transparency, contributor attribution, and signaling of uncertainty or disagreement, enabling diverse knowledge formats in an inclusive environment.

Bili combines custom retrieval pipelines with LLMs from AWS Bedrock, OpenAI, Google Cloud Platform, and locally hosted models. It is embedded in the Hub's full-stack MERN web application, MongoDB [25], Express.js [4], React [32], Node.js [10], with PostGIS [3] supporting geospatial data and APIs enabling querying, visualization, and summarization. Role-based views accommodate different user needs.

Bili translates plain-language queries into interpretable outputs, combining summaries, citations, and dynamic maps. For example, a user might ask, "What are the top drought resilience initiatives in

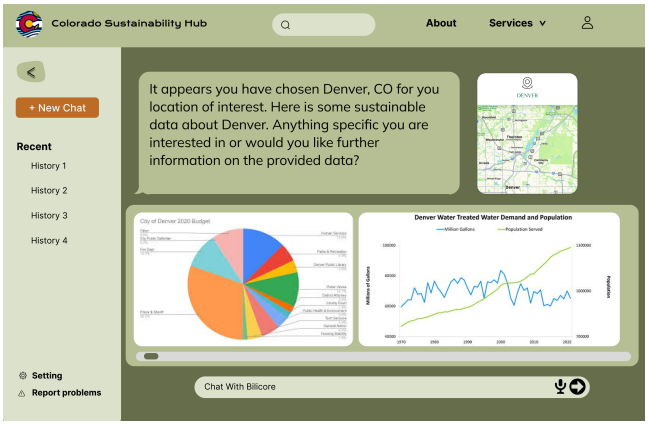

Figure 3: Bili chatbot prototype interface with textual summarization and geospatial visualization of sustainability data in response to user query.

western Colorado?" and receive (1) a summary, (2) linked sources, and (3) geospatial data visualizations.

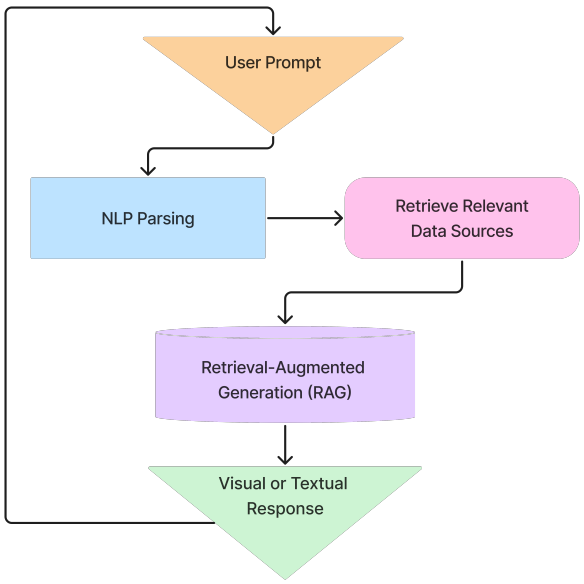

Figure 4: Architecture diagram of Bili + BiliCore stack with user flow

Designing this interface involves trade-offs between precision, transparency, and accessibility. Figure 4 shows how we apply best practices in civic LLM design [12, 14, 26] through:

- **Interactive Query Interface**: Threaded conversations with memory support for sustainability topics
- **Document-Aware Responses**: LangGraph and LangChain agents ground outputs in local reports and geospatial datasets
- **Visual Summarization**: Maps, graphs, and timelines contextualize retrieved results
- **Editable History and Feedback**: Users view, edit, and rate responses; feedback informs improvement

To evaluate and guide these systems, we developed BiliCore [29], an open-source framework for testing LLMs in sustainability contexts. Generic benchmarks often miss the complexity of sustainability queries, which require geospatial reasoning, provenance tracking, and synthesis across formats [15, 33, 35]. Built with LangChain [5], LangGraph [6], and Streamlit [19], BiliCore supports:

- **Cross-Model Evaluation**: Compare GPT-4, Gemini, Nova, LLaMA, and others for consistency and relevance
- **Custom RAG Pipelines**: Dynamically configure document stores (e.g., FAISS, OpenSearch), retrievers, and prompts
- **Interactive Testing**: Preserve and re-run conversations to assess reproducibility and robustness
- **Configurable Parameters**: Tune behaviors across task types and model switches

We plan to use BiliCore to stress-test prompts, explore failure modes, and analyze behavior on questions from community partners such as hallucination rates and spatial reasoning accuracy. The framework is publicly available on GitHub[1], and we are developing support for community-submitted prompts and shared benchmarks.

BiliCore also informs ethical and technical design decisions in Bili[2, 17], including prompt engineering, fallback logic, and interface strategy (e.g., disambiguating counties from municipalities). In doing so, it contributes to civic AI governance and HCI-aligned evaluation practices [24, 27, 31, 34].

5 Future Work

In summer 2025, we will launch a public beta of the Sustainability Hub, transitioning from prototyping to real-world testing. This phase will assess how diverse users engage with sustainability data in place-based, socially meaningful contexts, with a focus on civic and collaborative use.

A central feature of the beta is the introduction of Communities of Interest (CoIs), user-formed groups organized around specific topics, locations, or data sets. CoIs serve as social and epistemic infrastructure, enabling users to explore data through shared concerns and lived experience (e.g., fire recovery in Boulder County or water equity in the Arkansas River basin). Each CoI space will support:

- **User Profiles and Affiliation Tags**: Members identify roles (e.g., nonprofit staff, policymaker) and affiliations for context
- **Story-Based Data Exploration**: Users curate "storylines" linking datasets and annotations to local issues
- **Collaborative Annotation**: Community members flag issues, suggest metadata, and contextualize datasets
- **Discussion and Resource Sharing**: Threaded comments and shared bookmarks support sustained dialogue

This model builds on participatory infrastructure literature [16, 23, 34] and survey results indicating that many organizations are active stewards, not passive consumers, of local knowledge. CoIs

[1] https://github.com/msu-denver/bili-core

reflect a core principle: data becomes actionable when embedded in relational, community-based contexts. Through annotation, remixing, and shared curation, the Hub supports inquiry that foregrounds infrastructure, power, and access.

We will evaluate CoIs using a mix of analysis, interviews, and participatory methods. Rather than a fixed feature, CoIs function as a design hypothesis: structured data spaces can scaffold collaboration, trust, and civic learning.

Human-in-the-loop evaluation will also advance through BiliCore. Planned features include:

- Latency tracking, token usage visualization, and prompt–response ratio tools
- A user rating interface for assessing relevance, completeness, accuracy, and tone
- Role-specific rubrics for policymakers, researchers, and community members
- Task-type adaptations for summarization, explanation, and comparison

This builds on recent work in inclusive, domain-specific LLM evaluation [2, 24] and will be piloted during co-design workshops.

To grow our user and contributor base, we will pursue the following outreach strategies:

- **Webinars and Demos**: Co-hosted with regional partners to present features and gather early feedback
- **Conferences and Publications**: Engagement at AGU, Esri UC, CHI, AAAI, SIGSPATIAL, and similar venues
- **Community Documentation**: Support for tutorials, guides, and data stories grounded in regional use
- **Contributor Training**: Asynchronous onboarding, office hours, and technical support for collaborators

These activities aim to foster not only adoption, but a contributor ecosystem where local organizations, practitioners, and residents shape and evolve the platform. As a living infrastructure, the Hub will adapt alongside community needs, technical progress, and participatory governance to support inclusive, actionable, and grounded sustainability systems.

6 Conclusion

The Sustainability Hub presents a grounded, multi-layered approach to regional AI infrastructure. Unlike generic civic dashboards or standalone tools, it is designed around Colorado's distinct geographic, institutional, and social contexts. By integrating local data systems, participatory design, and open-source AI, the Hub becomes a flexible system that evolves alongside regional challenges and civic priorities.

This work addresses several key design questions relevant to sustainability and public-sector computing:

- **Whose data is visible?** Smaller municipalities, conservation groups, and nonprofits often maintain valuable datasets disconnected from broader systems. The Hub supports participatory authorship and collaborative curation to elevate these perspectives.
- **How are systems shaped by place?** Regional divides, environmental concerns, and local policies influence data selection, interface behavior, and conversational framing.
- **Can LLMs support civic reasoning?** Bili and BiliCore are designed to explore this question, emphasizing grounding in real data, transparent sourcing, and human-in-the-loop feedback.

The Hub functions as a hybrid infrastructure: part data commons, part AI sandbox, part community platform. Natural language interfaces lower barriers while preserving local context and agency. LLMs are not framed as decision-makers, but as tools for situated inquiry and collaborative exploration.

Our HCI-informed, community-led design process remains central to this vision. Through completed cataloging and survey efforts, as well as upcoming canvassing sessions and co-design workshops, we aim to build a system aligned with real-world goals, constraints, and interpretive needs.

Looking ahead, we see the Hub as a living infrastructure. It is an adaptable, open-source model for civic technology that is regionally responsive and broadly extensible. With a public beta scheduled for summer 2025, we welcome collaboration to advance place-aware, participatory approaches to sustainability computing.

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