Land use, climate change and water availability: Phase 2a

Development of the Rapid Evidence Assessment protocol

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Disclaimer

While every opportunity has been taken to ensure the accuracy of the information presented in this report, the Centre for Ecology and Hydrology cannot be held responsible for errors or omissions, but reserve the right to provide further consultation if clarification is required.

Forward

This report presents the protocol for a Rapid Evidence Assessment (REA) to address the question “Can land use and land management make a difference to water availability under conditions of climate change?” The REA approach provides a systematic search and critical assessment of the quality of evidence available to address the question.

This project is commissioned by the Department for Environment, Food and Rural Affairs (Defra) and co-funded by Defra and the Natural Environment Research Council (NERC). It represents a continuation of activity initiated under the Environment Sciences to Services Partnership (ESSP). The ESSP is a joint initiative between the British Geological Survey (BGS), Centre for Ecology and Hydrology (CEH), Defra, Environment Agency, Met Office, NERC and Ordnance Survey.

The REA team is based at the Centre for Ecology & Hydrology (CEH). The team is lead by David Boorman and includes Helen Houghton-Carr and Kay Heuser. James Miller has provided advice and guidance to the team.

The REA team reports to a Project Board which is lead by Henry Leveson-Gower (Defra) and includes David Boorman (CEH), Ian Holman (Cranfield University), Andrew Hughes (British Geological Survey; BGS), David Seccombe (Environment Agency; EA) and Rob Soley (AMEC).

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Glossary

Online databases and websites

BioOne	Biological, ecological, and environmental sciences. www.bioone.org
BIOSIS	Life and biomedical sciences. Part of Web of Knowledge. http://apps.webofknowledge.com/
Directory of Open Access Journals	Open access journals maintained by Infrastructure Services for Open Access (IS4OA). www.doaj.org
Google	Web search engine for any publically available online literature. www.google.co.uk
Google Scholar	Web search engine for "scholarly" literature. http://scholar.google.co.uk/
Ingenta Connect	Portal for scholarly, financial and business publishers. www.ingentaconnect.com
J STOR	Digital library for academic institutions, public libraries, research institutions, museums and schools. www.jstor.org
MEDLINE	US National Library of Medicine database. Part of Web of Knowledge. http://apps.webofknowledge.com/
NERC Library Service	Online catalogue of NERC centre-survey library holdings accessed through the WorldCat portal. www.worldcat.org/libraries/116546
NORA	NERC Open Research Archive providing online access to NERC research outputs. http://nora.nerc.ac.uk/
Science Direct	Physical sciences and engineering, life sciences, health sciences, social sciences and humanities. www.sciencedirect.com
Scopus	Scientific, technical, medical, and social sciences (including arts and humanities). www.scopus.com
Springer Link	Online editions of Springer's 1250+ scientific, technical, medical and professional journals. http://link.springer.com/
Web of Knowledge	Academic citation indexing and search service combined with web linking. http://apps.webofknowledge.com/
Web of Science	Sciences, social sciences, arts and humanities. Part of Web of Knowledge. http://apps.webofknowledge.com/
Wiley Online Library	Online editions of the majority of Wiley's 400+ scientific, technical, medical and professional journals. http://onlinelibrary.wiley.com/
Zetoc	British Library's electronic table of contents. http://zetoc.mimas.ac.uk/

1. Introduction

1.1 Background

Many driving forces affect the quantity and quality of water available to humans and the environment, including demographic changes, land use changes, technological developments, economic growth, policy and legislation, as well as environmental change including climate change. Attributing changes in water availability to an individual factor is difficult because of the complex interactions between these different factors. The need for a scientifically-based assessment of the potential impacts on water resources of changes in these driving forces, as a basis for society to adapt to such changes, is strong.

This project aims to identify and characterise the issues associated with the interactions between climate change and land use and management, and how they affect water availability. It follows on from a scoping report (ESSP, 2012) which identified a number of knowledge gaps around this topic and made a number of recommendations for further work to address them. The beneficiary of this work is the Department for the Environment, Food and Rural Affairs (Defra), which is responsible for compiling evidence and addressing the policy implications of changing water resource availability.

The project comprises two parts: a Rapid Evidence Assessment (REA) to review the evidence that interactions between climate change and land use and management can affect water availability, and model simulations to quantify how much water availability will be reduced under conditions of climate change affecting land use and management. This report describes the development of the protocol for carrying out the REA.

1.2 What is a Rapid Evidence Assessment?

A Rapid Evidence Assessment (REA) is one of a number of methods for reviewing existing evidence. An REA follows the principles of a Systematic Review to objectively assess a body of evidence, but is undertaken over a much shorter time-scale. This reflects the reality of resource constraints for undertaking the REA which do not represent the level and effort of rigour that would be expended when conducting a Systematic Review (Miller *et al.*, 2013). REAs aim to be rigorous and explicit in method, and thus systematic, but make concessions to the breadth or depth of the process by limiting particular aspects of the systematic review process. REAs represent a relatively new approach to harnessing evidence for policy-making using systematic review procedures in a more rapid manner to meet the urgent time-scales of decision-makers (Butler *et al.*, 2005).

An REA aims to primarily address the question of effectiveness or impact of a policy-driven intervention, though can also be used to address less quantifiable non-impact questions concerning policy. The approach provides a systematic search and critical assessment of the quality of evidence and what it says about the question (Miller *et al.*, 2013).

There has been significant work within the UK Government Civil Service to provide guidance on how to carry out an REA (http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance). This has been adopted by the Defra Joint Water Evidence Group in a draft guidance document for the completion of evidence reviews which contains specific guidance on how to conduct an REA for Defra (Miller *et al*., 2013). This approach has been followed in the planning of this REA which aims to capture as unbiased and comprehensive a sample as possible of published literature to provide an overview of the evidence on whether land

use and land management make a difference to water availability under conditions of climate change.

This report presents the protocol detailing the REA objectives and the process that will be undertaken to complete the REA. The protocol provides a transparent guide to those involved in the REA and those interested in how the evidence assessment will be carried out. The protocol discusses the question that guides the scope of the review, the strategy for the search, refinement and extraction of evidence, and the subsequent synthesis of that evidence. The protocol may require iterative updating during the review process.

The time frame for this REA is 14 weeks. This is comprised of two weeks to develop the protocol, eight weeks to conduct the review, the results of which will be presented at a stakeholder workshop (scheduled for early July 2013), and a further four weeks to complete the review report.

1.3 Structure of this report

After this introductory section, Section 2 addresses the objectives of the study in more detail and describes the initial scoping that took place to inform the development of the search protocol. The protocol is set out in Section 3, together with details of the subsequent data extraction and synthesis.

2. Objectives

2.1 Original primary question

The objective of this REA is to compile and assess evidence relating to the question:

> *Can land use and land management make a difference to water availability under conditions of climate change?*

This primary question has been presented to the REA review team as it is defined in the Phase 2a proposal to Defra (2012). As a first step to increasing understanding of the question, the question has been analysed using the Population (or Subject), Intervention, Comparator and Outcome (PICO) approach of breaking down the question into the constituent elements that best represent the initial scope of the work and scoping of the available evidence (Table 2.1).

It is evident that the question should apply to the availability of both surface water and groundwater (the population or subject). However, that availability may be quantified in numerous ways relating to runoff, flow and storage for surface water, and to recharge, water table level and aquifer storage for groundwater. Furthermore, the question asks about the difference in water availability, which could be reported as a change, an impact, an increase, a decrease or a variety of other terms (the outcome).

The intervention potentially causing the difference in water availability is also open to wide interpretation; indeed there are effectively two very different types of intervention in the question: human use or management of land and climate change. Land use (natural land cover and human-modified land cover) and associated land management (the practices adopted to develop or maintain a particular land use) can take a variety of forms from natural or semi-natural environment to highly urbanised cities or industrial complexes, with a range of land uses in between based in predominantly rural settings. It is also possible that land may be subject to several uses or management approaches by different stakeholders, potentially resulting in complex differences in water availability and consequent difficulties in isolating the difference from a single use or management approach.

Climate change provides an additional complication because climate change is anticipated to have an impact on water availability independently of land use and land management, through changes in the spatial and temporal distribution of precipitation and temperature (themselves the topic of debate). The question contains the implication that alternative land

Table 2.1: Definition of PICO components of the primary REA question

Population (Subject)	Intervention	Comparator	Outcome
Surface water Groundwater	Land use/management: • Afforestation • Agriculture (cultivation and livestock) • Parks and [semi-] natural environment • Removal of alien (non-indigenous) species • Urbanisation and transport Climate change	Control site or paired catchment studies: • Before management vs after management • No management vs with management • Upstream management and downstream water availability • No climate change vs with climate change	Difference in/impact on water availability/quantity: • Quantifiable change/increase/ • decrease in: • Runoff / river flow / streamflow / reservoir storage • Recharge / water table level / aquifer storage

uses and management practices may alter, and potentially mitigate, the impacts of climate change on water availability. However, climate change studies use a range of different models to simulate the impact of those changes, with each model generating different results, so the climate change impacts to be altered and possibly mitigated are uncertain.

There are no observed data on which to base the climate change element of the question, in contrast to land use and land management studies where there are likely to be observed data from control or paired catchment studies investigating before/after differences which may be at the study location or in a different location e.g. downstream (the comparator). This leads to the issue of how useful it is to compare observed data with modelled results which incorporate several sources of uncertainty (e.g. the scenario, the driving data, the model, etc).

The PICO analysis has also raised a set of linked secondary questions:

> *What land use and land management initiatives (covering awareness-raising, education, programmes and schemes) are there, who are they aimed at, and what makes some more successful (and how is this success quantified?) than others?*

These questions address the concern that it may be necessary to have knowledge of different land use and land management initiatives in order to understand, if an initiative's stated objectives are not directly related to water availability, whether this may bias any results, and why some initiatives may be more successful in achieving their stated objectives than others. Given the broad nature of the original primary question and the timeframe, these secondary questions are beyond the scope of the current REA but, depending on the outcome of this review, may be the topic of future work.

2.2 Initial scoping

To inform the REA search strategy, test searches have been carried to identify effective search strings and those online databases and other websites that may be of most use. EndNote X6 has been used to collate and manage test search results and identify duplicate citations. The tables below show the number of hits from the title, abstract and keywords of articles for:

- A variety of generalised search strings (without the *climate change* search term) from Web of Science (Table 2.2) to help refine the "water availability" element of the primary question;

- A specific search string (with and without the *climate change* search term) from other commonly used online databases (Table 2.3) to help refine the "climate change" element of the question and to provide an initial review of databases;

- A variety of specific search strings from Web of Science (Table 2.4) to help refine the "land use and land management" element of the question.

Table 2.2 shows that the *land*use* search term (where * denotes a wildcard, in this instance to cover both "land use" and "land-use") identifies, on average, 91% more hits than the *land management* search term. The number of duplicate hits is, on average, 42% of the *land management* search string hits, but only 4% of the *land*use* search string hits, revealing only partial overlap between the *land*use* and the *land management* search terms. However, the

majority of the *land*use* search strings, and several of the *land management* search strings are returning too many hits to be feasibly reviewed within the timeframe.

*Table 2.2: Indicative count for generalised search strings part 1 AND "land*use" or part 1 AND "land management" from Web of Science*

Search string part 1	Hits with AND "land*use"	Hits with AND "land management"	Duplicate hits
Aquifer	720	44	19
Evapotranspiration OR evaporation OR transpiration	1664	117	47
Flow	3523	327	120
Groundwater	2305	192	62
Recharge	730	62	21
Reservoir	755	39	19
"River flow"	108	11	6
Runoff	3367	358	149
"Stream flow"	220	24	24
Streamflow	683	45	22
"Surface water"	1051	91	43
"Water availability"	315	31	17
"Water balance"	725	73	35
"Water quantity"	103	12	7
"Water resource*"	1622	138	60
"Water table"	358	46	4
Wetland	1324	68	20

Table 2.3: Indicative count for specific search strings "land management" AND "water availability" with/without AND "climate change" from commonly used online databases

Database	Hits without AND "climate change"	Hits with AND "climate change"
BioOne	128	56
Directory of Open Access Journals	1	0
Google Scholar	14900	7630
Ingenta Connect	3	0
J STOR	566	228
NERC Library	28	10
NORA	1329	1015
Science Direct	1358	27
Scopus	58	18
Springer Link	865	513
Web of Science	31	11
Wiley Online Library	811	589
Zetoc	16	6

Table 2.4: Indicative count for specific search strings "water availability" AND part 2 from Web of Science

Search string part 2	Hits	Search string part 2	Hits
Agricultur*	829	"Land management"	31
"Alien species"	10	"Land*use"	315
"Best practice"	3	"Management practice"	11
Conserv*	470	Natural*	856
Crop*	1252	"Non*indigenous"	1
Drain*	206	Park*	173
Farm*	428	Pastur*	118
forest	1335	Restor*	175
Graz*	168	Transport	314
Impermeable	7	Urban*	177
Irrigat*	1317	"Wise use"	0

From Table 2.3, including the *climate change* search term in this search string reduces the number of hits by, on average, 54%. However, with or without the inclusion of this term, this simple search string is returning too many hits from some databases to be feasibly reviewed within the timeframe.

From Table 2.4, the majority of specific land use and land management interventions appear related to agriculture and forestry, and to natural or semi-natural environment, and the fewest to general use and management terms and to alien (non-indigenous) species. This suggests that some interventions may be excluded from a general search and need to be explicitly included. No comparison was made between the individual lists to identify duplicates. Again, many of the search strings are returning too many hits to be feasibly reviewed within the timeframe.

2.3 Refining the primary question

For an REA within this timeframe, the search strategy should aim to identify 500-1000 initial hits which should be rationalised to a final 10-20 articles through application of the protocol (J. Miller, *pers. comm.*).

The initial scoping to identify effective search strings and search sources and, thereby, help refine aspects of the primary question, has revealed that:

- There is only partial overlap between "land use"-focused searches and "land management"-focused searches;

- Including the *climate change* search term reduces the number of hits, but will also exclude articles that do not explicitly mention climate change but may provide potentially useful evidence on land use and/or land management and water availability;

- Including some search terms for specific land use and land management interventions may be necessary as many agriculture and forestry-related articles, for instance, may be missed by the generalised *land*use* and *land management* search terms; it may also be necessary to omit some land use types e.g. urban;

- There is a need for more complex search strings to reduce the number of hits and attempt to isolate relevant articles;

- There is a need to restrict the number of sources searched. For instance, the key online databases have been recommended as Scopus, Web of Science and Zetoc (A. Smith, *pers. comm*.), all of which ranked at the lower end for number of hits for a simple search string (Table 2.3). However, Zetoc has only a basic search facility.

Further exploration has examined complex search strings for surface water and groundwater, as set out in Table 2.5. There are 32 duplicates between the two lists of hits (on the date of the search). The titles of these 32 duplicates (8% of the combined total surface water and groundwater hits) were assumed to be randomly selected and were independently assessed by the three members of the REA team to ascertain the utility of these search strings, and also to assess the evaluation approach of the team members to inform future selection guidance.

Results showed 66-78% agreement between any two team members, and 56% agreement between all three team members, indicating that the exclusion and inclusion criteria in the protocol need to be significantly more stringent than those utilised in this test exercise (which

Table 2.5: Indicative count for complex search strings part 1 AND part 2 AND part 3 AND part 4 from Web of Science

	Part 1	**Part 2**	**Part 3**	**Part 4**	**Hits**
Surface water search string	water	runoff OR “river flow” OR streamflow OR “stream flow”	availability OR quantity	“land*use” OR “land management"	323
Groundwater search string	groundwater	recharge OR aquifer OR “water table”	availability OR quantity	“land*use” OR “land management"	103

was simply that the title of the article suggests the study is something to do with the quantifiable impact of a form of land use or land management on some form of water availability) in order to raise this level of agreement. Overall, two or all three team members assessed 11 of the titles (34%) in this test exercise as worthy of further consideration.

These results suggest that, with more specific exclusion and inclusion criteria, complex search strings of this form expanded for a range of specific land use and land management interventions may generate the appropriate number of initial hits and final articles.

On the basis of the PICO analysis and initial scoping, it is recommended that the refined primary question used in the REA is:

Can land use and land management make a difference to water availability?

This will mean that studies on the impact of land use and/or land management on water availability are included, whether or not they mention climate change, and will also attempt to ensure that the evidence being reviewed in the REA is sourced from observed data rather than modelled results. At the same time, any evidence from control or paired catchment studies that links land use and land management with climate change will be identified during the review. The issue of climate change and how it may drive future land use and land management will be addressed in the evaluation of the REA results and their implication for research and for policy.

In summary, the PICO analysis and initial scoping have been valuable exercises which have provided useful information to enable the primary question to be refined to ensure it is fit for purpose, and to inform the search strategy for the actual protocol to be used - which is set out in Section 3 - in particular the formulation of search strings (Section 3.3) and exclusion and inclusion criteria (Section 3.4).

3. REA protocol

3.1 Search strategy

The search strategy has been developed through discussion within the REA team and outcomes from the PICO analysis and initial scoping described in Section 2. The search will be limited to the English language. No restrictions will be applied regarding the year of publication. Furthermore, no initial restrictions will be applied regarding country (though this may be refined later) because it is anticipated that literature from central and northern European countries and non-European countries with similar physical and climatic characteristics to the UK (e.g. New Zealand, South Africa) may be directly relevant. However, the location will be one of the factors used to determine the relevance score for articles which reach the final list (Section 3.5).

3.2 Search sources

The search aims to capture an unbiased and comprehensive sample of published literature relevant to the question within the timeframe of the REA. A selection of different sources will be searched in order to optimise the coverage of the search.

On advice from the CEH librarian (A. Smith, *pers. comm*.), the following online databases will be searched:

- Scopus
- Web of Knowledge (comprising Web of Science, BIOSIS and MEDLINE)

The following websites of relevant research and policy organisations will be searched:

- Centre for Ecology & Hydrology www.ceh.ac.uk
- British Geological Survey www.bgs.ac.uk
- Cranfield University www.cranfield.ac.uk
- defra www.defra.gov.uk
- Environment Agency www.environment-agency.gov.uk
- Envirobase www.envirobase.info

The following search engines will be used to search the web:

- www.google.co.uk
- http://scholar.google.co.uk

Authors, recognised experts and practitioners will not be contacted for further recommendations, opinions, and/or for the provision of any unpublished material or missing data.

3.3 Search terms

The topic (title, keywords and abstract) of articles in online databases will be searched using the search strings in Table 3.1 (where * denotes a wildcard). Where possible, search terms within each group will be combined using the Boolean OR operator, and between groups using the Boolean AND operator.

Table 3.1: Search terms for online databases

Search string part 1	Search string part 2	Search string part 3	Search string p art 4	Search string part 5
water	runoff OR "river flow" OR streamflow OR "stream flow" OR discharge OR recharge OR "soil drainage" OR aquifer OR watertable OR "water table"	"*water availability" OR "availability of *water" OR "*water quantity" OR "quantity of *water" OR "*water resource* availability"	"land use" OR "land-use" OR landuse OR "land management" OR agricultur* OR "alien species" OR *forest* OR restor*	increas* OR decreas* OR chang* OR differen*

Table 3.2: Search terms for organisation websites and the internet

Search string part 1	Search string part 2
"land use" OR	"water availability" OR
"land-use" OR	"water quantity" OR
landuse OR	water AND runoff OR
"land management	groundwater AND recharge

For the websites of relevant organisations and the web searches, to address the limited ability of search engines to handle complex search strings, the search strings will be narrowed to some keywords. The generalised search strings defined in Table 3.2 will be used. Only the first 10 hits from each search will be examined for relevance, and no links will be followed from the original hit.

3.4 Refining the search

The search lists generated from the sources listed in Section 3.2 using the terms listed in Section 3.3 will be collated in EndNote X6 and duplicate citations removed. This inital list will be refined by applying exclusion and inclusion criteria to identify the most relevant articles, as described below and depicted in Figure 3.1.

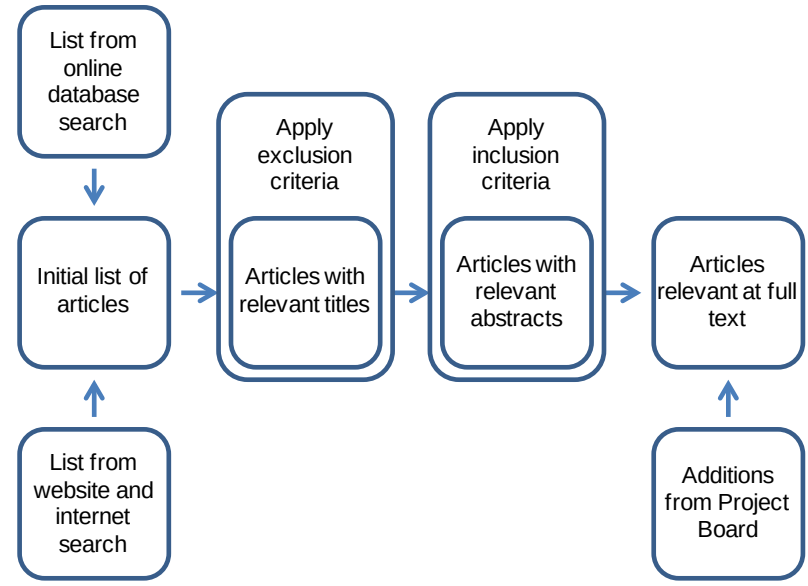

Figure 3.1: Process for refining the search

Exclusion criteria, generated during discussion within the REA team, will be applied to article titles in the initial list to eliminate non-relevant articles. The exclusion criteria specify that the REA is:

- Not about water quality;
- Not about green water (rainwater or soil moisture directly used and evaporated by non-irrigated agriculture, pastures and forests);
- Not about urban or transport-related land use or land management;
- Not about natural or semi-natural environment (e.g. parks) unless including some aspect of restoration;
- Not about multiple land use/management interventions;
- Not about water management (e.g. reservoirs, irrigation, drainage, abstractions, returns, etc);
- Not about changes in water availability as a direct result of climate change or climate variability;
- Not about modelling or future climate and/or land development scenarios.

Two reviewers will independently assess a random subset of 10% of the initial list of citations, applying the exclusion criteria. The level of agreement between the two reviewers will be measured by statistical technique called kappa analysis, aiming for a kappa rating of 0.6 or above which indicates "substantial agreement", compared to chance agreement. If kappa is less than 0.6, the discrepancies will be discussed and resolved by consensus and the criteria will be clarified or modified as necessary.

Subsequently, a number of inclusion criteria (Table 3.3) will be applied to the abstracts of remaining articles to refine the search results to the most relevant articles. If in doubt about inclusion at abstract level, the full text will be viewed.

Subject to time constraints, bibliographies of articles reaching this stage will be examined for any additional relevant references. This list will then be circulated to the Project Board for approval and to provide the opportunity for them to put forward any additional articles considered relevant to the review – a maximum of three per Board member - such as grey literature or specialist papers not uncovered by the search strategy.

Table 3.3: Search inclusion criteria used in the REA

Criteria	Description
Population (subject)	Water available for human use i.e. surface water runoff or river/stream flow/discharge only, groundwater aquifer, recharge or water table only
Types of intervention	Any replicable land use or land management practice
Types of comparator	Evaluations using control sites or paired catchment studies: with/without, before/after, upstream /downstream
Outcome measure	Changes in water quantity only; quantifiable changes only
Type of study	Assessment of primary evidence of a change in water quantity caused by a land use or land management practice

3.5 Assessing the quality

Articles which meet all the exclusion and inclusion criteria will be viewed at full text and either assessed relevance and robustness weightings, or ultimately excluded because upon examination of the full text they do not in fact meet the inclusion criteria. The relevance and robustness ratings will consider both the relevance of the article to the REA primary question and the quality of the methodological approach, which are critical to an objective and transparent assessment of the evidence in the data synthesis.

It is intended that the relevance of the article and reported research to the REA primary question will be assessed using components of the question in addition to location, as outlined in Table 3.4. Similarly, the robustness of the research methodology and reported outcomes will be assessed by the criteria presented in Table 3.5. However, these criteria used to assess the quality of the evidence in the final list of articles require consideration of a number of subjective decisions made by the REA team, and may need to be further modified by an iterative process as articles are read at full text and data extracted.

Table 3.4: Matrix table used to derive confidence in the relevance of selected articles

Component	Low (1)	Medium (2)	High (3)
Location	Countries with dissimilar climatic conditions to UK	Countries with similar climatic conditions to UK	UK
Scale	Any scale, but not explicitly considering water potentially available for human use	Field/plot scale considering water potentially available for human use	Catchment/basin scale considering water potentially available for human use
Subject (population)	Subjective findings based on stakeholders' opinions and perceptions	Change in water availability not quantified, but direction observed	Quantifiable change in surface water/ groundwater availability
Intervention	Land use/management practice not defined	Non-replicable land use/ management practice	Replicable land use/ management practice
Overall score	Overall score should reflect the mean across the four components		

Table 3.5: Matrix table used to derive confidence in the robustness of selected articles

Component	Low (1)	Medium (2)	High (3)
Objectives of study / hypothesis being tested	No clear objectives (e.g. effect of intervention on water availability is incidental/by-product of study)	General objectives (e.g. investigation of environmental impacts of intervention)	Clear specific objectives (e.g. investigation of effect of intervention on water availability)
Approach - quality of hydrometric monitoring and impact of intervention	Post-intervention hydrometric monitoring only, with/without stakeholder survey	Before /after hydrometric monitoring but no use of control sites/paired catchments, with/without stakeholder survey	Before/after hydrometric monitoring and use of control sites/ paired catchments, plus stakeholder survey
Evaluation - data reporting and analysis	No data quality control; minimal analysis and evaluation of study data; summary review of results	Quality control of data; basic data analysis and evaluation, but no interpretation of impact	Quality control of data; rigorous data analysis and evaluation; evaluation of impact of intervention
Reporting of evaluation	Unpublished, subject to no peer review	Reported in grey literature	Reported in peer-reviewed literature
Overall score	Overall score should reflect the mean across the four components		

Two reviewers will independently assess the relevance and robustness scorings of a random subset of 25% of the articles on the final list. The level of agreement between the two reviewers will be measured by kappa analysis, with a kappa rating of 0.6 or above considered acceptable. If kappa is less than 0.6, the discrepancies will be discussed and resolved by consensus.

The combined score (the product of the relevance score and the robustness score) will distinguish those articles that are most relevant and have the best quality methods, and as such are ranked highest, from those with little relevance and poor methods, ranked lowest. This will provide an indication of the confidence placed by the REA team in the evidence in the selected articles.

3.6 Data extraction strategy

Evidence will be extracted into a predefined spreadsheet template that will facilitate recording of the most important details that will provide a comprehensive overview. This template will include the following details for each article:

- **Title and authors** with full reference or web address;
- **Population (subject)** monitored including location and type of site/catchments/basins and measure of water availability;
- **Intervention** monitored including land use and type of land management intervention;
- **Evaluation methodology** including details of how the monitoring of the water availability has been carried out e.g. use of control sites or paired catchments;
- **Results** summarising the monitored difference (positive, no change, negative) in water availability, and including the numerical value and units that express this change;
- **Conclusions and recommendations** covering the key messages from the article;
- **Confidence scoring** for relevance and robustness of article;
- **Reviewer comments** from REA team.

3.7 Data synthesis

The articles identified as providing the most relevant evidence on whether land use/management makes a difference to water availability will be categorised and evaluated in order to make general observations, draw conclusions and make recommendations, including implications for research and policy. The detailed methodology for this will depend on the data retrieved during the data extraction stage, although it is hoped that some analysis may be done on the basis of catchment type and land use/management intervention. The issue of climate change and whether the REA review has provided any evidence for how it may drive future land use and land management and, potentially, impact on water availability will also be discussed.

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