Mind the gaps! Climate scientists should heed lessons in collaborative storytelling from William Shakespeare

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Abstract
To co-produce locally relevant climate knowledge, climate scientists are engaging in new collaborations—with stakeholders and with scholars in the humanities, arts, and social sciences. In our work as a Shakespeare scholar-turned-public-humanist and a climate scientist, we have created a methodology that allows researchers and communities to co-produce knowledge by co-producing narratives. We combine principles from emerging climate “storylines” research with collaborative storytelling inspired by William Shakespeare’s plays and theatrical practices. Shakespeare’s plays spark collaborations and interpretations, in part, because of how Shakespeare leaves gaps in the narrative. These gaps allow others to enter as collaborators, creating a “cognitive ecology” that fosters knowledge and action among all engaged. Integrating these methods into climate storyline-making offers a radical paradigm: it upends the scientist’s role as the focal storyteller and expert, and fosters, instead, partnership, equity, and a co-exploration of multiple uncertainties. It is time for researchers to cede control to a cognitive ecology of collaborative action.

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- cognitive ecology, co-production, storytelling, Shakespeare, storylines

1 | INTRODUCTION

In a recently published IPCC report, Working Group I emphasizes the need to co-produce knowledge with stakeholders (Doblas-Reyes et al., 2021). To be relevant and actionable, climate information must be attentive to lived values, local contexts, and diverse ways of knowing. Including these ideas in WG1’s report marks a paradigm shift. It aligns with the groundswell of research calling for increased stakeholder engagement as well as deeper collaboration with scholars in the humanities, arts, and social sciences (Castree, 2017; Norström et al., 2020; Robin, 2018; Rodrigues & Shepherd, 2022).

These emerging collaborations often incorporate storytelling to engage stakeholders in processes that reimagine the quantitative output of climate projections as lived experience.

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Transdisciplinary teams are developing a narrative approach—called storylines—to engage civic decision-makers in climate planning. With storylines, researchers relate multiple, plausible climate futures (including those with low likelihood) to recognizable, high-impact events that stakeholders may have experienced or heard about (Hazeleger et al., 2015; Shepherd et al., 2018).

In our collaboration as a Shakespeare professor-turned-public-humanist and a regional climate modeler/IPCC Lead Author (for AR5 and AR6), we have created a methodology for co-producing knowledge with stakeholders by co-producing narratives. We incorporate principles of storylines from climate research with those of collaborative storytelling: from the humanities—in our case inspired by William Shakespeare and early modern theatrical practices. What Shakespeare and other storytellers know is that narratives that invite partnership have something rather counter-intuitive: they have gaps—spaces left unspecified into which others can insert their own local experiences, needs, values, and creativity (Abbott, 2015; Bernaerts et al., 2013; Popova, 2015). These spaces allow others to connect with a story and make it their own. In *Romeo and Juliet*, for example, Shakespeare leaves unspecified the reason the families are feuding—allowing each reader and each production to place the conflict within current contexts, such as the racial tensions of *West Side Story*. What is more, the working conditions of Shakespeare’s repertory theater offer a paradigm useful for producing knowledge collaboratively—that of a “cognitive ecology” (Tribble, 2005; Tribble & Sutton, 2011). In a cognitive ecology, cognition is not individualistic but rather distributed across individuals with diverse expertise who, in turn, use different artifacts (maps, datasets, promptbooks) and interact within an environment (Hutchins, 1995). Shakespeare’s company maintained an intense production schedule that required distributing cognition across experts, allowing them to memorize a staggering number of lines, cue each other, and coordinate staging collectively. There was no centralizing director, and each actor received only his “part” (his lines and simple cues). Each player thus had only a piece of the story and relied on others’ contributions, promptbooks, and documents called “plots” to create the production.

We began our collaboration wondering how climate scientists might take lessons in co-created storytelling from Shakespeare’s narrative gaps and his theater’s cognitive ecology. In turn, we bolstered our methods for creating this collaborative cognitive environment by drawing on principles from other disciplines, especially participatory computer simulation modeling from the sciences and participatory action research (PAR) and social capital building from the social sciences. In this Perspective, we describe our process; include some outcomes from our work with community groups and university students; and, finally, share what challenges arise for researchers when they are no longer the lead storytellers.

Through this work, gaps emerge as spaces that truly must be minded. They require attention and caution. They upend the scientist’s role as the one in charge of the narrative and the one credited for producing it, which brings new challenges in how we approach and give credit for research. Even more radically, gaps can be “places of brittleness” that reveal the blind spots in research, offering places both that need strengthening by layering diverse knowledges (Hulme, 2018) and that invite interrogating researchers’ underlying assumptions and the uncertainty in their data. By minding these gaps, we leave creative space that can foster a cognitive ecology where communities and researchers co-produce actionable narratives as partners.

## 2 | BEGINNING WITH STAKEHOLDERS’ NARRATIVES

We begin our process with stakeholders sharing their narratives, which immediately establishes an atmosphere of distributed expertise. The community members recall an important memory or set of conditions that is important to their story—who they are, what they value, what projects they are considering. Beginning with their stories involves the bottom-up engagement practices of PAR, which emphasizes collective inquiry with community stakeholders and frequently involves storytelling (Goldstein et al., 2015; Kemmis et al., 2014). Beginning with community members’ stories is not just about circumventing the convention of researchers as the first and primary storytellers. It informs our view of our own position as fellow storytellers with community experts. We, like the early modern players, bring only parts of the story to a session. The storylines that will emerge are pieced together by the full group as a cognitive ecology of interdependent experts. This creates a nonhierarchical approach which, as Rodrigues and Shepherd (2022) have noted, allows the process of storyline creation to grapple, right at the outset, with local complexities.

Because climate change information is most focused on extreme events, we initially asked stakeholders to share their memories of extreme weather, thinking that these would be the largest drivers of their decision-making. Some stakeholders did describe the high-impact events typical in disaster-related climate storylines—flooding that made
national news or times when their lives, homes, or livelihoods were threatened. But just as often, individuals shared situations that were smaller in intensity and scale. For example, in the summer of 2020, half of women farmland owners we worked with focused their first scenarios on recent dry conditions because their sessions occurred during a period of limited rain, though not severe drought. These drier spells had been happening several years in a row, oftentimes not making national news but becoming a local concern. Interest in dry periods made sense, but it was not the concern about flooding and damaging rains we had expected.

A neighborhood group in a different session realized that they had in common stories of species loss (particularly birds and fish). Before the session, they knew they wanted to conduct an environmental, specifically water-wise, project to mitigate the more frequent heavy rains their area was experiencing. They ended up devising and completing a project that not only addressed increasing weather extremes but also provided habitat for birds—a combination that further energized their collaboration with researchers, local watershed advisors, and each other. Their project became part of what has now been 2 years of continued climate and sustainability-wise projects. In keeping with this group’s shared stories of loss, we found that these narratives also mingle with positive memories that remind people of what they want to protect—family times at the lake, learning how to fish, a childhood spent playing in an unpolluted creek. With increasing academic attention to the role of positive visioning and supporting values in climate planning, these positive stories support climate action based on a larger range of values, as well as on the slower-onset changes that often have serious impacts and expose environmental injustices (Nixon, 2011; Tschakert et al., 2017).

Having stakeholders begin by sharing their stories also opens the door for discussions that emphasize how all involved are equals. This aspect is particularly important for inspiring action with stakeholders who have not felt empowered, but rather marginalized, such as the women landowners. These stakeholders have often experienced barriers in the farmer-centric, male-dominated world of agriculture, and thus, community partners in the Women, Food and Agriculture Network created programming just for them. For all marginalized populations, elevating their stories and contributions in the cognitive ecology not only ensures that their voices are heard but also emphasizes how each holds crucial knowledge. Early in the development of our methodology, for example, one group of under-represented youth, after their storytelling, shared that they were experts alongside their community partners. As they described it, “we are the social interactions experts because we know our community.” These middle schoolers went on to use their local knowledge to collaborate with community partners (all adults) as equals—a situation many of these community partners had never experienced (Shenk et al., 2019).

Starting by distributing the cognitive process among stakeholders and researchers supports equity and validates the importance of involving multiple ways of knowing (such as indigenous and place-based wisdoms) that too often have been silenced by Western research practices (Kimmerer, 2013; Whyte, 2020). This first stage of individual storytelling serves as the foundation on which researchers and stakeholders can begin to create narratives in partnership.

3 | FROM INDIVIDUAL STORIES TO SHARED STORYLINES

The leap from individual stories to shared storylines is the most complicated part of the process: it is at this stage where storytelling to each other becomes storytelling with each other. This step involves both narrative gaps to allow multiple knowledges to layer together and the larger paradigm of cognitive ecology, which acknowledges how tools and social exchange expand and shape cognition. At the center of this step is a cognitive tool—a computer simulation model we have created called “Community Environment” (CE). CE provides a framework for integrating and merging narrative pieces to evoke shared storylines (see Figure 1). In some ways, it functions like the “plot” document in Shakespeare’s theater that allowed actors to see how their scenes and staging fit into the performance trajectory.

CE is a simple, “conceptual model” built on agent-based modeling, wherein diverse “agents” interact and affect each other. Agent-based modeling, in fact, has been used to demonstrate the interplay of mind, body, and environment in cognitive ecology (Froese, 2018). CE’s agents are rain, people, important insects for ecological health, and action projects (visualized as native flowering plants). The interactions of these elements involve weather characteristics and impacts of climate change that community members can observe directly: periods of heavy rainfall, flash-droughts, erosion, hardened land, water degradation, species loss, and decline in human and environmental health. As a social-
environmental model, it also integrates social-science research on the importance of social and human capital for community action and resilience (Adger, 2003; Aldrich & Meyer, 2015).

Based on how groups adjust CE’s settings, rain falls on the land, erodes less-stable soil, degrades water, and threatens biodiversity. Human individuals who are “ready” to take action (in yellow) implement projects on the landscape, which are visualized as native flowering plants. Those “not ready” to take action (in red) move across the landscape but do nothing. How far each human agent can travel, interact with others, and enact change is based on the amount and diversity of a community’s social capital—the relationships that foster cooperation, trust, and collaborative action.

As is perhaps obvious from its cartoonish simplicity, CE offers only an approximation of conditions and interaction, not data-driven precision. That is the point. It is a cognitive artifact for researchers and community individuals to think with each other rather than a complex piece designed to think for these individuals. Coded using simple, open-source software, CE can run on laptops and allows stakeholders to run the model, observe, and comment on outcomes in real-time rather than wait for results from complex models, sometimes weeks later (Shenk et al., 2021).

Most important, CE’s minimalism provides only placeholders for the fuller parts of the story that both researchers and community members have and need from each other. This is where the role of narrative gaps becomes important.

Like the unspecified reason behind the feuding in Romeo and Juliet and like other Shakespearean spaces (such as the unspecified location of The Tempest), CE’s abstract, sketch-like visuals invite each group of stakeholders to place their narratives in contexts that represent their needs, values, and goals. What is the geographical scale that matters to us—a town?, a farm?, an urban neighborhood?, a regional watershed? What are the types of weather events that are most relevant for decision-making? What supports or hinders individuals from being ready to take action? What collaborative ties support action in this community—who works together, who currently does not, but could? As one Shakespeare student described it, CE is a “model that asks as much as it answers.” CE provides a rich set of social-environmental causations based on research. But, by including gaps like Shakespeare’s unspecified contexts and sparse stage directions, we leave space for each group to consider these causations in light of their specific needs. One neighborhood stakeholder noted “I bet this model does something different for every group. I find that liberating.”

FIGURE 1 The “community environment” (CE) model’s simple interface. (Shenk et al., 2021. http://modelingcommons.org/browse/one_model/6792)
Sidebar title: Stage directions for engagement

Shakespeare’s sparse stage directions invite others to engage in creating the action. For Shakespeare, the shareholder-actors co-created the staging in a highly structured theater space, rendering detailed stage directions unnecessary. In our current time, the sparse simplicity allows for infinite configurations that yield different interpretative possibilities. For example, before Hamlet’s famous “To be or not to be” speech, Shakespeare merely writes “Enter Hamlet.” This stage direction leaves open how the actor playing Hamlet enters, but its minimalism has even greater possibilities. King Claudius (who killed Hamlet’s father) has just hidden behind an arras with his counselor Polonius, and Polonius’s daughter Ophelia is visible, pretending to read a book. “Enter Hamlet” does not specify when he first sees Ophelia or if he suspects that Claudius and Polonius are watching. It does not specify if Hamlet is to be represented as so overcome with indecision and despair in his reflection of suicide that he does not see Ophelia or have the capacity to consider if anyone might be listening. This sparsity allows for the anguished overwhelm of David Tennant’s Hamlet as well as the performative calculation of Kenneth Branagh’s. The tenor of Hamlet’s speech is unaffected, but the context and values the production is pursuing are open for each production to own and shape differently. So it is, too, with CE’s invitational and strategic sparsity.

Together, groups create multiple scenarios using CE’s skeletal building blocks. Some groups adjust the settings to approximate a specific, headline-producing situation they all experienced, such as a recent derecho (powerful windstorm) in our state. Many groups, however, do not share a common memorable experience, but the abstract nature of CE allows groups to explore differing experiences that have common characteristics. For example, each participant in one group remembered a different flooding event, all in the same US state but years apart. Another group had members who each recalled an extreme event from radically different geographies—one from Texas, two others from Iowa, and another from Siberia. Their co-created storyline pooled diverse local knowledges and climate projections of downpours following dry spells, severe erosion, and ultimately sediment going downstream to other states. Suddenly, local mitigation strategies had national, motivating significance. Other groups explored common weather events but changed the social settings to explore how different communities, or sectors of the same community but with different resources, were able to respond. Groups explore what they describe as “questions we all had” or, as another group put it, “similar curiosities,” while also retaining the individuality of their own narratives.

This process of shared curiosities allows researchers to discover what characteristics from climate, environmental, and/or social research are going to be relevant. The weather-event characteristics from the climate projections, for example, will be pieced together into the ones stakeholders are pursuing in the storylines they are creating. A characteristics-based approach allows for co-created narratives that cross the divide between data and local experience. For this purpose, we have begun using a methodology for working with climate-model output called object-oriented analysis. The objects in this case are weather and climate events of interest, and the analysis focuses on event characteristics. The events we are studying include patterns that are observable and allow for the examination of slower-onset changes rather than only dramatic, singular events. We examine 5-day periods of heavy precipitation as well as 30-day episodes of substantial precipitation; we examine 5-day heat waves as well as 40-day dry episodes that indicate “flash droughts.” These events break complex patterns and statistics of climate change into observable weather events that, as storylines, better match stakeholders’ experience. In turn, extracting characteristics such as areal coverage, duration, location, and intensity of several similar events in an object-oriented analysis yields a set of similar events with common characteristics—an approach well-suited to creating storylines and exploring shared curiosities about climate change.

Because CE is characteristics-based, groups can (and do) co-create multiple, even competing, storylines. Such emphasis on multiplicity is a hallmark of existing storylines research (Rodrigues & Shepherd, 2022). What is distinctive about using CE is that groups create the scenarios themselves, which engages their creativity and further allows their questions and discoveries to expand and shift. For instance, the local neighborhood group and several of the women landowners began by considering their immediate land and environmental action. Over the course of
co-creating multiple scenarios, however, they began to recognize the importance of their work to larger scales—the local city, local watershed, regional watershed. Others began to realize how their individual environmental action could include their neighbors and build wider ties of social capital that would strengthen not only the environmental but also the social infrastructure. Still others began to use the multiple runs to consider issues of equity—how communities with different access to resources and/or willingness to collaborate across diversity could fare quite differently. The narrative gaps in CE that do not specify location, nature of collaborators, or aspects that determine “readiness” allow the nature of the questions and topics considered to shift as cognition expands to consider new ideas.

It is important to emphasize that researchers are part of this shifting and expanding cognition. They discover new ideas as well. When time permits, we, as researchers, openly invite groups to explain what CE does not simulate or leave space to discuss—but should. This process allows groups to explore the uncertainty in what CE and the scientific data provide. Community voices, therefore, add to, challenge, even revise the nature of stories CE helps tell. Stakeholders show us gaps in our narrative—a use of gaps that gives scope to Hulme’s notion of gaps as blind spots (Hulme, 2018). These moments reveal what researchers have failed to consider or understand. As stakeholders expose these gaps as places of brittleness, they offer ways to reshape and strengthen them. Now they own part of the model’s questions and modes of extending cognition. CE’s intentional inadequacy allows all involved to strengthen the stories to be told. It functions, in some ways, like Oldenburg’s “third place” (Oldenburg, 1989), an environment where people from different backgrounds, experiences, and perspectives come together and establish a sense of community separate from their individual, personal spaces. CE is a minimalist “third space” designed to stimulate stories for building community outside CE—in the real world. Here is where the paradigm of theater as a cognitive ecology moves the storytelling outward from shared storylines to partnerships of action.

4 FROM SHARED STORYLINES TO PARTNERSHIPS OF ACTION

In our work, the co-produced storylines are not the end products. Much like reading a Shakespearean play can be a deeply engaging experience, the play is designed to be embodied—an experience that actors and audience share. We take very seriously the importance of embodied and engaged storytelling as a manifestation of cognitive ecology. It is cognitive ecology that helps move individual knowledge to co-produced knowledge to partnerships of action. Research in cognitive ecology recognizes that cognition is, as Shakespeare scholar Amy Cook (2018) describes, “not computing in the brain but action with the body in the world”—action within an ecology that is a whole social-environmental system. On one level, our work uses CE’s agent-based methodology to simulate the social-environmental interplay of a cognitive ecology, as the little “pixel people” (as our students call them) interact with each other and the natural world. But that action is only in a simulation; we want to put those created storylines on their feet, and, to do that, we provide each community group who works with us and CE some modest funding to conduct action projects that emerge through shared storylines.

All the women landowners we worked with took climate-wise action—they worked with their renters to implement, increase, or diversify the use of cover crops on their farmland in ways that supported relationships with the renters. They also chose to host events that built relationships in their communities around conservation, bringing in individuals not yet included in the standard environmental action circles. When one woman landowner realized that her land and the neighboring acreages around her were at the top of a crucial local watershed, she hosted an event to bring her neighbors together and begin conversations involving conservation. Her projects and attention to a scale larger than her farmland emerged as part of her cognitive collaborative process. The neighborhood group has done a tree project, introduced native prairie plants to their area, and, through these relationships with each other and researchers, have gone on to do composting projects and reach out to the community outside their immediate area. The women landowners continue to meet with researchers now almost 2 years after their official workshop and storytelling activities ended.

Storytelling in a cognitive ecology begets more action and strengthens partnerships. In the past few years, community members and our community partners have continued to work with us and CE beyond a one-and-done session. These extended collaborations have not only resulted in collaborative action but also co-produced articles (Shenk et al., 2022; Shenk et al., forthcoming). Community members are now fellow authors in the narratives of research; researchers are fellow authors in the narratives of community action. The model of cognitive ecology as knowledge spread across diverse groups makes research and community action different products of a shared process.
5 CONCLUSION

This shift to a distributed, co-produced process is energizing, but it also brings its own tempests. It puts pressure on researchers to recognize the incompleteness of our approaches, the blind spots that can limit the questions we are asking, and thus the biases that can affect what we are getting from climate simulations. It also raises the question of who gets credit for storylines, action projects, and articles produced. Many universities have been slow in adopting language for recognizing community engaged scholarship as scholarship—action that does not always produce the tidy articles that can so conveniently be counted. Research articles where “participants” are co-authors and fellow experts are not common. Gaps continue to be places of vulnerability that require strengthening. A key part of that strengthening needs to come, this time, from academic and funding institutions by providing pathways to support less researcher-centric processes and outcomes. We are still navigating these issues ourselves. By minding the gaps, however, researchers invite communities into collaboration to create research that can be more responsive, relevant, and just.

Here is a fitting place to end with Shakespeare. In The Tempest, the magician Prospero controls the entire story until he transfers control to the audience at the end. It was Prospero who had summoned the forces that created the dramatic tempest that opens the play. And it is Prospero who orchestrates the resolution of all the play's subplots. However, in the play's final moments, Prospero cedes his power to the audience, asking that their clapping hands create the winds that will fill the sails of the ships taking him and the other European characters back to Naples. The winds of Prospero's opening tempest become the winds of clapping—a clever wink and nod to the play's communal and interactive theatricality. It is perhaps no surprise that this play—set on an unidentified island that allows each production to determine its location—is Shakespeare's most sustained meditation on centralized authority. And the controlling Prospero turns his power over to the audience—those who will leave the representational Globe to enter the real one, carrying with them the play’s questions and lessons.

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Linda Shenk: Conceptualization (lead); data curation (lead); formal analysis (lead); funding acquisition (equal); investigation (lead); methodology (lead); resources (equal); writing – original draft (lead); writing – review and editing (lead).
William Gutowski: Conceptualization (supporting); data curation (supporting); formal analysis (supporting); funding acquisition (equal); investigation (supporting); methodology (supporting); resources (equal); writing – original draft (supporting); writing – review and editing (supporting).

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DATA AVAILABILITY STATEMENT
The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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