frontiers in Environmental Science

ORIGINAL RESEARCH
published: 05 February 2021
doi: 10.3389/fenvs.2020.589856

Towards 'Creative Participatory Science': Exploring Future Scenarios Through Specialist Drought Science and Community Storytelling

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There is a growing interest in different forms of participatory modeling that bring science and lay knowledge into the same space. This recognizes that, traditionally, the environmental science community has mostly seen stakeholder engagement as a 'follow on' activity to be undertaken once the key scientific research has been completed. By excluding communities from the scientific process, or at best approaching communities in one-way communication, scientists are missing out on the wealth of local community knowledge about the very facets of the environment which they seek to understand. The challenge, however, is in identifying, developing and adopting appropriate platforms for communication and co-creation to allow scientists and local communities to have effective dialogue, efficiently gather, interpret and evaluate lay knowledge, and develop relevant, scientifically robust, but widely comprehensible, results. DRY (Drought Risk and You) was a 4-year project, funded under the RCUK Drought and Water Scarcity Program, with the aim of developing an evidence-based resource to support better decision-making in United Kingdom drought risk management. In DRY, scientific data and multiple narrative approaches have been brought together to facilitate decision-making processes and improve community resilience. Creative experiments were designed by the DRY interdisciplinary team to engage local communities in using specialist science as a stimulus for storytelling at catchment level, but also to give scientists the insight required to develop meaningful scenarios of local change to explore potential drought impacts in a particular river catchment. One challenge of working with storytelling is that it is very often retrospective and linked to past experiences and memories. It can be seen as a backward-looking activity, learning principally from what has happened before. The participatory approaches applied in DRY demonstrated that storytelling can be also used to imagine, interrogate and plan for a future that communities might collectively wish to subscribe or adapt to. In particular, by co-designing and facilitating storyboarding workshops, the DRY team, together with local stakeholders, have been exploring the 'scenario-ing' of possible futures as a way of creating a story and visualizing a picture for the future of the community. By allowing the scientists, community and local stakeholders to develop model drought scenarios

OPEN ACCESS

Edited by:
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Specialty section:
This article was submitted to Science and Environmental Communication, a section of the journal Frontiers in Environmental Science

Received: *03 August 2020*
Accepted: *21 December 2020*
Published: *05 February 2021*

Citation:
Liguori A, McEwen L, Blake J and Wilson M (2021) Towards 'Creative Participatory Science': Exploring Future Scenarios Through Specialist Drought Science and Community Storytelling. Front. Environ. Sci. 8:589856. doi: 10.3389/fenvs.2020.589856

iteratively together using storytelling, these scenarios should not only be scientifically accurate, but should also reflect local interests and aspirations, as well as local drought mitigation practices. This process integrates valuable knowledge exchange and the building of mutual capital to support local risk decision-making - scaling up from the level of the individual to the collective.

Keywords: drought, hydrological modeling, storyboarding, scenarios, participation, open science, creative experiments, Community

INTRODUCTION

Drought is a slow onset, diffuse, pervasive, 'hidden' risk that tends not to connect with the public psyche unless through intense heat. It is set to increase within the Anthropocene (Van Loon et al., 2016). As a complex uncertain hazard, drought is socially constructed differently across diverse publics and sectors (Taylor et al., 2009). It also provides well known perceptual and public risk communication challenges among different stakeholder groups (Weitkamp et al., 2020). Past experience of severe drought in the United Kingdom is highly variable, depending on geography, personal activities and local impacts, as drought infrequently develops into full blown 'water supply' or 'socio-economic' drought (see Wilhite 2011 for drought typology). Unlike flooding, at the other end of the hydrological risk spectrum, drought is not easily observed or visualized locally at least in its early stages, and tends to get scant media attention until well into a drought situation. This poses questions about how to engage different publics in resilience thinking about future drought risk, and what the role of visualization in daylighting a hidden risk could be in these engagement processes. The imperative for citizen involvement in local governance, including water risk management, is playing out at a range of scales, linked to diverse agendas (increased recognition of value of local knowledge, climate resilience, austerity etc., McEwen et al. 2020). In tandem, there is increasing concern to develop methods of meaningful participation in environmental decision-making, building on early thinking within Arnstein's 'ladder of participation' (Arnstein, 1969) in how to achieve 'higher rung Arnstein', and relationships between participation, social learning and knowledge for local decision-making (e.g., Callon, 1999; Collins and Ison 2009). This involves exploring the role of the citizen in these processes, how that might be supported, and different understandings of what ecological and hydro-citizenship might look like in an increasingly uncertain future (McEwen et al., 2020). This is evidenced in a growing body of research focused on the tools and methods in participatory modeling with at risk communities mainly related to flooding (e.g., Landström et al., 2011). There is also growing interest in research and practice about anticipatory adaptation (DeSilvey, 2012), and what 'resilience thinking' looks like in practice and, how it might be encouraged (Walker and Salt, 2012; Sellberg et al., 2018).

This interdisciplinary research reflects on ways of interweaving science and narrative approaches for understanding future drought risk within a specific case-study catchment. It analyses its impact on both research and public engagement processes and the different participants. This paper aims to:

- share an emergent creative participatory methodology for bringing science and narrative into the same space as a platform for supporting resilience and thinking about possible adaptive scenarios for uncertain and hidden future risks;
- reflect on the implications for opening up of complex and uncertain science in ways that engage different publics in future thinking;
- critically reflect on the implications for the role of 'storying' in participatory methods not only to encourage creative local resilience thinking, but also to develop locally resonant and meaningful scientific scenarios.

Mirroring the nature of the interdisciplinary and transdisciplinary dialogues that have generated the most innovative insights in the DRY Project, this paper includes multiple voices and proposes different ways of thinking about the process from science and narrative perspectives.

CONTEXT

The shift from uni-directional communication to knowledge exchange and co-generation is a journey of travel involving transitioning (see below/5). Communicating about United Kingdom drought risk, as a hidden risk, is a recognized challenge across stakeholders and sectors (Weitkamp et al., 2020). Most often this risk communication is left to statutory organisations – the water supply companies and environmental regulators – and tends towards one-way or broadcast models. Participatory modeling is classically construed as the bringing together of natural and social sciences (specialist hydrological modeling science and participatory methods). Examples include work on 'environmental knowledge controversies' in flood risk management (Whatmore, 2009). While historically specialist science has been the principal evidence used to support drought risk decision-making, growing recognition exists of the value of local or lay knowledge in local risk management (McEwen et al., 2016), the importance of anticipatory histories (De Silvey, 2012) and anticipatory adaptation and transformation in socio-ecological climate resilience (cf. Shinn, 2018). Recognition also exists of the hybridity of knowledge; for example, Haughton et al. (2015) argue for hybrid knowledge formation and co-production in flood

knowledge. In a different take on participatory methods, Holmes and McEwen (2020) explored the role of digital storytelling as creative action in capturing local flood knowledge for resilience and exchanging it from recently flooded communities to those without recent flood experience that faced future flood risk. Elements that traveled included psychological resilience, empowerment and community cohesion during flooding.

Personal storytelling, or sharing of 'small stories', has been explored as a participatory method in other small group settings, for example, in public engagement, deliberation and dialogue to understand public, environmental and governance issues where there may be conflict or argument (e.g., Endres (2012) on competing values in participation). Storytelling can assist individual participants to overcome barriers to deliberation such as limited knowledge as well as having a collective function in building a sense of community (Ryfe, 2006). This approach can allow participants to establish important interactional identities (see Sprain and Hughes, 2015). Black (2008, p. 93) argues that such storytelling can be "a bridge between dialogue and discussion" with stories inviting "dialogic moments because they help group members negotiate the tension of self-other". Forms of expertize in deliberative environmental forums can be differentiated into institutional, local and issue (Sprain and Reinig, 2018). They emphasize the importance of thoughtful deliberative designs and alternative forms of reason-giving that reduce hierarchies, recognize different ways of knowing and support conditions needed for democratic deliberation (see also Sprain et al. (2014) re careful consideration of communication design in deliberative forums).

The Connected Communities Program of research, an initiative by the United Kingdom Arts and Humanities Research Council which began in 2011, supported the participatory turn in research, and, considering different disciplinary traditions in participatory research, expanded the opportunities for academic researchers within the arts and humanities to work with communities in new collaborative ways. This was "characterized by a radical intermingling of disciplinary traditions and by creative methodological experimentation" (Facer and McKay in Banks et al., 2019, p. xii). This strongly recognized communities as repositories of local knowledge, emphasizing them as co-researchers, co-creators, co-producers of knowledge (Facer and Enright, 2016). While participation and consultation have long been a part of research approaches in participatory design, citizen science and participatory action research, for example, the Connected Communities program supported a more fundamental shift in power within the research process.

As stated by Banks et al. (2019, p. xii) 'academic research is increasingly realizing the critical importance of community knowledge in producing robust insights into contemporary change in all fields'. This recognized the value of the different types of knowledge and ways of thinking that emerge from communities' deep connection to their geographical and temporal landscape, and which communities can contribute to processes of interrogation, knowledge production and critical imagination.

The DRY (Drought Risk and You) Project

The four-year, interdisciplinary DRY (Drought Risk and You) project aimed to improve the evidence-base to support better catchment-based drought risk decision-making in the United Kingdom. The team involved drought risk modellers, ecologists and agronomists working with specialists in narrative methods from the arts, humanities and social sciences. The original concept of DRY was to explore different ways to bring together specialist science (in particular, hydrology, ecology, agronomy) alongside stories as an evidence base to support decision-making. This recognized that there is a wide interest in research and practice about how different knowledges come together (Lewis, 2011; Bourbonnais and Michaud, 2018). DRY undertook a series of creative experiments to bring science and narrative approaches into the same space. Its design involved working with diverse stakeholders in seven case-study catchments on gradients (hydrometeorological; urban-rural) across the United Kingdom. The Bevills Leam catchment in the Fens, Eastern England was one such catchment.

The adaptive participatory storytelling approaches that emerged within DRY are outlined in Bryan et al. (2020). This research involved longitudinal co-working with multi-stakeholder, catchment-based, local advisory groups, and multi-stakeholder partners within that process. These local advisory groups met six times during the funded lifespan of the DRY project. The United Kingdom Center for Ecology and Hydrology had a crucial role in facilitating this process within DRY in a number of settings, and, in particular at the catchment level within the Local Advisory Groups (LAG), to share their science early on, and to use that as a stimulus for people to talk about their experiences of drought as part of an arts and humanities rich process for the co-production of knowledge.

The DRY-LAG process was one of true iterative co-development which drew upon local knowledge, data and understanding to improve the drought risk hydrological modeling, to develop and identify locally resonant climate change, land use change and catchment management scenarios, and to explore potential drought risk mitigation measures. At the same time, it also opened up the modeling process, revealing the complex decision making and thought processes behind hydrological model development. It has gone a long way towards addressing the perceived challenges of incorporating citizen science in hydrology (Buytaert et al., 2014).

This paper focuses on one of the creative experiments in that process, drawing on experiences of implementing what we have called a 'scenario-ing' process (which includes participatory scenario building, scenario making, scenario designing) in the Bevills Leam catchment. Qualitative scenario development has been used as a tool in various disciplinary research and practice, sometimes combined with participatory methods that involve stakeholders. However the emergent approach in DRY involved explicit co-working with the arts and humanities in the co-development of its participatory scenario-ing methods involving storytelling, and in particular storyboarding techniques. This specific approach was the result of a co-design process that was implemented through a cross-fertilization of different storytelling approaches as a way to:

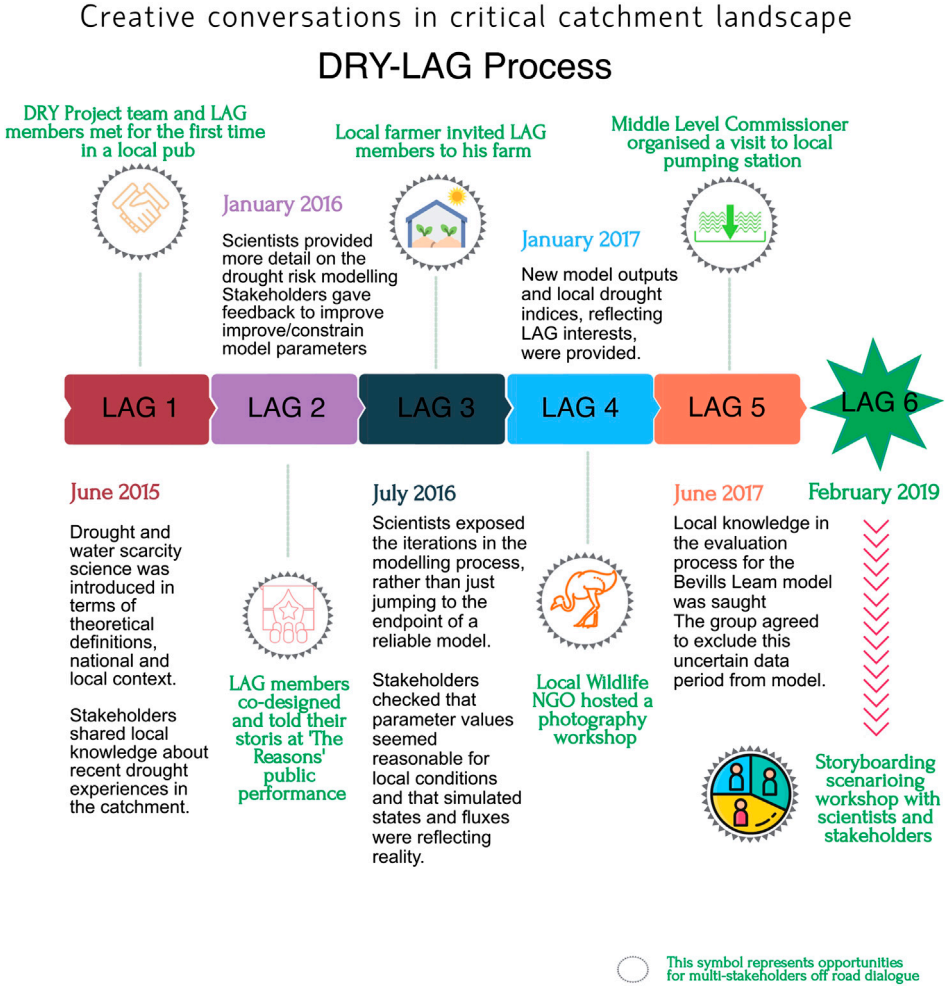

FIGURE 1 | Timeline for stakeholder engagement in the Bevills Leam catchment, indicating past reconstruction and future facing scenario-ing activities.

understand the science behind drought; bring together people from different sectors to discover hidden stories; amplify silent voices and visualize the hidden; dismantle knowledge hierarchies (lay vs. scientific); combine traditional forms of communication with various creative practices (including storyboarding, song-writing, performative and digital storytelling); and rethink open science in an transdisciplinary scenario-ing context.

Bevills Leam as a Case-Study Catchment

The Bevills Leam catchment is a 179 km^2 area of the Cambridgeshire fens in the East Anglia region of the United Kingdom (see Blake and Acreman, 2009; Blake et al., 2012; Blake and Ragab, 2014). The area is predominantly low lying, with large areas at or near sea level. In the 'lowland' area, the soils are generally peat overlying impermeable clay. The hydrology in the area is highly managed following intensive drainage of the peat in the 1800s and earlier to provide land suitable for agriculture. Peat drainage, shrinkage and wastage mean that significant parts of the 'lowland' catchment area are now below sea level. There is a pumped drainage system whereby water levels in the high-level main drains are managed by the Middle Level Commissioners, with water eventually being removed from the catchment at the Bevills Leam Pumping Station at Tebbits Bridge (see **Figure 1**). Other relatively smaller drains are controlled by local Internal Drainage Boards, farmers, the local Wildlife Trust and Natural England. Water level management balances winter flood relief, water storage for irrigation and water levels for boating navigation. There is extensive agriculture in the area with crops including cereals, sugar beet, potatoes, onions and carrots. Much of the horticultural crops are irrigated, traditionally by spray irrigation but with some recent movement towards more water conserving techniques. Irrigation water sources may be direct from the drains, but due to limited summer resources, there have been more recent moves to storage of winter water for subsequent summer use. The catchment is also the location of nationally significant wetland restoration, the 'Great Fen Project' (see *Community Storyboard Scenario-ing Workshop with the Great Fen Project*), which aims to restore up to 37 km^2 of wetland linking the Holme and Woodwalton Fen National Nature

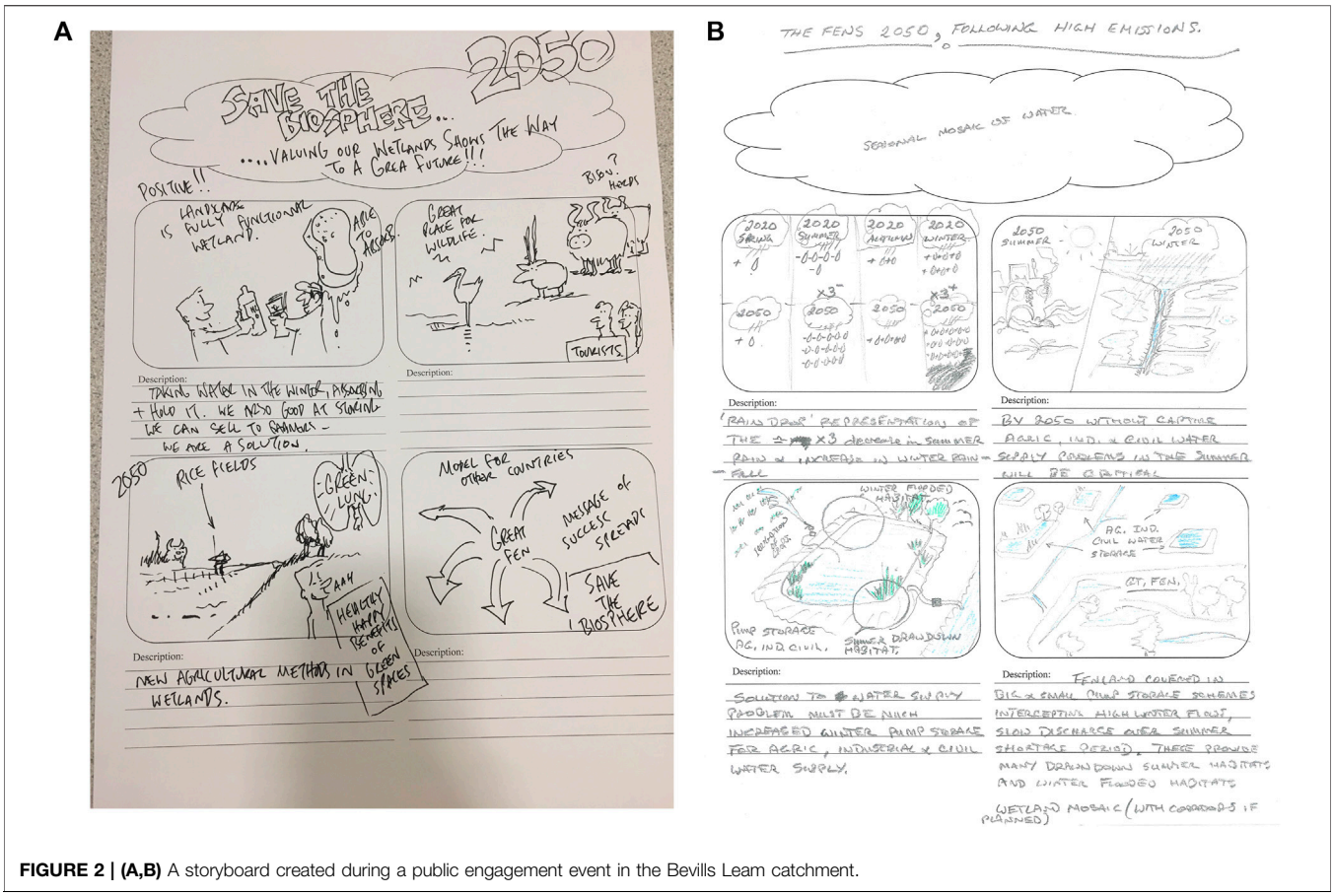

FIGURE 2 | (A,B) A storyboard created during a public engagement event in the Bevills Leam catchment.

Reserves. There are scattered rural villages, hamlets and farms throughout the catchment, with the larger villages of Yaxley and Ramsey to the NW and SW of the catchment respectively. The city of Peterborough is just beyond the NW catchment boundary. The catchment is within one of the driest regions of the United Kingdom, with only 630 mm average annual rainfall (1961–90). Recent drought experience includes: 1965, 1973, 1976, 1990, 1997, 2003 and 2011–12.

METHODS

This section shares the progressive opening up of the science as a precursor to working creatively with the science as a stimulus to the storyboard scenario-ing. It then outlines the initial interdisciplinary scoping of scenario-ing and the emergent methods that followed.

The LAG Process: Communicating Drought Risk and Opening up the Science

An overview of how the interaction between scientists and local stakeholders happened within the Bevills Leam catchment over three years is proposed in chronological order (from the first to fifth Local Advisory Group meetings) to reflect on some crucial steps that could inform future similar research processes. The drought risk science then became a forward-looking activity in the sixth LAG during which scientists and stakeholders explored together the creative use of storyboarding techniques to understand potential impacts of various scenarios on personal lives (**Figure 2**).

During the first LAG meeting, drought and water scarcity science was introduced in terms of theoretical definitions, and national and local context. A key element of this initial interaction with LAG members was to garner local knowledge about recent drought experiences in the catchment. For our scientist, it was essential to present the identified local events as tentatively ascribed on the basis of available high quality, national hydrological datasets, while explicitly highlighting that the reality or experience on the ground might not always match the theory. This provided an opportunity to start working together to compile and refine local drought knowledge. The meeting was also an opening to introduce the Bevills Leam hydrological model (Blake et al., 2012), which had originally been developed to provide an assessment of the feasibility of wetland restoration in the catchment. In the LAG, the scientist outlined how the model might be improved and developed further as part of DRY to investigate drought risks and impacts across sectors and the potential for locally-defined drought indices. This included initial conversations about accessing local (hard?) data which could support the drought risk hydrological modeling. Key to this was having local contacts

on the ground - gatekeepers, who knew what data might be available and could help facilitate access.

The second LAG meeting provided further detail on the drought risk modeling, highlighting progress with setting up the model, initial exploratory model simulation runs and recent/potential model developments to improve hydrological process representation. It provided an opportunity to start using local knowledge to attempt to improve/constrain model parameters. It was important to emphasize that scientific models are by definition a simplified representation of reality, seeking to incorporate key processes at a scale relevant for their intended purpose. It was also crucial to highlight that the data used in the modeling also had gaps and uncertainties, and how these could be accounted for. Drawing these two themes together converged to the concept that although hydrological modeling has a sound theoretical basis, its application can be a far messier, fuzzier process with the need for a good degree of pragmatism. Opening up the scientific process in this iterative way therefore attempted to provide reassurance to the LAG members that their local knowledge could also make a valuable contribution to the drought risk modeling.

The third LAG was unusual in that it exposed the iterations in the modeling process (model setup, calibration, development, 'validation'), rather than just jumping to the endpoint of a reliable model. The modeling process is a journey, along which various decisions are made, some of these turn out to improve the model, others might be less successful or even make the model worse. It is not unusual to revisit previous decisions and follow alternative routes to attempt to improve the model. For Bevills Leam, early models were not particularly reliable, and a series of model process developments were needed to provide improvement (following the flexible approach to modeling advocated by Bredehoeft (2010)). It was particularly useful from a drought scientist's perspective, to be able to run the trial model calibrations past the LAG members, to check that parameter values seemed reasonable for local conditions and that simulated states and fluxes were reflecting reality. This has clear parallels with the suggestion to incorporate experimentalist's qualitative 'soft' data about process understanding in model calibration (Seibert and McDonnell, 2002), advancing hydrological model testing to get the right answers for the right reasons (Kirchner, 2006), and innovative approaches to help identify hydrologically realistic catchment models (Wagener, 2003). It could even be seen as a qualitative form of model 'internal validation' (Fawcett et al., 1995). The LAG process facilitated this exchange as by the third LAG, a good open working rapport had built up within the group, so our scientist felt comfortable sharing interim results which were still undergoing improvement.

The fourth LAG meeting focussed on further model development and improved calibration for Bevills Leam. As the Bevills Leam modeling used a tailor-made catchment water balance model (due to the unique hydrological characteristics of this pumped drainage catchment), there was greater flexibility to provide new model outputs and local drought indices, reflecting LAG interests.

The fifth LAG meeting provided a novel opportunity to include local knowledge in the evaluation process for the Bevills Leam model. At this point, our scientist believed that the development of a reliable model was near completion as the final calibration had realistic parameters and reasonable 'goodness of fit' measures. However, although the model could generally replicate the monitored flow data, there was a data period which could not be simulated successfully with the calibration parameter set. Our scientist's inclination was to exclude this period of uncertain data; however, he did not feel able to justify this decision based only on intuition as although the data appeared unreliable, a cause could not be identified. He therefore sought advice from the LAG members, in case there was a local factor at play during this period which may have been responsible for the unusual hydrological response. The group could not identify any local factor, and therefore the group agreed to exclude this uncertain data period from the model. That incorporation of local knowledge provided a more secure justification for this exclusion, rather than just relying on the hydrological modeller's intuition. This could be seen as a novel approach to the issue of excluding periods of hydrological disinformation, as raised by Beven and Westerberg (2011).

Particular benefits of including local knowledge and understanding in the model development process included: i) guidance on how to represent complex hydrological systems in the modeling, e.g. pumped drainage system operation (Bevills Leam: Middle Level Commissioners); ii) confirmation of potentially unreliable data and more secure justification for its exclusion; and iii) ensuring that the model parameters and modeled states/fluxes are reasonable, reducing potential over-reliance on statistical goodness of fit measures. This relies on an open-minded approach from the hydrological modeller, with respect for different forms of knowledge and understanding. It also depends on the LAG members being convinced that qualitative knowledge can be incorporated into the modeling approach. Opening up the modeling process helps greatly in this regard as it exposes the myriad of decisions and iterations needed to develop a reliable model. In this aspect, hydrological modeling can perhaps be seen as part science and part art, incorporating both hard data and process understanding, but also experience, ideas and intuition.

The iterative process of model setup, calibration, improvement and 'validation', can also be seen as essentially a backwards looking activity, using past data and knowledge to create as reliable a model as possible at the present time utilising current scientific and lay understanding. This formed the basis for the forward looking scenario-ing work that followed in the sixth LAG, when the model is 'driven' with data representing different scenarios of possible future climate, land use and water management change.

Interdisciplinary Perspectives on Scenario-Ing

Alongside this emergent process of opening up the science, the DRY team reflected on the possible framing and practice of 'storyboard scenario-ing' drawing on its interdisciplinary expertize. While DRY faced opportunities and challenges in adapting well-established storytelling methods, our processes built in iterative opportunities to reflect collectively on, and

confront, what can be understood as 'storytelling', and how this might be applied to bridge scientific and 'lay' knowledge. This involved adopting and re-adapting multiple narrative approaches, with the awareness and willingness to take risks and receive unexpected responses. Our processes aimed to advance knowledge on how drought impacts on different communities and different sectors in nuanced ways and, importantly, to increase their potential agency in adaptation to future drought risk.

The original DRY methodology had 'scenario-ing' as a bridging concept and major element in considering past, present and future drought risk in adaptation. Qualitative scenarios have been used as an approach in other participatory contexts over the last couple of decades, mainly from social science perspectives co-working in socio-environmental systems analysis to support decision making and learning (Elsawah et al., 2020). Such scenarios can be considered as qualitative, ideally integrated storylines (cf. Kok et al., 2006). Reed et al. (2013)'s development of a methodological framework for participatory scenario development cites strengths including the empowerment of stakeholders and the development of robust scenarios that help more effective preparation for future change. Qualitative descriptions of plausible futures have been translated into quantitative modeling (cf. Rao Mallampalli et al., 2016). The European Environment Agency[1] defines the 'story-and-simulation' approach to (environmental) scenario analysis as one that combines different types of information: "narrative describes in story-form how relevant events, key driving forces and step-wize changes unfold in the future. The results from model calculations complement the storyline by presenting numerical estimates of environmental indicators". Critical in framing these methods is the disciplinary understanding of 'narrative' and 'story', and the participatory roles and sequencing within science-narrative processes.

DRY in its transdisciplinary methods involving the socially-engaged arts conceived 'Storytelling scenario-ing', as a possible softer, more fluid way in for community engagement, dialogue and deliberation. Such scenario-ing has potential to release the mind to explore possible futures, and free stakeholders' thinking from the constraints of current water realities, current water governance, current institutional or personal thinking. Nevertheless, this approach presented multiple challenges linked to the different disciplinary and professional understandings of the term 'scenario', and also related to the specific context in which we were delivering our public engagement activities: across catchments and within each catchment. We had to respond creatively to challenges linked to the drought risk focus (challenge: how to engage the public with a hidden risk?), the timeliness of our work (challenge: how to discuss future drought risk in periods with water excess?) and locations (challenge: how to connect with a changing landscape without being actors of change locally?).

Co-production was a key component of the DRY project and unfolded as an iterative process applied at various stages (for the definition of research problems, delivery of activities, analysis of the results) and various levels (within the research team; with the Local stakeholders involved in the six Advisory Groups; with the general public). At team level, our reflections on the various meanings of key terminology from different disciplinary perspectives enriched the collaborative process at an early stage. 'Scenario' was one of the multi-meaning terms approached, unraveled and explained from each disciplinary perspective represented within our team, not only to bridge these diverse approaches, but also to shape our thinking while extracting and understanding different meanings. In fact, this 'lexical' analysis offered new angles to reflect on how to engage different water users about future drought risk, water scarcity, water shortage, and water efficiency. In a video recorded during an early project team meeting (https://youtu.be/AGPPIHyEcpw; https://dryutility.info/science-and-narrative/), we summarized our multiple understandings of the word 'scenario' from different disciplinary perspectives including hydrology, business, agronomy, ecosystem services, drama, media and communication. From each of those very particular definitions, we extracted key components of what a 'scenario' is as understood in various disciplines, to elaborate new creative tools and engage the general public around issues concerning future droughts in the context of climate change. From a hydrological perspective, scenario was defined as 'a reaction to a hypothetical situation assumed under a *what if* action'. From this approach, we adopted and re-used the notion of 'what if' as a first step to present scientific data to the general public, showing the impact of multiple changes, and to find an accessible common ground to analyze various future projections.

Within business, they talked about scenarios (in its plural) as 'stories that encapsulate possible imagined futures'. From this approach, we understood how important it was to make clear to a wider audience that scenarios are not tools for predictions, but tools to try and surface barriers and enablers that, from a business perspective, might 'aid decision-making and help organisations to be better positioned for the future'. This aspect was particularly useful when we had to design engagement activities for organisations that are working in turbulent and dynamic environments, or environments that are characterized by a large degree of uncertainty. From an agronomics perspective, scenario was defined as 'a plan of specified events to be considered, studied or investigated' and the importance of addressing the unknown while emphasizing the role of knowledge exchange was strongly emphasized. A technically precise description was offered by researchers in ecosystem services where 'scenario' was understood as 'a resolution of a range of drivers of change into principal components, structuring the development of a set of *plausible futures* which collectively illustrate different trajectories within what is known as a *possibility space*'. The notion of a 'possibility space' informed our process in terms of creating new tools to make accessible this exploration of the possible. Talking about 'scenario' from a drama perspective brought into the transdisciplinary dialogue a completely different voice, harking back to the origin of the term 'scenario':

[1]https://www.eea.europa.eu/help/glossary/eea-glossary/story-and-simulation-approach

It is, in fact, a word that comes from the Italian 'Commedia dell'Arte', which was an improvised form of theater. Within that original context, the 'scenario' was the piece of paper that was pinned to the back of the scenery to sketch out the structure and key points of the action of the play, around which the actors would improvise. Another distinctive reflection came from a media and communication perspective, from which the importance of understanding who is defining what a scenario is, as well as the meaning of the word itself, was highlighted. Google's search algorithm and ranking system suggest as dominant visual representations of the term 'scenario', images related to planning, pathways, opportunities and decision-making. In addition to the conceptual input offered by the previous definitions gathered within our team, these last two reflections, informed by the arts and social sciences, inspired the form and the structure of the creative tools initially proposed and then co-designed with our Local Advisory Groups, and eventually applied in working with the general public to trigger individual and collective explorations of possible futures. While we used the active term 'scenario-ing' in our team creative experimental processes, in our discussions with Local Advisory Group stakeholders, we agreed 'What if' to be a more accessible way forward for engagement. We spent considerable time creating accessible bite-sized science resources that could act as stimuli for exploring 'What ifs' around possible futures. These included two red/blue tables of summary UKCP09 projections with % change in average temperature and rainfall, along with % change in frost free days and cloud cover for those interested in growing.

Our Emergent Process: 'The Reasons' as Initial Future-looking Storytelling Process Within the Bevills Leam Catchment

The co-production process, triggered within the Local Advisory Groups (LAG) in each of the seven catchments selected as case studies in the DRY project, was found to be particularly successful in the Bevills Leam catchment, a rural area in Cambridgeshire described in *Bevills Leam as a Case-Study Catchment*. Stakeholders' engagement in the research at local level offered the DRY academic team the opportunity to co-design context-tailored approaches, and to experiment with a variety of storytelling techniques that could respond to emerging community issues.

Within the Bevills Leam catchment, LAG members also participated in additional public engagement and dialogic activities, such as two public storytelling events, a visit to a local farm, an excursion in the Great Fen nature reserve, a visit to the Bevills Leam pumping station, a photography workshop, and a storyboarding workshop (see **Figure 2**). Through their professional and personal views, the Bevills Leam LAG members inspired our initial future-oriented storytelling process and contributed to conceiving and planning a performance event aimed at capturing community views on local water dilemmas, unlocking their complexity, and questioning possible plans for the future. Two iterations of this performance event, called 'The Reasons', were organized in rural Ramsey and urban Peterborough with the idea of bringing together the local community to share stories about water usage, the flood/drought nexus, and to talk about common views and solutions for the future of the Fens (see video documentation: https://dryutility.info/reasons/). 'The Reasons' was devised by researchers from Loughborough University in collaboration with the local stakeholders as a forum for public storytelling (Bakewell et al., 2018). It was inspired by a traditional forum for conflict resolution that was used until the early 1960s, as an alternative to the official court system, in Gallura, a rural region in Sardinia, Italy.

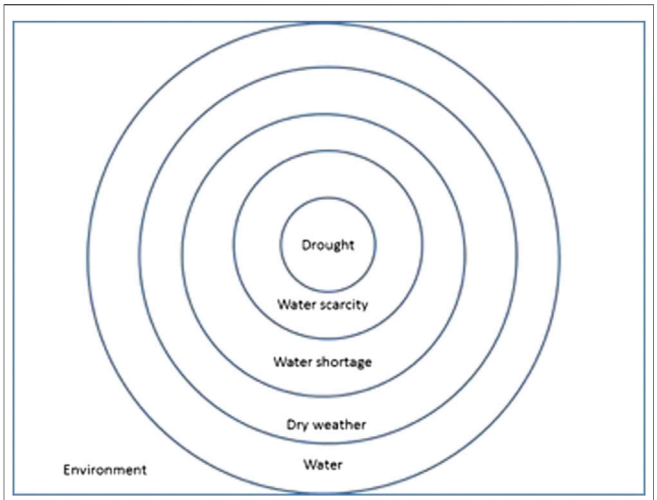

FIGURE 3 | A bull's eye target as a way of defining the spectrum of themes included in the DRY Story Bank.

This original 'judicial' procedure is best described by an oral testimony from November 1963, gathered by the local ethnographer Pietro Sassu (Sassu 2009). What was maintained in the adaptation created in the Fenland was the principal aim of 'la Rasgioni' (to give it its Sardinian name) that consists in preserving community cohesion and reinforcing local relationships by co-designing the resolution to a conflict. The local stakeholders in the Bevills Leam catchment wanted to avoid the word 'conflict' to emphasize the importance of opening up the discussion to the most diverse views on future-looking ways of managing water in the area, preferring to talk about 'water dilemmas'. To expand the range of 'characters' involved in the performances and gain a greater representation of 'voices', in addition to the 10 storytellers (recruited from the various organisations involved in the DRY Local Advisory Group), audience volunteers were appointed to an advisory jury to discuss potential disagreements and propose ideas for the future to the whole community. Another innovation, designed to support community cohesion and future-scanning, was the participation of a singer-songwriter to bring together all the views expressed by the storytellers and the jury, into a community song (see video co-created with local stakeholders: https://dryutility.info/reasons/), performed by all participants after the delivery of the conciliatory, future-looking verdict. As commented by one participant (and also commonly featuring on audience feedback forms), 'The Reasons' represented a new way of engaging people

as they had learned 'a great deal about the complexities of water management', which they might not have known otherwise. This was perceived as particularly meaningful because participants (storytellers and audience members) were invited to challenge the various ways of approaching and dealing with those complexities, while reflecting on possible futures. This process attuned the participants to working with storytelling, and made them eager to explore further its potential.

Storyboarding as a Tool for Scenario-Ing

By experimenting with oral storytelling techniques to unlock community knowledge and mull over future water dilemmas on a stage in 'The Reasons', we moved a step closer to the potential use of that piece of paper pinned to the back of the scenery, that a storyteller would call the 'scenario' and here is presented as the 'storyboard' (see **Figures 3A,B**). During the preparatory work for 'The Reasons' and other follow-on discussions with team members and local stakeholders, we identified 'storyboarding' as a possible way to visualize future scenarios that could sit alongside the scientists' toolbox of drought visualization – graphs and maps of drought indices etc. Storyboards are widely used in film production and animation, and they consist of a series of pictorial frames to explore the use of points of view, camera angles, close-up, and to communicate visually the vision for the film or the animation to the wider team (script writers, photographers, filmmakers, directors…). Within this sector, storyboards are generally of a high standard and very detailed. Storyboarding for storytellers is mainly used as a technique to develop a narrative, create a structure and prepare the story for a live performance. Typically, for a storyteller, it would consist of 6–8 frames to describe visually the key moments of action and development of a story. For this specific use, even if the storyboard is visually represented, it does not require a particularly high standard, because it is serving only as a reminder and prompt to the storyteller. Linking back to the theatrical meaning of the word 'scenario', for a storyteller, a storyboard is in fact a scenario, and therefore a visual representation of the structure of a story around which they may improvise in telling their story. Storyboards are also used in other sectors, such as business, communication and marketing, design, for example, to develop ideas, explain concepts, plan actions, create new contents/media, describe user experience, instruct, communicate, imagine in a (chrono)logical sequence of actions (Nardella et al., 2014). Emerging from an understanding of these various approaches, the use of storyboarding was then proposed within the DRY project as a way of reflecting on the structure of a story about a possible future and making decisions around the characters involved in that story, the place, the key moment of actions, and how all the components will fit together. One reason why this approach is particularly effective to explore future scenarios, and to provide a tool to merge scientific and lay knowledge, is because, in order to put together a storyboard, we are required to think very carefully and very deeply how the story is going to unfold. In fact, when we talk about imagining stories about our drought futures, storyboarding has been revealed to be a useful way to build those stories and explore connections to place and people, and their implications for place and people, while understanding the science behind those risk projections. As a participatory workshop activity, it allows the bringing together of scientific information to be shared with the general public, and local knowledge shared by the local participants. It also facilitates conversations among different knowledge domains; and builds together various blocks of knowledge, perceptions, imagination, visual representation, into a complex and multimodal narrative in which different elements, 'voices' and characters can be combined.

It is interesting to note that when storyboarding was used as workshop activity, within the DRY project, the science shared with the audience is often presented in a visual format through graphs, charts and animations, and what happens at the end of this process is that the two elements of the DRY project, the science and the narrative, are both represented visually and discussed starting from the same mode of communication. Yet storyboarding provides opportunities not only to bring together two different types of knowledge into the same form, but also allows different knowledges to support or scaffold each other in developing new knowledge. This happens by enabling participants to identify assumptions within a specific context, to explore the impact of behavioural change in a certain scenario, and to offer personal insights within that scenario. Storyboarding works well as a group activity, as a clearly defined and achievable task that enables creative and reflective thinking, action on knowledge and social learning. It also produces a output that can be easily edited: the audio can be captured during oral sharing of adaptive thinking at the workshop, and the storyboard and audio can then be combined in a video for communication to promote further dialogue (see as example: https://dryutility.info/2019/02/08/the-fens-in-2050-following-high-emissions-seasonal-mosaic-of-water/).

CASE STUDY: STORYBOARD SCENARIO-ING IN THE BEVILLS LEAM CATCHMENT

An iterative 'build-up' process of participatory scientific scenario-ing was critical to the storyboard scenario-ing process.

Scientific Scenario-Ing

The proposed Bevills Leam drought risk future scenario modeling, while mentioned earlier in the project engagements, was formally introduced in the fourth LAG meeting. It was important to attempt to introduce the concept without using excessive technical jargon, with the following definition provided: 'Simulating the potential impacts of changing factors (e.g., climate, land use, water management etc.) on water resources and dependent activities'. Through the use of only example changing factors and the term 'dependent activities', this also attempted to promote the idea that the scenario-ing activity would be an 'open' concept with much scope for co-development, rather than something prescriptive or predetermined by the scientist. It was also very important to emphasize that the scenarios were not a prediction of the future,

but merely an illustration of a range of possible changes and potential futures.

Since climate change scenarios, based on the latest United Kingdom climate change impact projections at the time (UKCP09), were likely to be of great interest and potential debate among the LAG members, while simultaneously being less open to technical critique by the group, these were introduced first (in terms of driving data for the model, rather than modeled water resources impacts). To avoid overwhelming the group, only three scenarios were selected for initial introduction, one based on the near future (2020s with 'Medium' greenhouse gas emissions), and then two on the more distant future (2080s) with an optimistic and pessimistic emissions scenario ('Low' and 'High' emissions respectively). The purpose of selecting the near future scenario was to slowly ease the group into the idea of future scenarios by presenting something which was only a slightly modified version of their current experience. The use of more extreme distant scenarios was an attempt to provoke discussion, in terms of the scale and direction of potential impacts and possible step-changed actions for resilience, while invoking a somewhat reassuringly distant time-period to avoid concerns about any perceived inability to influence the extreme scenarios. This happened intentionally during the sixth LAG when stakeholders and scientists participated to a storyboard scenario-ing activity together. It was assumed that there would be a range of familiarity with formal climate change scenarios among the LAG members, therefore, as the concept is relatively abstract, an attempt was made to tie this into local knowledge by sharing a screen grab from the UKCP09 web user interface which overlaid the projection data 25 km grid box on a basic map of the area to illustrate the that projections were indeed tied to the local. An attempt was also made to explain the probabilistic nature of the projections, and how this could be simplified to joint probability 'central estimates' of the most likely changes in average seasonal precipitation and temperature for the Bevills Leam catchment under the various scenarios. While 'central estimates' were found to be simple and effective for communicating the scenarios, this did put the scientist in a position of discomfort as the UKCP09 guidance recommends that these should not be used in isolation and a full range of probabilistic projections should be considered. The presentation ended with a slide outlining a number of potential 'scenario modeling ideas', under the broad headings of climate, land use and water management changes, with some suggested possible areas of exploration identified by the scientist on the basis of previous group discussions and knowledge of the catchment. All suggestions were presented as questions on the slide, to again try and emphasize that the process was open to co-development.

Three initial/trial land use change and water management scenario results were presented at the fifth LAG meeting. These results included example model output in terms of hydrological impact on crop yield, main drain levels and pumped drainage requirements, agricultural and habitat reservoir water levels and on wetland plant community hydro-ecology. Unfortunately, results from the UKCP09 climate change scenarios were not yet available to share due to additional model development required to estimate potential evaporation from the available projections and the need to estimate projected catchment inflows under the different scenarios. As with the initial climate change scenarios presented, the initial land use change scenarios reflected two extreme, end member states: the entire Bevills Leam catchment under either agricultural or restored wetland land use. These extremes were selected, not because they might be likely in reality, but because they would hopefully provoke useful discussion within the group which could be used to agree on more plausible potential scenarios, and also as a mechanism to investigate if the model outputs were sensitive to this change. In effect, this was a deliberate strawdog to be pulled apart, with the aim of encouraging a group, with potentially conflicting views, to come up with and agree upon more plausible alternative scenarios, which they would then have more interest in as they were part of the scenario development process. This appeared to work as the LAG participants developed several good ideas for locally relevant land use change scenarios. The third scenario involved more flexible water abstraction during the winter for storage in reservoirs and subsequent use for summer irrigation. This scenario had been developed from the previous LAG meeting discussion, and was shown to have multiple benefits in terms of increased drought resilience and reduced requirements for pumped drainage in winter. In an iterative process, it is essential to provide feedback along the way, in effect showing the results and benefits of previous co-development. This acknowledges the value of previous contributions and provides stimulus for future input.

The finalized results from the climate change, land use change and catchment management scenarios were shared at the sixth and final LAG meeting. There were nine scenarios, with four apiece for 'agriculture' and 'Great Fen wetland restoration' interests followed by a final merged continuing agriculture and Great Fen wetland restoration scenario under climate change (with 9 combinations of time period and emissions scenario). Based on local interests gathered through the LAG process, the agricultural scenarios included increased peat wastage, potential for reduced irrigation and potential for more drought tolerant crops. The Great Fen wetland restoration scenarios included more flexible water abstraction for winter storage, varying sizes of potential reservoirs for habitat restoration and the potential impact in a reduction in the water diverted into the catchment from the River Nene (due to increased abstraction for public water supply). These scenarios were really tied into the local, in terms of local crops, local wetland plant communities, local soils and local water management. It would not have been possible to develop such locally resonant scenarios without the LAG scenario-ing process. While sharing the results of the scenario modeling, it was important to acknowledge the LAG members who had contributed to the particular results being presented as the work was not solely the work of the scientist, but the co-produced work of the involved group as a whole.

Community Storyboard Scenario-ing Workshop with the Great Fen project

In addition to their involvement in the LAG process, some local stakeholders, working with the research team, co-designed public engagement activities to expand the exploration of future scenarios with the general public, as it

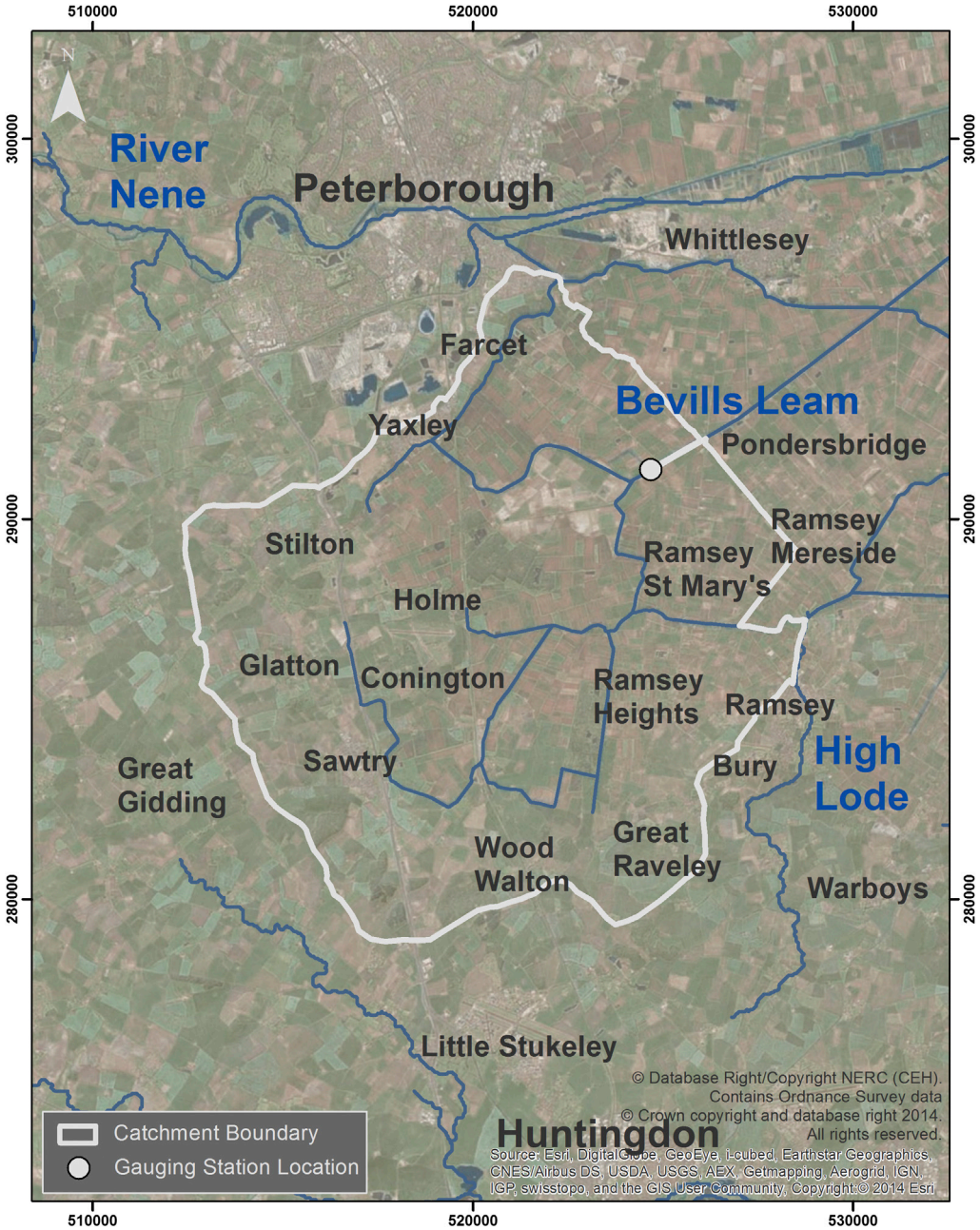

FIGURE 4 | Bevills Leam catchment map.

happened during the community storyboard scenario-ing workshop organized with the Great Fen project (**Figure 2**). The Great Fen project is an ambitious restoration initiative led by Environment Agency, Huntingdonshire District Council, Middle Level Commissioners, Natural England, The Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire, with the vision of restoring 14 square miles of land to wild fen and creating in 50 years-time a vast nature recovery network between Peterborough and Huntingdon, in Cambridgeshire. Since 2001, they have been undertaking local consultations and, more recently, they have been also contributing to research projects, such as DRY, to expand their public engagement activities and understand people's perceptions around their long-term plans. As part of DRY project, the Great Fen project was actively involved in the Local Advisory Group for the Bevills Leam catchment, and hosted local meetings and storytelling community workshops.

In February 2018, during a storyboarding workshop, facilitated in collaboration with the cartoonist John Elson, at

the Wildlife Trust Countryside Centre, in Ramsey Heights, local community members were invited to imagine future water stories about climate change impacts in the Fenland in the next 30/60 years. Scientific scenario-ing was briefly introduced by examining potential future impacts of climate change at a local level, including accessible summaries of climate change projections for seasonal changes in temperature and rainfall compared to the 1961–1990 baseline period. Participants were then invited to use this scientific framework to set the context for their story by selecting one of the three potential greenhouse gas emissions scenarios ('low', 'medium' and 'high'), and to project that scenario into one of two given time-frames, the 2050s and the 2080s (see **Figure 4** for cartoon note-taking from the science-narrative scenario-ing workshop). Before starting the practical and creative part of the workshop, participants reflected collectively on how to frame their ideas in a narrative form, and how to visually represent the story arc on a simplified storyboarding template in four blocks that they were expected to complete in an hour. Looking at previous examples of using a similar template to develop stories on water use and showing what was created during a previous LAG meeting was an effective way of explaining the creative process. The majority of them worked individually drawing and writing text on their own storyboard; some worked in pairs, with one being the storyteller and the other one the story-listener and creator of the storyboard. Two participants were supported by the cartoonist John Elson to visually translate their thoughts into drawings. After everyone had completed the storyboard, all the stories were shared with the group, and further discussions were facilitated to scope variables that will change in the Bevills Leam catchment over time in the near and far future, and also to explore the scale of that change.

When community members reflected on both land use and demographic scenarios, urbanization and population growth in the areas around Peterborough, Huntingdon and Cambridge were mentioned. This was often linked to the growing disconnection of the new population with the local heritage and landscape, and more broadly a general disconnection between the city and the countryside. Other stories revealed different hierarchies of needs among various sectors, and also different ways of perceiving impacts of the Great Fen project on land use. Talking about population growth linked to the wetland restoration project, a local farmer expressed his apprehension about increasing food demand:

> "I look at really good farmland around here, which is going to be flooded and taken out of production. I'm all for not just myself being self-sufficient, but the whole country being self-sufficient and were going to end up importing a lot of food".

Extreme weather events were often considered in stories that included water use scenarios (see as example: the story "The Fens in 2050": https://dryutility.info/2019/02/08/the-fens-in-2050-following-high-emissions-seasonal-mosaic-of-water/), especially to talk about the role of agriculture within the restoration project, and also to reflect on how vital reservoirs are for farmers' drought resilience and how farmers could contribute to undertake flood mitigation measures, with potential implications on land use. While listening to other stories, those types of concerns were mitigated by the general understanding that new measures are required for better local water management. One community member highlighted:

> "The Great Fen should hopefully sort out water storage and hold some of that back, then release it back in the summer. We need something in the future because of the way the patterns have changed".

For the ones who imagined a positive future scenario linked to a wider access to green and open spaces, such as the Great Fen area, the positive impact of the natural environment on communities' health and wellbeing was a recurrent theme (See, as example, the story "The Great Fen is a diamond: https://dryutility.info/2019/02/08/the-great-fen-is-a-diamond-exploring-the-conflict-between-people-and-wildlife/). One of the participants pictured the area as a 'green lung' that in the future will mitigate the increasing air pollution.

Comparing stories is a way of uncovering conflicts and dilemmas, and of discovering unexpected common ground in the dialogue between lay and specialist narratives due to the authenticity of personal stories and the natural 'mess' (Wilson, 2014) of the world that storytelling both exposes and helps us navigate. Furthermore, exploring future scenarios with different sectors of society through science-informed storyboarding activities revealed a critical tension around the interaction between opinions and facts, which requires a deeper reflection on the perceptions, beliefs and value-systems that drive people's behaviours. This also highlights the urgency of connecting scientific and local knowledge, and of approaching stories as a way of beginning a conversation that allows facts to be better engaged with. In addition to analyzing the stories produced during the workshop in a way that could inform our research process and enhance our understanding of the variety of local needs, we have also reflected with the stakeholders on the co-production process itself, and in particular on our creative experiments to bridge scientific and community knowledge, and explore future scenarios.

One of the measures of success of this type of intervention was for us their replicability in various contexts and beyond the duration of our project. In this regard, the feedback received from LAG members offered a very positive insight, as said by a participant from a local Angling Trust:

> 'From my prospective the most useful output from the DRY project was the underlying experience from the citizen trial and evidence. I have used the material and experience many times and even most recently as pressures continue on water needs'.

DISCUSSION AND CONCLUSIONS

In returning to our three aims, we found that exploring future scenarios across disciplines and knowledge systems generated multiple transitions in ways of thinking as part of what was revealed to be a transformative process for multiple actors. These

FIGURE 5 | Cartoon note-taking from the science-narrative scenario-ing workshop.

diverse actors comprised the researchers of different disciplines involved in DRY, the local stakeholders in the catchment as individuals, and the local community.

Inter- and Trans-Disciplinary Reflections on Our Processes

Various positive impacts were gained through feedback and observation during the participatory storyboard scenario-ing workshops designed and delivered as part of DRY. The process supported co-design and co-creation, enabling specialists and 'lay' people (that can be expert in their realm) to work together. It made communication and deliberation (during and after the creative process) more accessible and engaging, and translated scientific principles into locally meaningful information. Critical reflection was encouraged throughout the process on the impact of individuals' behaviours on community preparedness and resilience. The storyboard scenario-ing promoted creative thinking and open sharing about different possible futures and anticipatory adaptation.

Yet the two main obstacles identified as potential disadvantages of storyboarding scenario-ing revealed opportunities for further improvements of the process. For instance, a cartoonist was invited to be part of the workshops and help resolve the potential barrier of drawing, working closely with those participants who appeared to be reluctant for various reasons to do so. His contribution to the creative process also emphasized the importance of dialogue and active listening in storytelling, and highlighted some crucial issues within the knowledge sharing processes, in particular related to jargon, specialist language and scientific capital. Furthermore, the use of storyboarding as tool for creating stories about an imaginative future sometimes generated contributions that are far off the 'what is a drought story?'. To respond to this lack of focus or obliqueness of some of the stories reflecting on future scenarios, during story screening sessions and participatory tagging activities organized with local stakeholders, we have proposed the use of a bull's eye target (see **Figure 5**) as a way of defining the spectrum of themes included in the DRY Story Bank (https://dryutility.info/story-bank/) and their 'distance' from the central theme of drought risk.

Reflections on Transitions

Scenario-ing was approached as a 'bridging concept' in our creative experimentation with science and narrative, as something to which everyone could relate, but throughout this journey, it manifested as something more than a process to link different entities. In fact, throughout our participatory processes that started with an exploration of language and meanings, scenario-ing was found to be better represented as a coalescing concept. Here different components were integrated into one new holistic concept, working beyond any simplistic notion of 'bridging', looking outwards in multiple directions, to draw in meaningful experiences and practices, and shifts in understanding, some transformative.

We are not pretending here that it was a neat and linear process. We recognize that some of the actors, who found it questioning of their pre-existing ways of working and practices, preferred to withdraw rather than trying to adapt to some of the

challenges implied in this collective journey. Those who were open to dialogue within hybrid knowledge systems that value both science and lived experience, have participated in a set of transitions that produced an innovative model of transdisciplinary and inter-professional work.

[Transition 1] Insights to Inform Scenario-Ing as Concept and Practice

The scenario-ing work in the Bevills Leam catchment provided an opportunity to experiment creatively in how to communicate complex results and invite dialogic moments in a group with very varying levels of scientific and technical expertize, and different narrative capital. As well as providing sets of technical tables and plots with detailed results for each broad scenario class, the scientist, working in opening up his science, also attempted to distil the key information down into higher level text summaries, and finally into a bullet point summary of 'take home messages' presented in accessible qualitative terms. Starting with these summaries provided a route into the results without overwhelming the LAG members with all the scientific details. It was then possible to explore and discuss selected scenarios, based on the specific interests of those LAG members present at the final meeting. The iterative longitudinal nature of the LAG process also presented challenges, particularly in the temptation for the scientist to keep improving the hydrological model as much as possible, given the extended timeframe for model development and calibration. It was also challenging at times to reconcile local practice and theory. For example, in the Bevills Leam catchment, much irrigation practice is based on experiential knowledge, with little regard made to published irrigation guidelines. This required model development to include more realistic, but unquantified, practices. It was also important to manage expectations and remain impartial. Some potential drought indices suggested based on local interests were not possible given the scope of the hydrological model, and it was important to select a balanced range of scenarios for modeling.

[Transition 2] Developing Researcher Skills at Transdisciplinary Scenario-Ing Interface

Communication and creativity are constantly interwoven within the catchment-based DRY-LAG process, and this implied scientific upskilling on working with narrative approaches. Storyboard scenario-ing progressively unfolded its own strong arts elements and required the co-design of different participatory tools and a longer two-way engagement process. At the start of that process, our scientist introduced the drought risk science using a formal presentation with multiple slides with graphs that although as scientific convention might expect, may in hindsight have been too technical for some of the LAG members. Scientific communication at the LAG meetings evolved into more informal presentations with less formal graphs, often with digressions, anecdotes, vignettes and discussion, in effect bringing story into the science. For one of the early meetings, the scientist spent some time providing a hands on demonstration of the Bevills Leam water balance model, both to demystify the science and to demonstrate how changes in model inputs affected the model behaviour. This both opened up the hydrological modeling process and emphasized the high degree of flexibility in the model which would facilitate the incorporation of local knowledge, understanding and land use and catchment water management scenarios. At the final LAG meeting, the scientist and the stakeholders, as a group, had the opportunity to participate in a storyboard scenario-ing activity: participants were creatively stimulated to investigate scenarios of particular interest in a more conversational style and use their imagination to explore possible adaptive scenarios for uncertain and hidden future risks. The scientist definitely changed from being somewhat apprehensive with an unknown audience at the first LAG to very comfortable with a trusted group of co-developers at the final LAG, and this was reflected in their communication skills within an art-based process. As a proof of that 'transition', when the scientist presented his storyboard during the sixth LAG, it is worthwhile sharing a comment form a participant:

> 'You're wasted at CEH. You should think for a change in your career'.

Nevertheless, there was a tangible difference between the scenario-ing in longitudinal engagement with LAG members, and that in the one-off community workshop. Stakeholders' participation within the LAG process allowed deeper connection with the science in a longer-term perspective, and also more familiarity with the storytelling approach. One-off workshops presented the challenge of making several aspects of our processes accessible to the general public in a short time. This involved exposure both to new cultures, and the interweave of science and storytelling, with the ambition to create a safe environment for knowledge sharing and for co-developing a practice.

[Transition 3] Challenging Storytelling: From Personal Memories to Future Community Narratives

The scenario-ing process represented a learning experience for local stakeholders as well as for academics from the arts and humanities and beyond: stories float around within the science; they exist within the world of science in a way that it was not expected when this coproduction process started. The original assumption that imagined the science world as being very closed and very protective through its use of specialist knowledge language, very difficult to penetrate and being very suspicious of people, was completely dismantled by this co-production of knowledge. That is not to say that the original assumption was incorrect, but that our scientist was interested and willing to experiment with a more flexible and open scientific approach without succumbing to peer pressure from more traditional colleagues. This may well have been aided by his prior exposure to the humanities as an undergraduate and an interest in the arts, leading to a receptive view of multi-disciplinary working. Science therefore opened its doors to other disciplines and knowledge systems, and offered storytelling a new platform to challenge the practice itself and experiment with two main transitions: from past to future, and from individual to community storytelling.

While creating their stories to explore future scenarios, LAG members and local stakeholders shifted from personal memories

to community-oriented stories much more often than while recalling memories from their past lived experiences. One participant concisely pinpointed something that completely changed our perspective:

> 'I remember my life as individual because I know more details and I can explore those memories more deeply from a personal perspective; but I project myself in the future as a community member or on behalf of someone else, my children, someone younger than me, because it's easier to imagine the unknown as a shared and collective experience'.

Switching from memories to future projections throughout the creative process appeared to be perceived as a sort of transition from self-interest to participation (Liguori 2019).

The connection between imagination and community building is articulated by Irene Baker thus: 'Listening to a story is not a passive act. It engages imagination and abstraction. It creates a community' (Dorer, 2018, pp. xxviii, 20). Her main focus is on the educational value of storytelling. Nevertheless, she is mainly referring to the social function of story-sharing that is revealed to be even more evident when future stories are created.

[Transition 4] Valuing Hybrid Knowledge: Towards Inclusive Knowledge Networks

Transition in how the different knowledges were valued in the process occurred when scientists shared the decision-making around the progression of the science with the stakeholders, in particular about data, quality and its gaps (what to collect and how).

To counterbalance the challenge of presenting scientific data when it is over-simplified to make information accessible, new settings for scenario-ing engagements were developed. This was particularly relevant to the specificity of the landscape in the Fenland in which the local community wants to be informed about how the system is managed to understand the flood/drought nexus, and be more proactive in thinking about its future management and also in terms of socio-ecological resilience. This was in spite of the potential tensions between ecological thinking and adaptive strategies from one side, and engineering thinking to control the system on the other side; and additional potential tensions with farming vs. ecology. The latter in fact did not materialize during our research project, perhaps as those farmers participating were self-selecting, and therefore more open to different views and perhaps all too well aware of long-term issues of peat wastage and consequences for agricultural productivity.

In the Bevills Leam catchment, additional field visits, communal eating and collective dialogue within the landscape as part of the LAG meetings (hosted each time in a different venue by one of the organisations involved in the process) were found to be an excellent way of both exploring the various catchment interests and their future interaction (e.g. farming, wetland restoration and drainage) in more detail and also building a strong LAG group. The LAG members were in effect opening up their work, their lived experience, in the catchment, showcasing achievements and highlighting issues, and in doing so providing a far deeper insight and understanding for the wider group, including the scientists.

CONCLUSION: TOWARDS 'CREATIVE PARTICIPATORY SCIENCE'?

Storyboarding scenario-ing was revealed to be a new way of creative participatory working in transdisciplinary research, innovatively involved socially-engaged arts practices in creative participatory science. This distinctive longitudinal process was found particularly effective as a co-produced open research method that could be adapted and re-applied in various contexts or fora that aim to promote dialogue, knowledge co-generation, and deliberative democracy. This is despite its uniqueness in terms of levels of creativity and human capital and the specificities of locale.

One of the main learning outcomes for the researchers was generated by multiple 'lay-ness', derived by the fact that each of the actors involved in our research process (academics from different disciplines, multi-sectorial stakeholders from a catchment, and community members from different groups of the society) has challenged the self-evidence and truth of each other's practice, knowledge, beliefs and value systems, questioning the validity of what was done. By doing so, each of the actors involved in this 'journey' had to adapt their own language and forms of expression (oral, visual) to make both the process and the outcome meaningful to everyone. This co-creative journey was always nourished by the awareness that risks were involved in the process and serendipity could generate innovative approaches and insights. Within this process, a strong arts element catalyzed participants' creativity and produced methodological innovation as an iterative experience: by interweaving different skills and languages (including drawing and song-writing), new participatory tools and arts practice were co-designed and applied. Some of them have also already demonstrated their transferability and success in other research and community engagement contexts. In particular, the storyboard scenario-ing has been adapted and re-applied as a workshop practice for museum audience engagement by educators at the Smithsonian Institution in the United States, and as a tool for youth participation as part of the East Education Summer School at Here East in Queen Elizabeth Olympic Park in London; 'The Reasons' event, including community song-writing, was re-framed and performed in a Nairobi slum, in Kenya, as part of an initiative led by UN Live – The Museum for the United Nations on UN Sustainable Development Goals. The efficacy of these different participatory tools on public engagement and co-production of knowledge, and their very effective replicability, would suggest that a more diffuse and meaningful use of creative methods (also co-facilitated by professional artists) would be desirable to achieve a greater impact of research around environmental issues and to pursue a more active and deep community engagement on societal challenges.

In hybrid-knowledge research environments as within DRY, it is important to emphasize the role of individuals, in terms of dispositions and skill-sets, to facilitate discussions for the co-production of knowledge. It is not just the method that counts; it is also how it plays out iteratively within an evolving co-productive 'community of practice'. There is in fact an important human element to be considered: in this specific case

study, social dynamics also worked well because there was a significant investment in terms of time and energy to create local connections, personal and collective relationships, and build mutual trust across all participants including the research team. It is obvious to observe that where those connections are generated and nourished over time in a research process, the legacy of community-based research and learning will last longer.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://dryutility.info/.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Approvals (Human Participants) Sub-Committee, Loughborough University, United Kingdom. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors contributed to conception, design and evolution of the DRY study. JB performed the drought risk hydrological modelling and associated scenario-ing. The participatory research process involved all authors. AL, LM, and JB wrote the first draft of the manuscript, with MW providing first edit. All authors contributed to manuscript revision, read, and approved the submitted version.

FUNDING

DRY – Drought Risk and You Project was funded by: Natural Environment Research Council (NERC), Arts and Humanities Research Council (AHRC), Biotechnology and Biological Sciences Research Council (BBSRC), Economic and Social Research Council (ESRC), Engineering and Physical Sciences Research Council (EPSRC). The DRY project was funded through United Kingdom Natural Environmental Research Council Grant (No: NE/L01033X/1).

ACKNOWLEDGMENTS

The process described in this article was co-designed with local stakeholders representing the following organisations in the Bevills Leam catchment, listed here in alphabetical order: Anglian Water, Angling Trust, Environment Agency, Fenland Trust, Great Fen Project, Huntingdonshire District Council, Middle Level Commissioners, National Farmers Union, Natural England, Warboys Archaeology Project, Warboys Local History Society, Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire. Special thanks to the cartoonist John Elson who co-facilitated with the research team the storyboarding process during the community workshop at the Great Fen Project. The contributions of the wider DRY research consortium are also acknowledged, as are those of participants in the Bevills Leam catchment.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.