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Department for Environment Food & Rural Affairs

Evidence Project Final Report

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Project identification

1. Defra Project code: WT15124
2. Project title: Reviewing Approaches for communicating Drought status And Risk (RADAR)
3. Contractor organisation(s): UK Centre for Ecology & Hydrology
   Open University
4. Total Defra project costs (agreed fixed price): £ 99428.36
5. Project: start date ..... 25th January 2020
   end date ..... 30th June 2021

6. It is Defra's intention to publish this form.

   Please confirm your agreement to do so.....**YES** ☒ **NO** ☐

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   (b) If you have answered NO, please explain why the Final report should not be released into public domain

Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

Drought events are notoriously difficult to communicate due to their large spatial scale, slow onset, and typically long duration. There are many different practitioners and stakeholders affected by drought, who need to both disseminate and receive drought communications before, during and after drought events in order to make strategic decisions.

The aims of the RADAR project were Reviewing Approaches for communicating Drought status And Risk, co-developing alternative approaches, and examining the appropriateness of these alternatives for different sectors and communities, reaching a suggested solution for a cross-sectoral drought communication platform. This was achieved via a Quick Scoping Review of the relevant literature, an online survey, targeted Focus Groups, and reporting on the results across multiple media (reports, a slide pack, and an animated video).

The Quick Scoping Review systematically evaluated 101 documents, with an additional 56 documents added for completeness. The online survey assessed what drought communications are sent, and received in the UK, which are considered effective, and who are the trusted communicators. The respondents showed most trust in the regulators, followed by academics, water companies, central government, NGOs and environmental groups. Social media, TV/radio, and emails/text/phone alerts were considered the most effective means of drought risk communication. Seven key themes were identified from the literature review and the survey together:

1. Language – explain and expand on definitions were necessary. Use the word drought where appropriate,
2. Communication routes – enable a two-way system with multiple routes of communication,
3. Availability – make materials openly and publicly available,
4. Trust – drought risk communications must come from trusted, verified sources,
5. Delivery – the right delivery method must be chosen, e.g., social media, formal reporting etc. online, and simple methods are preferred,
6. Design – drought risk communications need to be carefully designed paying particular attention to accessibility, being appropriate for the audience, being emotive and empowering action,
7. Timing – drought risk communication needs to be sent at the right time before, during and after a drought; long term understanding is also needed.

Focus groups were conducted across three "user" groups: agriculture, environment, and communities, and

one “providers” group; each group convened twice.

The first round of Focus Groups were used to explore current drought communication systems in use by each sector and map the diverse routes of information described by the participants. Based on the key themes identified in the literature, strengths, limitations, and opportunities of various elements were discussed, and routes forward were suggested. Drought risk communications are experienced in different ways by the different user, and provider groups, though common conditions for effective communications emerged, which were closely aligned with those identified in the literature and survey. Trust was perhaps the most important of these conditions, though trust depends not only on WHO sends the communications, but also HOW they are sent (by what means), WHAT the format and messages are, and WHEN they are sent. Participants also particularly noted that drought risk communications should enable:

- Continuous status reporting,
- In-drought incident communications, and
- Long-term understanding of the flood-drought continuum and changing risks with climate change.

The RADAR project team used these findings to develop a conceptual “Central Drought Hub” for cross-sectoral two-way communication of drought at a range of spatial and temporal scales. The central drought hub concept requires an underpinning consortium of trusted communications providers, careful consideration of the 7 key communication themes, as well as resources to enable the three temporal elements of drought risk understanding identified above. Mock up slides of a drought hub website were produced and were shared and reviewed in a second round of Focus Groups.

The prospect and design of the Central Drought Hub, collating such drought resources and communications into one place was well-received by the Focus Group participants, and presents an opportunity for further development of this research into an operational solution for UK drought risk communication.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Exchange).

Reviewing Approaches for communicating Drought status And Risk (RADAR)

1. Aim and Objectives

The overall aim of the RADAR project was to explore alternative, more relevant and useful approaches for communicating drought risk and status. This aim was centred on the following objectives:

1) Review current approaches to communicating drought risk and status
2) Co-develop alternative approaches
3) Test the appropriateness of different drought communication approaches and identify the most promising, and
4) Summarise and disseminate key findings.

Objectives 1-3 form the basis of the first three work packages, with a fourth work package to review the findings and produce guidance for future Drought Risk Communications (DRC), and a fifth for project management. Our approach is conceptually represented in Figure 1.

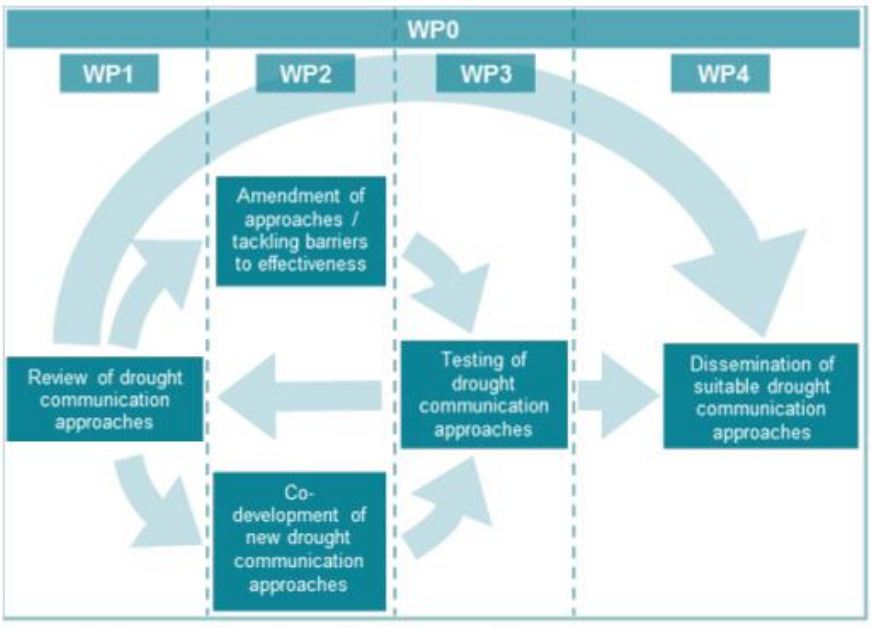

Figure 1 Conceptual diagram of RADAR work package interactions

2. Amended Objectives

The objectives were amended for two principle reasons: (i) the Covid-19 pandemic and associated severe restrictions on movement and working patterns; and (ii) emerging findings from WP1.

Covid-19 restrictions required a shift to wholly online working within the RADAR research team and also when engaging with external stakeholders. This has led to some minor revisions to the aims and more significant changes to deadlines. These were agreed with the Steering Committee. It also necessitated re-consideration of the methodology given the need for shorter, online events.

However, the main changes in RADAR objectives arose from early findings from WP1. The analysis revealed that DRC is not simply a technical communication problem which can be solved through better graphics, targeting or media strategies, although these are still relevant. Instead, DRC emerged as a more complex, higher-level issue which requires a commensurate review of multiple factors which constitute DRC processes. In particular, many users find current communication practices are generally fit-for-purpose (in terms of general content) and that some of the major improvements needed are actually in modes and mechanisms of delivery, which are likely to vary across sectors and between users. A central theme that emerged from both the literature review and the online survey was the recognised need for tailored, context-relevant communications. This implied a need for RADAR to adopt a more sector-orientated methodology earlier than originally planned in the proposal. As a combined result of Covid-19 and the WP1 findings, the intention to have day long workshops of mixed groups of stakeholders was

replaced by online, sector-based Focus Groups (FG).

Shorter and repeated FG presented a significant opportunity to have multiple interactions with the same audiences exploring and building on previous discussions and suggestions. The disadvantage was that interaction *between* the sectors (as originally envisaged in Objective 2) was limited, although the material discussed in the second round of FGs was based on cross-sector contributions and analysis. In addition, the RADAR team will be convening a cross-sector event later in 2021 as part of dissemination. The main changes are summarised for each objective below.

1) Review current approaches to communicating drought risk and status. This was achieved through a review of literatures and a survey.

2) Co-develop alternative approaches. Due to the pandemic and social restrictions, meetings and interactive events such as workshops were moved online, limiting time for interactions. Shorter, sector-based FGs were convened rather than day-long cross-sector face-to-face workshops. Repeating the FG and the use of shared whiteboard technologies ensured the online meetings were effective in understanding participants' experiences, communicating our early findings and bringing the required interactivity to the events. Within sectors, participants were able to contribute and co-develop their ideas and suggestions for future DRC.

3) Test the appropriateness of different drought communication approaches and identify the most promising. The focus of this objective was moved away from 'testing' in an absolute sense to understanding the appropriateness of different DRC approaches and how 'appropriateness' varied according to context, sectors and needs of diverse providers and user communities. Suggestions and recommendations to improve DRC emerging from the literature, survey and FGs were reviewed by the DRC provider and user representatives in the FGs.

4) Summarise and disseminate key findings. This report, other documentary material and online workshops and outputs provide summaries and constitute dissemination of our key findings. The contracted outputs are:

O1.1 – Method for Rapid Evidence Assessment
- This was achieved, and a protocol submitted.

O1.2 – Rapid Evidence Assessment of literature
- This was achieved, and an 83 page Quick Scoping Review (QSR) was submitted. This activity took substantially more time and staff resource than expected.

O1.3 – Survey to assess stakeholder use and production of drought communications
- This was achieved, a survey of 32 questions was issued using "online survey", and 160 responses were obtained.

O1.4 – Summary of findings from stakeholder surveys, including fact sheets
- Resource limitations meant a formal summary of the survey findings was not produced. However, a PDF of the responses in summary was extracted. Key graphs and infographics were also produced from the findings to support the first round of FGs and feature in the Slide Deck and video (see below) and will be used in the scientific paper emerging from RADAR.

O2.1 Examples of drought data presentation improvements to existing or alternative approaches
- As explained above, this activity was amended as the findings of the QSR and Survey found that the issues with DRC were more rooted in contexts, communication systems, and modes and methods of delivery, rather than in the specifics of data presentation. Therefore, alternative materials to support the first round of FGs were produced. These included key themes identified by the first task, our understanding of the DRC system for each sector, and examples of communications currently produced, to enable participants to critique and suggest improvements and alternatives.

O2.2 Report on the findings of the Workshops
- These workshops were conducted as FGs, and reports were written up to summarise the discussions for each of the four FGs.

O3.1 Mock-ups of communication methods incorporating drought data as well as findings and feedback from the FGs undertaken in Task 3.2
- A conceptual diagram of an idealised DRC system was developed, based on the learning from RADAR. Mock-ups of web pages that could help achieve that system were also produced.

O3.2 Reports on the FGs
- This was achieved, a combined report was written to summarise the findings of all eight FGs.

O3.3 Webinars or testing packs for engaging with wider networks

- A webinar to present the findings of RADAR will be scheduled once the final documentation has been approved. Testing packs were no longer deemed appropriate given the direction of the research.

O4.1 Final report on recommendations of approaches

- This report serves as the final report on recommendations, along with the animated video

O4.2 Summary of key findings presented in a slide-pack

- This was achieved

O4.3 Blog post, social media coverage of the BHS meeting and a meeting review in BHS newsletter 'Circulation'

- This will be arranged once the final documentation has been approved by the Steering Committee.

O4.4 Journal article to be submitted to Geoscience Communication

- This could not be achieved during the time frame of the project, but it is anticipated that a journal article will be produced making use of the approved final reporting material. The draft article will need to be approved by the Steering Committee.

Animated video

Due to the Coronavirus outbreak, travel and subsistence funds could not be spent conducting workshops and FGs. Therefore, with agreement from the Steering Committee, these funds were utilised to hire a graphics design company to produce an animated video summarising the RADAR project and its findings. This constitutes a valuable additional dissemination tool.

3. Methods

3.1 Design & Approach

Our overall approach and methodology recognised that communicating drought status and risk needed to be more than a linear and technical process and more than a PR strategy. Reception of communications about drought will always be mediated and interpreted in the light of historical antecedents, previous experiences of risk, stakeholder perspectives and practices in any given sector or socio-ecological context. Equally, the diversity of stakeholders means that communicating drought status and risk requires commensurate diversity. Our methodology was designed as (i) a review of existing literature and indicators; (ii) a co-inquiry into meaningful indicators and communication strategies with diverse stakeholders; and (iii) development of communication strategies. As noted above in section 2, some aspects of the design were altered due to Covid-19 restrictions and emerging findings.

Given the restrictions, our methodological approach consisted of a Quick Scoping Review, an online survey and a series of FGs with user and provider communities in England and Wales.

3.2 Quick Scoping Review

A Quick scoping review (QSR) was chosen to determine current research and practice. A QSR is not a full scale 'traditional' literature review, but was chosen because of the open nature of the primary question. The QSR seeks to reveal the breadth of communication approaches, methods and platforms that have been employed to date. The QSR consisted of a semi-systematic search of online materials, and collation of policy documents identified and provided by stakeholders. These documents were then appraised for their methods and approaches to communicating drought risk.

The QSR was conducted to address the primary question and two additional themes:

- **What are the existing means of communicating drought status and risk?**
- **What are the existing dissemination methods used to communicate drought status and risk?**
- **Are existing communication methods effective?**

We were aware that 'dissemination' tends to assume and frame communication as one-way, top-down process. Approaches to communicating flood status and risk, and other environmental risk communication were considered. As this scoping review took place during the Covid-19 pandemic, some literature on health risk communication was also included.

Searches using Google Scholar and Web of Knowledge were based on the keyword “drought” in conjunction with “messages”, “media”, “management”, “communication” and “risk” in various combinations. The terms “dry spells” and “water shortage” produced limited results in the academic literature. “Flood” in combination with the above keywords was also used. Literature was filtered by initially reviewing the titles of the studies and disregarding any that were obviously irrelevant e.g. plant stress, and then by reviewing abstracts, methods, and/or discussions of the remaining papers to assess relevance.

A similar protocol was adopted for searching diverse grey literature sources and database. The DRC grey literature can broadly be divided into low-middle income countries and regions and higher income countries, although this boundary is somewhat blurred by regional studies, especially in Asia. As might be expected, the very different contexts mean few of the findings are directly relevant, but some studies provided insights into similar issues, trends and approaches to DRC in the UK. Both UK and international grey literatures include experiences of floods and other ‘environmental’ hazards. Figure 2 summarises the reviewed literature.

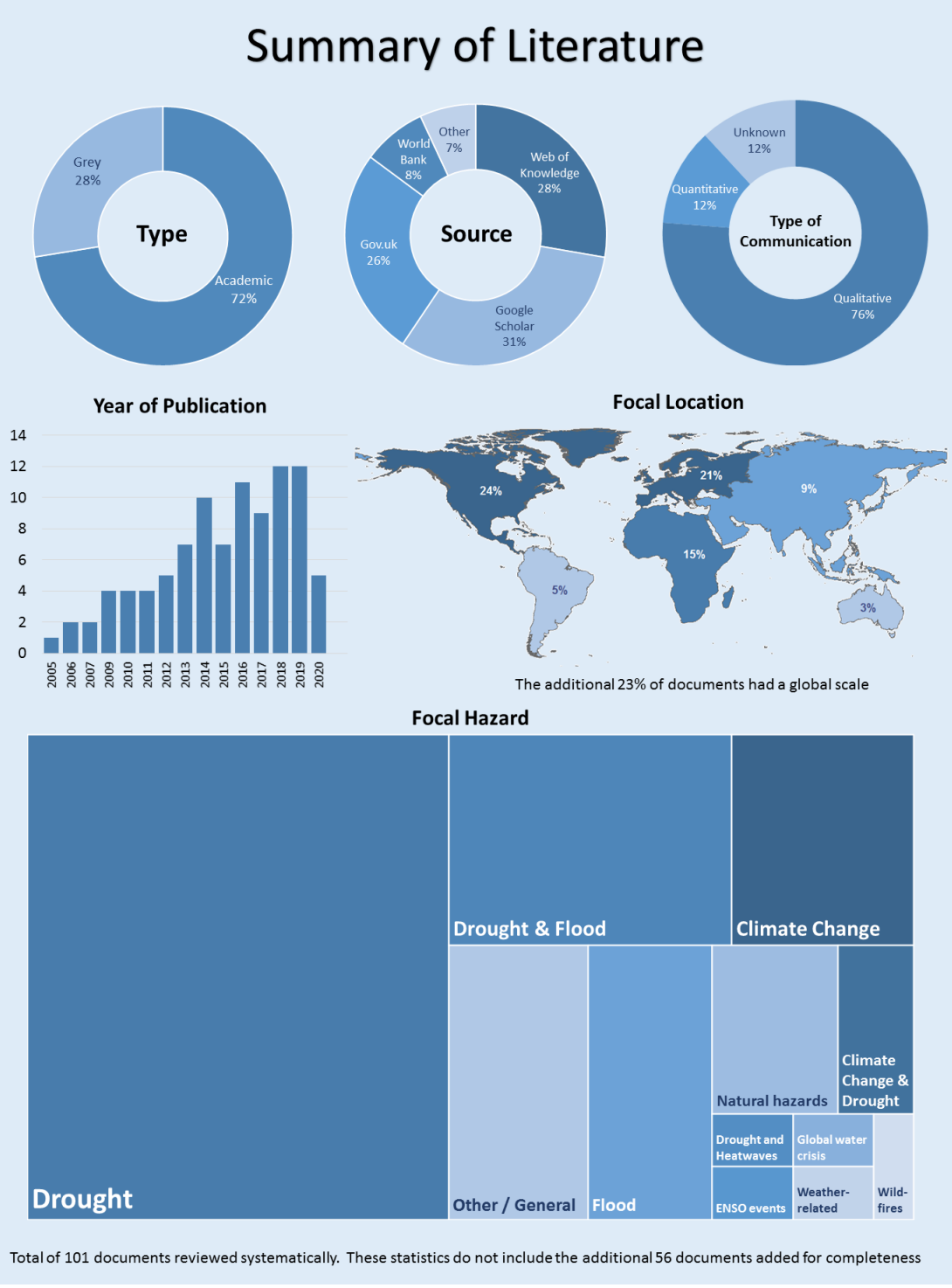

Figure 2 Summary of literature reviewed as part of the Quick Scoping Review.

3.3 Online Survey

In parallel to the QSR, an online survey was compiled to identify methods that have not been found during the literature review, as well as to understand stakeholder perspectives on the effectiveness of the methods they have used or experienced to date. This was sent to those who produce and receive drought (or dry weather) communications, including intermediaries.

The survey consisted of 32 questions, some with multiple parts, and was conducted online between 2nd July and 31st October 2020 and was responded to by 160 members of public and private organisations and representatives of different sectors including regulators, producers, environment and community organisations (as shown in Figure 3).

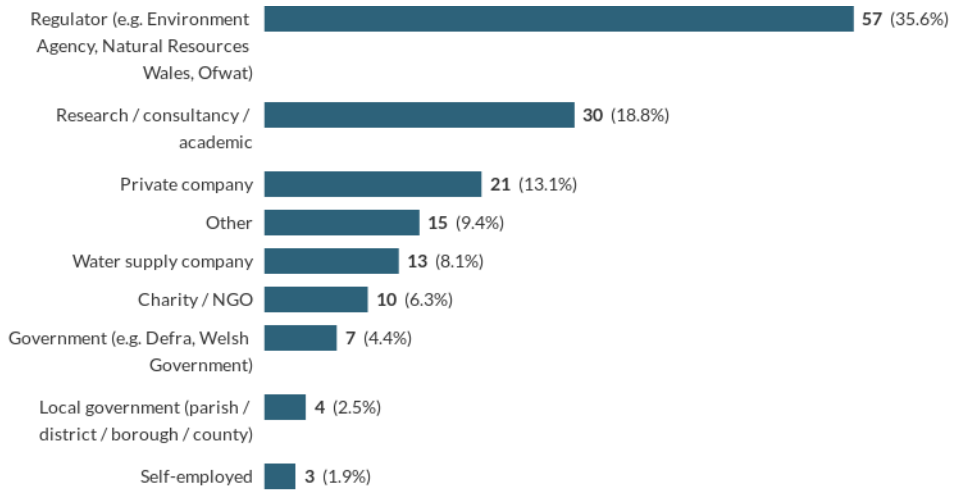

Figure 3 Summary of respondents to the survey

3.4 Focus Groups

The FGs were designed to consider three sectors of DRC "users", and one group of DRC "providers", as shown in Figure 4. The descriptive names for each FG are illustrative and based on information from the project team and individuals who expressed their willingness in the RADAR Survey to participate in the FGs. These broad sectors come out of previous research (such as ENDOWS knowledge exchange component of the NERC Drought & Water Scarcity programme). The 'sectoral' groups are a composite of many smaller sub-sectors (e.g. agriculture could be sub-divided into irrigated/rain-fed, various cropping/livestock types, farmers/growers, and the supply chain and so on), but the main groupings were a pragmatic boundary choice, particularly in the constrained circumstances prevailing at the time.

We also acknowledge that these sectors do not exist in isolation and there are many links between them in the drought management/communication system. Some 'users' will also be 'producers,' dependent on their multiple roles. During the FGs it also became clear that some organisations were intermediaries i.e. passing on DRC from others to their own networks. Our demarcation of sectors also does not encompass 'all' users – business and industry for example are brought into each of these groups rather than seen as its own sector.

Within these caveats, the three groups of users accommodate and represent a range of both public and private sector entities due to overlapping and cross-cutting interests.

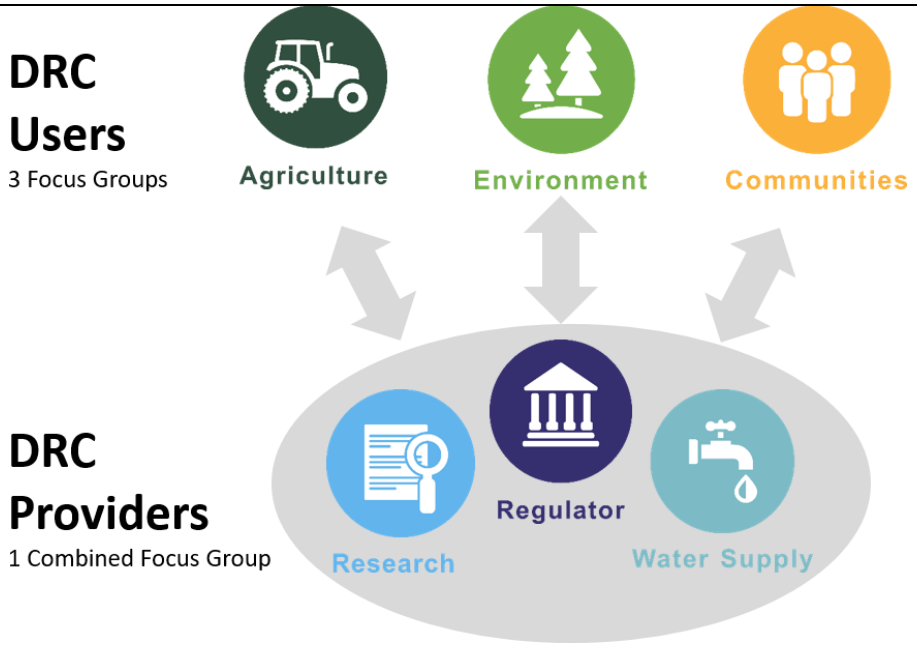

Figure 4 Schematic of Focus Group Participants

The FG sessions were iterative, with the first round held in December 2020/January 2021 and the second round held in April/May 2021. Each iteration had a different purpose.

Purpose of the First Round of Focus Groups

The first round of FGs explored the current DRC systems experienced by different user groups. Draft systems maps were produced by the RADAR team to help record, collate and convey the provision, scope and diverse routes of DRC described by participants. Strengths, limitations and opportunities of various elements (based on the eight key questions - see Table 1, section 4.4), such as language, delivery format, timing and intention) of existing approaches were also discussed and noted. Finally, participants' suggested improvements and routes forward were documented. The FG report from round 1 was made available to each specific FG for review prior to round 2.

Purpose of the Second Round of Focus Groups

The second round of FGs aimed to review the combined findings (i.e. integrating across all sectors) of the first round, and then to critically review the hub design concept developed by the RADAR team as a possible means to address some of the findings and issues identified. Again, comments and implementation planning beyond the lifetime of the RADAR project were considered.

Focus Group Approach

The FGs were convened on Microsoft "Teams" and facilitated by the RADAR team. Each FG round used a combination of presentations, open discussion and e-whiteboards (MIRO). The latter enabled participants to view a range of visual material and graphics and allowed the RADAR team to directly annotate the presented material with participants' comments and suggestions in real-time. Figure 5 illustrates how whiteboards were used to explore the FG material (note: all FG participants viewed the same screen at any one time).

The results of the FGs are a combination of presentations, written material and annotated diagrams. Although the FG meetings on "Teams" were recorded, the recordings were only as backups for the RADAR researchers in case of IT failures or loss of connection. No transcripts were made. This was to ensure participants were free to comment.

Figure 5 Illustration of a Focus Group, with online whiteboard materials showing real-time annotations on key discussion items

The volume and range of the material produced by each FG was considerable and it is not practical to reproduce it here – individual FG reports from RADAR provide a more comprehensive account.

4. Results and their reliability

4.1 QSR results:

The QSR sought to reveal existing approaches to communicating drought status and risk, their dissemination methods, and their effectiveness. The literature review highlighted a number of key considerations common across DRC in the different settings we considered:

- The need for localised and sector specific communication in order to be relevant
- The range of risks and impacts – not all sectors are impacted equally and at the same time
- The need to express uncertainties and likelihoods, as well as impacts that are understandable
- Data storage and verification – how is drought data gathered, verified and kept up to date?
- Language and terminology – the word “drought” does not resonate with all members of the UK public, but other terms such as “prolonged dry weather” can be seen as ambiguous
- Tone, empowerment and ambition of the communications – how to encourage action?
- Individual and community response to risk
- Complimenting and enhancing drought planning arrangements
- Who is the messenger?
- Timing of messages.

The language of drought was a consistent theme as definitions are contested and vary by sector, context and geography. Similarly, people’s perceptions of risk vary, and longer term understanding needs to be improved. Approaches to communicating drought are very varied, and narratives and storytelling can be effective at fostering behaviour changes, yet statistics are also embraced by certain audiences. Methods of drought dissemination were also varied, and the need for different levels of detail according to audience interest was identified. Social media, emails and news reports were more likely to reach and impact audiences than lengthy drought reports. The timing of drought communication was also highlighted.

The overriding message from the QSR is that the complexities of drought definitions, language, measurement and phenomena in highly contextualised situations with segmented audiences and potential collaborators presents significant challenges to DRC content and processes. Importantly, the QSR revealed that DRC needs to be reframed from a “thing” or a singularity that is communicated, towards being a “system” that has many inter-related elements.

These issues and themes were explored further in the survey and discussion in FGs.

4.2 Reliability of QSR results:

The QSR is not a full scale systematic review but is more replicable than a ‘traditional’ literature review, and was deemed suitable by the team and steering group for revealing the breadth of communication

approaches, methods and platforms that have been employed in DRC and other contexts to date. While any non-systematic literature review is subject to biases and interpretation, steps were taken to ensure wide coverage and repeatability given the project constraints. The QSR focussed on documents published through reputable organisations, or peer reviewed journal articles. Only literature written in English and published in the last 15yrs were reviewed, which places a limit on how comprehensive the review is, but this is standard practice. Even throughout the duration of the RADAR project, grey literature was continually being produced on the subject, as major changes to water management legislation and practice are underway in the UK (e.g. drought plans and water resources management plans). The initial UK focus was expanded to other nations, including Europe, the Americas and Australasia to widen the breadth of DRC approaches. Global scale and non-location specific studies were also included.

4.3 Survey results:

The survey questions were informed by the results of the QSR. The results highlighted that people were concerned about many drought risks including: environmental loss and damage; water supply interruptions; restrictions to abstractions; reduced food production and the extra costs to adapt to or manage drought (Figure 6). Respondents showed good awareness of the risks of drought occurring in the next decade, although it should be noted the survey was not public.

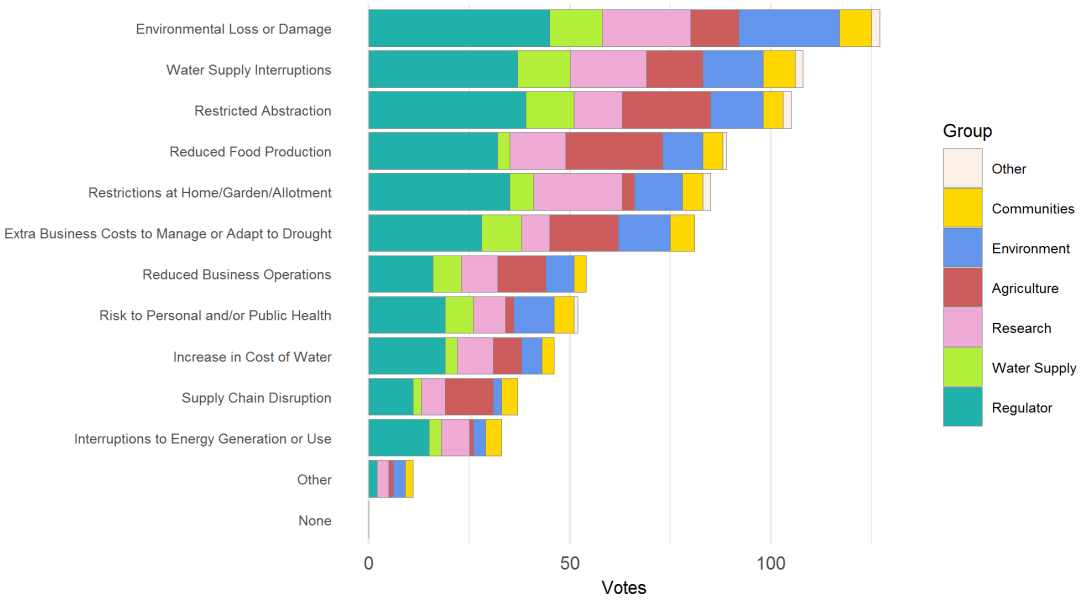

Figure 6 Main drought risks facing online survey participants

The survey also revealed that communications mostly came from regulators and water supply companies (

Figure 7), and that those were the most trusted sources (Figure 8).

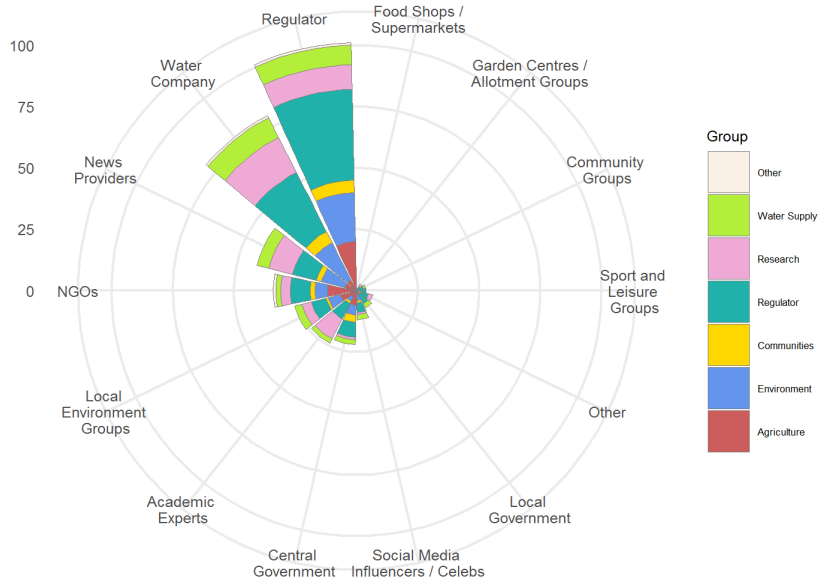

Figure 7 Sources of Drought Risk Communications, according to the online survey

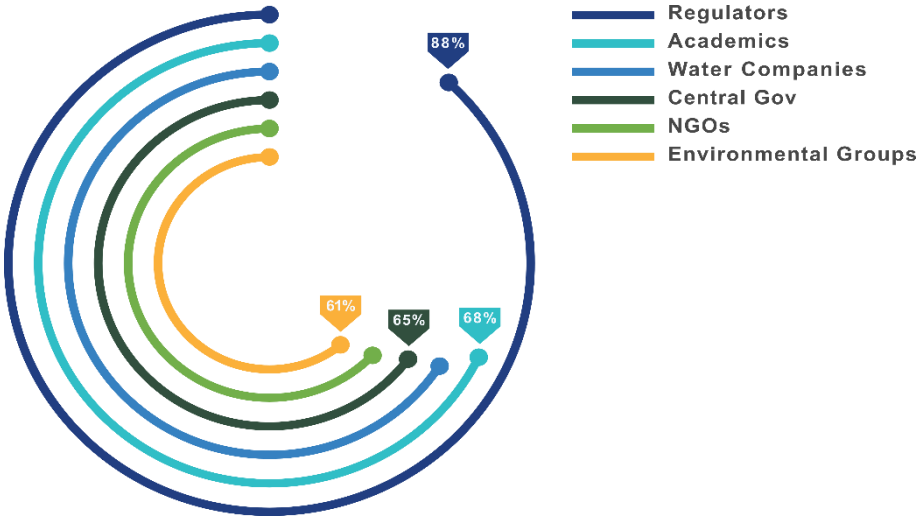

Figure 8 Top 6 most trusted sources of Drought Risk Communication, according to the online survey

Media choices revealed interesting results, as respondents preferred online formats such as social media, TV or radio adverts, and emails. The results implied that "drought reports published online", although widely used, were not a very effective means of communication (Figure 9).

Respondents raised concerns that drought communications need to begin before drought becomes an issue and wish to be informed when the event has ended. However, the substantial majority of respondents that issue drought communications stated that they send drought communications before an event is declared. This mismatch of opinions suggests that drought communications are not always reaching their intended audiences. Similarly, communications producers responded that their drought communications are tailored to a specific locality, yet other responders stated that drought communications could be improved by making them more locally specific. People felt the main barriers to communicating drought risk were: that people do not see drought as an issue in the UK; people are not interested or do not care; and that people do not feel empowered to take action or don't think they can make a difference.

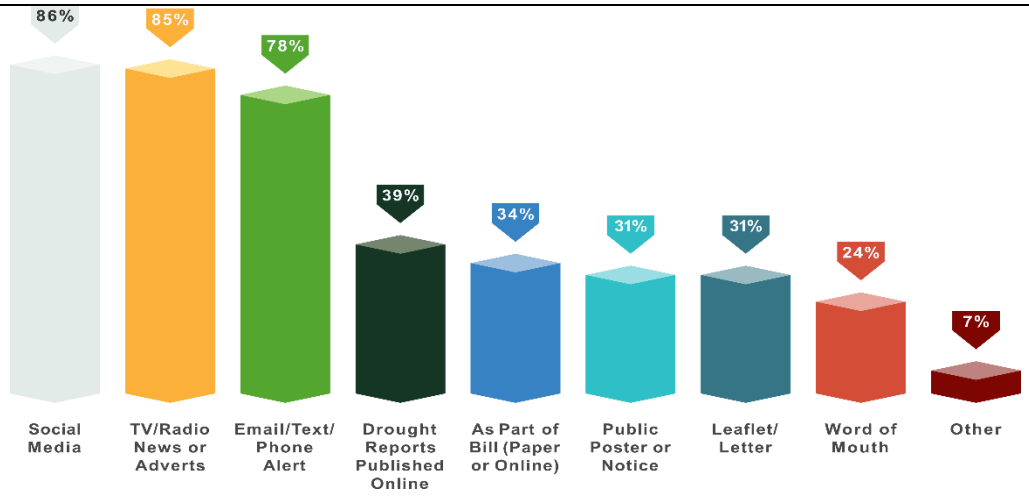

Figure 9 Most effective methods of Drought Risk Communication, according to the online survey

These comments suggest the main issues with DRC are centred on public perceptions of drought and their ability to respond. This in turn suggests that the framing of the communications, and long term understanding of drought need to be addressed.

In terms of improving DRC, there was preference for: earlier communications, situation reporting at a local level and suggested actions for individuals and organisations. Some support was also evident to make DRC easier to understand using graphics and images, although media diversity was less a concern for survey respondents than expected (see Figure 10).

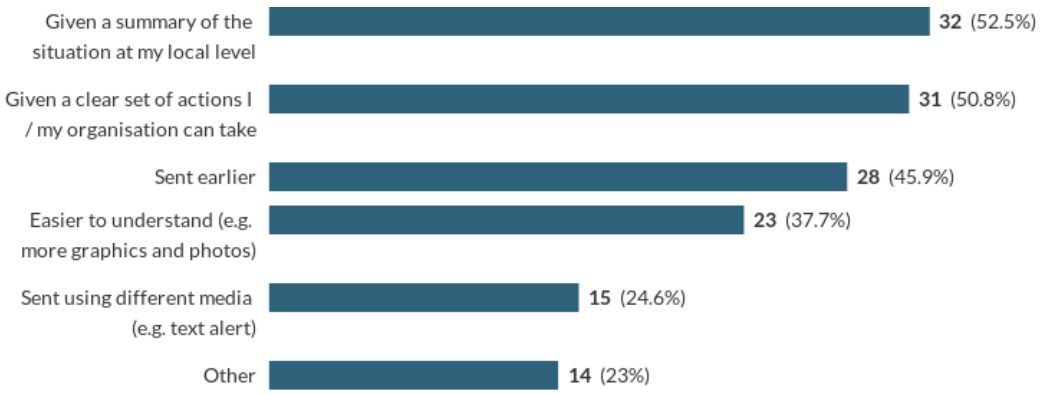

Figure 10 Suggested means of improving Drought Risk Communications, according to the online survey

The Quick Scoping Review, and the online survey, revealed 8 key questions that were put forward for discussion at the FGs.

Table 1 Key questions resulting from the QSR and online survey, used to inform the Focus Group discussions

WHAT is measured (indicators, Return Periods, uncertainty)	**WHEN** is it delivered (timeliness, frequency)
WHAT is described (language of “drought”, “normal”, anomalies)	**WHO** delivers it (trusted messengers, intermediaries)
HOW is it conveyed (visualisations, narratives, traffic lights, comparisons)	**WHO** is it delivered to (segmentation of audiences, tailoring of messages)
HOW is it delivered (twitter, emails, letters….. web portals)	**WHY** is it communicated (behaviour changes, building long-term resilience)

4.4 Reliability of Survey results:

The online survey is not (nor intended to be) statistically representative of a wider population of those involved in DRC. However, the targeted invitations to key organisations did allow for a range of views to be included from producers, users and intermediaries of DRC. These targeted individuals did however mean that the respondents to the survey were generally "drought conscious". "Regulators" (e.g. the Environment Agency, Natural Resources Wales) were over-represented at 36% of respondents. The survey was not designed or intended for members of the public on the basis that the survey respondents would, by proxy, include their experiences of engaging with the public. While there are always gaps in any survey of similar size, overall, the survey identified and reveals broad agreement on a range of concerns, issues and suggestions relating to current and future DRC content and processes in England and Wales. The survey results were also corroborated with the findings of the QSR and in many instances reflected the themes identified in the literature, thereby providing further assurance of the reliability of the online survey results. The survey was issued in summer 2020, when the coronavirus restrictions (and notable heatwave in August) was impacting water availability. This may have influenced people's responses, but could have been favourable too in increasing awareness of the issues.

4.5 FG results:

The FGs provided a rich set of insights into current experiences and possible future practices of DRC. In summary terms, the first round of FG revealed that DRC is experienced in very different ways by diverse organisations – whether producers or users. The FGs noted the 2-way nature of DRC even in current DRC processes, thereby blurring the boundaries of providers and users.

Recognition of existing strengths and weaknesses in current DRC vary according to a stakeholder's position in 'the' DRC system. Thus a farmer may experience drought concerns and risks a few days into planting while a manufacturing company may be assessing risk in terms of weeks or months or barely at all. It follows that the DRC requirements related to each would vary widely.

Nonetheless, common themes emerging from the FGs noted a range of *conditions* for effective DRC including being tailored to sectors, conveying drought as normal and enabling actions in the short and longer terms. Trust emerged as perhaps the single most important meta-theme of DRC. Trust in the DRC was dependent on several elements including: the 'status', significance and relevance of the messenger (including intermediaries), the medium, format, content (data), scale (local/national), purpose, timing and context of the user group or sector experiencing different types of droughts.

The possible permutations of these elements make clear that DRC cannot be reduced to a singular 'thing' or communications route, but instead DRC needs to be understood as a complex process or system with many interdependencies and multiple stakeholders.

A key finding of RADAR is that DRC is *always* contingent. Given the diversity of users and producers of DRC and the complexity of drought situations as experienced by different communities, it is not possible to provide definitive examples of DRC which will be effective in all instances. The extent to which DRC enables different sets of stakeholders to make sense of the situation and possible actions from their perspective will be an important measure of success.

For each user FG, a synthesis of what DRC "should be", "should convey", and "should enable" emerged from Round 1, and the common themes across the groups were identified, as shown below in Table 2.

Table 2 Drought Risk Communications "should"…

	Should Be	Should Convey	Should Enable
Agriculture	• Agriculture specific • Localised • Context relevant (i.e. for agricultural drought) • Timely and frequent • Automated/digital (e.g. HOFs) • Trusted • Understandable language • Accessible	• The relevant risks and impacts (e.g. on different farm types, up-/lowlands, England/Wales etc.) • Uncertainty and likelihood of drought • Data and interpretation that is meaningful to farmers	• Actions in the short and long term • Two way communication • Compliment/enhance drought planning • Public understanding of the challenges of farming and agricultural drought

Environment	• At multiple scales (local, area, national) • Timely and frequent according to the different messages & impacts • Trusted • Clear in terms of language and graphics • Accessible	• Drought as normal • The resilience/status of the environment • The range of impacts • National picture • Specificity of impacts for localities and sectors • What will happen if no action is taken	• Actions in the short- and long-term • Two way communication • Citizen science? • Public understanding of drought-flood continuum • Water balance/land management • Links to news and weather briefings etc.
Communities	• Localized • Context/sector relevant • Timely (earlier, at termination and ongoing) • Trusted (experts + local) • Clear/simple language and terminology • Purpose/impact driven	• Drought by saying 'drought' • Drought is normal • Risks for self, family, locality and/or sector • Uncertainty/likelihood	• Actions in the short- and long-term • Water management and resilience • Two way communication • Citizen science? • Public understanding of drought within the wider picture (e.g. flood drought continuum)
Common Themes	• **Tailored to sectors** • **Trusted** • **Accessible and in clear language** • **Scaled** • **Timely**	• **Drought as 'normal'** • **Meaningful and sector relevant data** • **Resilience / status of the environment** • **Range/scale of risks and impacts** • **Uncertainty and likelihood**	• **Short and long-term actions and planning/resilience** • **Public understanding of flood-drought continuum** • **Two-way communication** • **Citizen science**

The opportunities arising from these common themes were also discussed in the FGs and are summarised in Table 3 in relation to the series of whats/how/when/who/why questions identified in Table 1. The emphasis of each FG is show by the icons. Where all FGs were in agreement is shown by the 3 icons highlighted in green.

Table 3 Summary of opportunities proposed by DRC Users in three sectoral focus group sessions. Icons are used to indicate which sectoral group provided comments associated with each opportunity, and under which context heading. Boxes are highlighted green where all sectoral groups mentioned a similar opportunity.

= agriculture = environment = communities	OPPORTUNITIES (SUMMARISED FROM LIMITATIONS AND OPPORTUNITIES)	WHAT METRICS	WHAT LANGUAGE	WHAT PRESENTATION	HOW DELIVERY FORMAT	WHEN TIMING	WHO PROVIDER	WHY INTENTION
INCREASED SPATIAL AND TEMPORAL SCALE OF INFO	Provide information at different spatial scales (national-regional-catchment-local and administrative)							
	Earlier start to DRC / regular DRCs (and real-time data)							
CLEAR, SIMPLE, ACTIONABLE AND SECTOR SPECIFIC LANGUAGE AND MESSAGES	Simplify outputs using key messages, simple graphics and meaningful metrics and/or qualitative information							
	Develop simple, clear, consistent and sector specific drought definitions (that are applied across the UK) which may use the word 'drought' and have clear links between definitions and regulator actions							
	Describe impacts and key mitigating actions with DRC (e.g. potential for what if scenarios)							
	Use different language for the public compared to professionals and/or depending on the message being conveyed, and use communications specialists to test and translate DRC							
TRUSTED AND ACCESSIBLE COMMUNICATIONS DELIVERY	Disseminate DRCs using trusted organisations							
	Develop a central website or portal to find drought information							
	Use of texts/email alerts, local news/weather media and well publicised information							
IMPROVE LONG-TERM DROUGHT RESILIENCE	Improve drought resilience, understanding and knowledge through long-term education/ information, including info on climate change and drought in the context of water management, build on lessons learnt after events							

The green highlighted areas indicate that DRC should: be real-time; simplified and meaningful to recipients; carry sector specific explanations of drought; co-ordinated via a central portal; and enable adaptation and resilience through long-term education.

4.6 Reliability of FG results:

The FGs were comprised of invited individuals and representatives based on two main categories of 'DRC producer' and 'DRC users'. While this was a pragmatic boundary choice, there was some minor overlap – a producer could also be a user and it also became clear that some organisations were intermediaries i.e. passing on DRC from others to their own networks.

Regarding the FG process and analysis, FGs are discursive by nature and the outcomes of FGs are emergent and cannot be replicated. FG do not provide statistically reliable data. However, the strength of FGs is they can promote co-creativity through discussion and exchange of ideas and can reveal the complexity of problems alluded to through other means such as a survey. In the RADAR FG, this aspect was particularly evident in helping to reveal the contextual complexities and political, policy and organisational nuances of DRC processes and content. The two rounds of FG also enabled a rapport and trust to be established with the participants, including researchers, which enriched discussions throughout.

Assessing and interpreting largely qualitative and diagrammatic outputs does, in turn, require some qualitative judgements. The RADAR team reviewed the FG outputs collectively to ensure the range of views were captured and represented appropriately in the issues, themes, recommendations and final reports.

5. Findings and Recommendations

Our research identified seven key themes which are key to DRC being meaningful to users in context and, by extension, actionable:

1	Language	Explain and expand on definitions where necessary. Use the word drought where appropriate
2	Routes	Enable a two-way system with multiple routes of communication
3	Availability	Make materials openly and publicly available
4	Trust	Communications must come from trusted, verified sources
5	Design	Communications must be carefully designed, paying particular attention to accessibility, being appropriate for the audience, including narratives, being emotive, and empowering action
6	Delivery	The right delivery method must be chosen, e.g. social media, formal reporting etc. online, and simple methods are preferred
7	Timing	Continual reporting is necessary, from drought development, within a drought incident, and after recover. Longer term understanding is also needed e.g. understanding the flood-drought continuum and climate change risks and resilience.

The particular configuration and expression of these themes will vary according to context and need. It cannot be over-stressed that the seven key themes are inter-dependent e.g. appropriate timing and language of DRC for a sector or particular user group links to trust in the sources and the possibility of action. Focussing on just one element e.g. timing, risks losing sight of the systemic nature of DRC rather than just a 'one-size fits all' information system based on a knowledge-deficit model.

Of particular note is that, collectively, all of the themes constitute of a re-framing of DRC as more than just instrumental, media-led communication and dissemination about a particular event. Instead, the key themes point to understanding DRC as a learning process designed for and situated in providers and users' contexts where drought begins to be understood as one part of the way water 'works' in England and Wales in a climate change context. In academic terms, the themes position DRC as part of understanding the flood-drought continuum of the hydrological cycle to enable increased resilience through adaptation. There is a clear need for DRC which enables the following:

- *Continuous status reporting* – to develop public and sector understanding of drought status in real-time. This would provide information during all drought status', thus alleviating the

early/late drought communications issue.

- *In-drought incident communications* – to improve understanding of current drought incidents and enable user action.
- *Long term understanding* – to improve user understanding of the flood-drought continuum in a UK context, to communicate changing risks with climate change, and enabling increased adaptation and resilience.

Each element is dependent on the other. In-drought communications will be more effective if there is underlying engagement through continuous status reporting and investment in long term understanding.

A further implication of the findings is that DRC cannot be reduced to a single provider, conduit or format of DRC that will be trusted and actioned by all recipients, with the exception perhaps of centralised, legal strictures and enforcement during a national extreme event, as seen during the Covid-19 pandemic.

While DRC is currently 2-way, with 'users' providing inputs into regional and national processes, the extent and sector coverage is patchy. Improving 2-way DRC processes and integrating them will be essential if DRC is to become more localised and sector-relevant. The possibilities of involving the public in 2-way communication are, in terms of technology at least, continually expanding, although this does bring its own problems of information and channel overload.

6. Possible future work

In order to advance and realise the research conducted under the RADAR project, work engaging further audiences needs to be conducted, and funding also sought. These activities are detailed in Section 7.

Central Drought Hub

Based on the above findings and recommendations, the RADAR team developed the concept of a "Central Drought Hub" (see Figure 11).

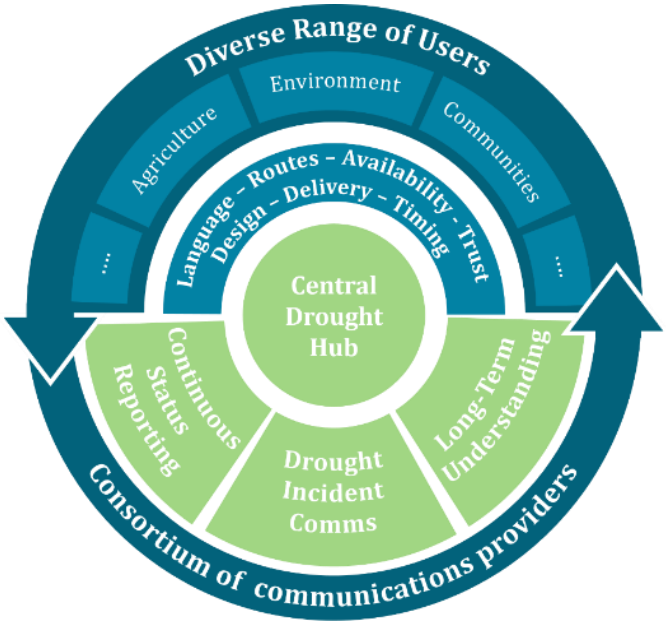

Figure 11 Conceptual Diagram of the Central Drought Hub

This concept proposes a dynamic centralised communication platform that hosts resources at a range of spatial and temporal scales to a variety of end users. It would be underpinned by a trusted consortium of communications providers, including key members of user communities to enable, eventually, two-way communications. It would be openly available and collate sources of information into one place. The seven key themes serve as 'filters' and are essential to ensure relevance of DRC developed for users. The CDH would encompass the three identified elements of drought event communication: continuous status reporting, drought incident communications, and long-term understanding.

Mock-ups of the CDH were discussed by the FGs for each of the themes and different user communities. Some exemplars for “continuous status reporting” are shown below in Figure 12. High level national and more focussed regional summaries for all sectors could incorporate reported drought impacts/incidents from a range of sources as well as more quantitative data. The design would also allow different sector-specific pathways through the site.

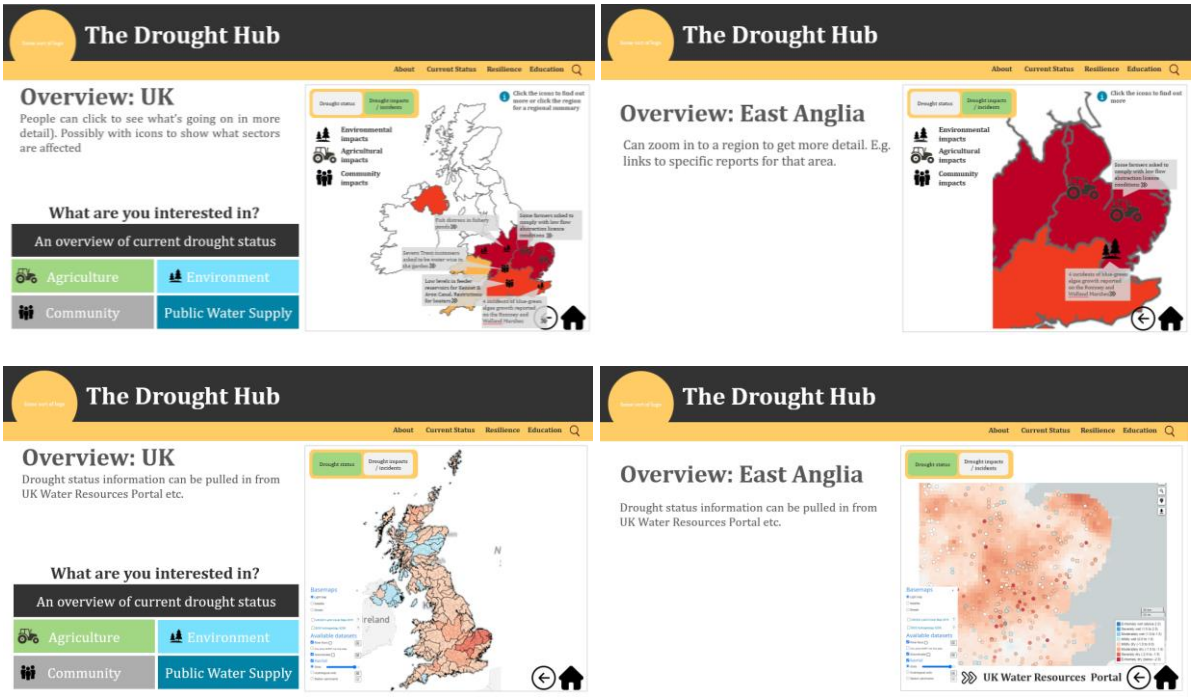

Figure 12 Mock-up of the Continuous reporting overview element of the Central Drought Hub shown to the User groups

The CDH could also collate resources for different sectors as shown in Figure 13. Specific sectoral drought status information could incorporate drought incident comms via Twitter feeds, as well as links to other situation reports and monitoring products. Pages for forecasts relevant to each sector and long-term understanding “knowledge and learning” would help to ensure that the three elements of DRC are addressed.

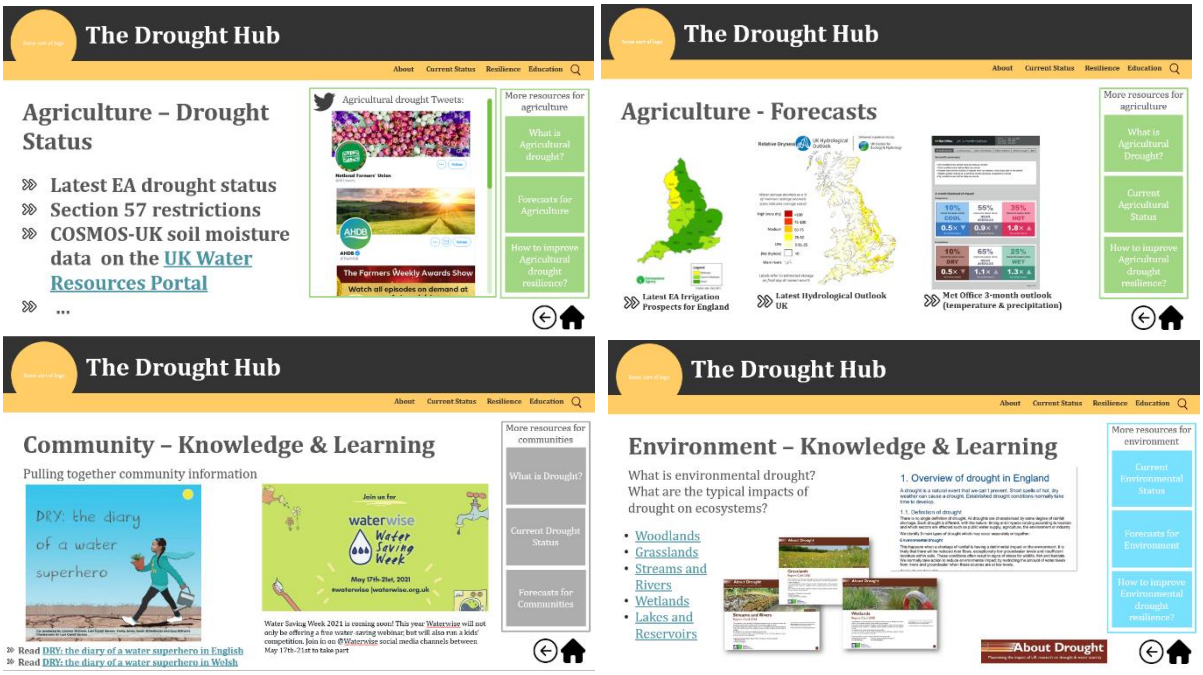

Figure 13 Mock-ups of sector specific pages of the Central Drought Hub including sector-specific status monitoring information, forecasts and knowledge and learning pages to improve long-term resilience to drought.

A key part of the CDH concept is to establish a consortium of DRC providers. Although many

organisations were present at one or both of the FG rounds, the FG participants suggested other organisations and groups that should be consulted if a CDH or similar, were to be developed.

The CDH is a proposition arising out of the RADAR research and to be implemented would need further development and consultation with a wide range of stakeholders (see the RADAR FG reports for detailed suggestions). Topics for agreement would include: language, budgets, ownership, collation and integration of data and communications, and policy integration. The possibility of reputational risk would also require careful consideration. Additional contextual challenges include the prevailing view the UK is a wet country, limited public understanding of water supply origins and processes, and the often hidden environmental costs of water. It should also be noted that the CDH is not a solution of itself to DRC, but a means to enable new practices and understandings to develop among the producer and user communities.

7. Any action resulting from the research (e.g. IP, Knowledge Exchange)

By design, the RADAR research as a whole has been a form of knowledge exchange. Early findings have been communicated to a range of participants as part of the FG discussions. Of themselves, the FGs have brought together a diverse range of participants, even within sectors, and enabled exchange of ideas, experiences and insights about contemporary and future possibilities of DRC processes and content.

Once RADAR outputs have been finalised, a liaison event(s) with the National Drought Group (England) and Drought Liaison Group (Wales) will be convened to communicate the RADAR findings and recommendations.

As noted in section 2 a RADAR webinar will also be convened in which will provide further opportunities for engagement and knowledge exchange with academic, policy and practitioner communities. This is likely to be conducted as an event with the British Hydrologic Society (BHS).

A blog post, social media coverage of the BHS meeting and an article in BHS newsletter 'Circulation' will be arranged once the final documentation has been approved by the Steering Committee.

The Steering Committee will be asked for approval to extend the RADAR findings beyond England and Wales, and engage the devolved governments of Scotland and Northern Ireland to enable UK-wide review and uptake of the recommendations.

Funding opportunities to continue research and development of DRC, as well as the possible implementation of "Central Drought Hub" will be sought in liaison with the RADAR team of researchers and the RADAR Steering Committee.

Acknowledgements

The RADAR team consisted of Katie Facer-Childs, Jamie Hannaford, Lucy Barker, and Kevin Collins. The team wish to acknowledge and thank all the participants who completed the online survey and participated in the FGs.

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

In addition to this summary report, the RADAR project has produced (links TBC):

1. A Quick Scoping Review
2. A summary of the online survey results [*not for public release*]
3. Four reports from the first round of Focus Groups
4. One combined report from the second round of Focus Groups
5. A set of “mock up” slides for the Central Drought Hub
6. A Slide Pack summarising the project
7. An animated video summarising the project