Australian Government

BIOREGIONAL ASSESSMENTS

PROVIDING SCIENTIFIC WATER RESOURCE INFORMATION ASSOCIATED WITH COAL SEAM GAS AND LARGE COAL MINES

Current water accounts and water quality for the Central West subregion

Product 1.5 for the Central West subregion from the Northern Inland Catchments Bioregional Assessment

2 March 2015

A scientific collaboration between the Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia

The Bioregional Assessment Programme

The Bioregional Assessment Programme is a transparent and accessible programme of baseline assessments that increase the available science for decision making associated with coal seam gas and large coal mines. A bioregional assessment is a scientific analysis of the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of coal seam gas and large coal mining development on water resources. This Programme draws on the best available scientific information and knowledge from many sources, including government, industry and regional communities, to produce bioregional assessments that are independent, scientifically robust, and relevant and meaningful at a regional scale.

The Programme is funded by the Australian Government Department of the Environment. The Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia are collaborating to undertake bioregional assessments. For more information, visit <http://www.bioregionalassessments.gov.au>.

Department of the Environment

The Office of Water Science, within the Australian Government Department of the Environment, is strengthening the regulation of coal seam gas and large coal mining development by ensuring that future decisions are informed by substantially improved science and independent expert advice about the potential water related impacts of those developments. For more information, visit <http://www.environment.gov.au/coal-seam-gas-mining/>.

Bureau of Meteorology

The Bureau of Meteorology is Australia's national weather, climate and water agency. Under the *Water Act 2007*, the Bureau is responsible for compiling and disseminating Australia's water information. The Bureau is committed to increasing access to water information to support informed decision making about the management of water resources. For more information, visit <http://www.bom.gov.au/water/>.

CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation. For more information, visit <http://www.csiro.au>.

Geoscience Australia

Geoscience Australia is Australia's national geoscience agency and exists to apply geoscience to Australia's most important challenges. Geoscience Australia provides geoscientific advice and information to the Australian Government to support current priorities. These include contributing to responsible resource development; cleaner and low emission energy technologies; community safety; and improving marine planning and protection. The outcome of Geoscience Australia's work is an enhanced potential for the Australian community to obtain economic, social and environmental benefits through the application of first class research and information. For more information, visit <http://www.ga.gov.au>.

ISBN-PDF 978-0-642-70658-4

Citation

Aryal S, Northey J and Peña-Arancibia J (2015) Current water accounts and water quality for the Central West subregion. Product 1.5 for the Central West subregion from the Northern Inland Catchments Bioregional Assessment. Department of the Environment, Bureau of Meteorology, CSIRO and Geoscience Australia, Australia.

Authorship is listed in relative order of contribution.

Copyright

Disclaimer

The information contained in this report is based on the best available information at the time of publication. The reader is advised that such information may be incomplete or unable to be used in any specific situation. Therefore decisions should not be made based solely on this information or without seeking prior expert professional, scientific and technical advice.
The Bioregional Assessment Programme is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please contact <bioregionalassessments@bom.gov.au>.

Cover photograph

Macquarie Marshes, on the north-western end, between Carinda and Warren, NSW, 2009

Credit: Arthur Mostead © Commonwealth of Australia (Murray–Darling Basin Authority)

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO

Contents

Figures

Tables

Contributors to the Technical Programme

The following individuals have contributed to the Technical Programme, the part of the Bioregional Assessment Programme that undertakes bioregional assessments. Leaders are underlined.

Assistant Secretary	Department of the Environment: Gayle Milnes
Programme Director	Department of the Environment: Anthony Swirepik
Technical Programme Director	Bureau of Meteorology: Bronwyn Ray
Projects Director	CSIRO: David Post
Principal Science Advisor	Department of the Environment: Peter Baker
Science Directors	CSIRO: Brent Henderson
	Geoscience Australia: Trevor Dhu
Integration Lead	Bureau of Meteorology: Richard Mount
Programme management	Bureau of Meteorology: Graham Hawke, Louise Minty
	CSIRO: Paul Hardisty, Warwick McDonald
	Geoscience Australia: Stuart Minchin
Project Leaders	CSIRO: Alexander Herr, Tim McVicar, David Rassam
	Geoscience Australia: Hashim Carey, Kriton Glenn
Assets and receptors	Bureau of Meteorology: Richard Mount, Eliane Prideaux
	Department of the Environment: Larry Guo, Glenn Johnstone, Brad Moore, Wasantha Perera, Jin Wang
	Geoscience Australia: Joe Bell
Bioregional Assessment Information Platform	Bureau of Meteorology: Brian Cannell, Trevor Christie-Taylor, Jason Guo, Lou Markovski, Paul Sheahan, Kellie Stuart, Joseph Zhao
	CSIRO: Peter Fitch
	Department of the Environment: Geraldine Cusack
	Geoscience Australia: Neal Evans
Communications	Bureau of Meteorology: Mel Martin
	CSIRO: Chris Gerbing
	Department of the Environment: Sophie Alexander, Milica Milanja, Kirsty Rolls
	Geoscience Australia: David Beard, Chris Thompson

Coordination	Bureau of Meteorology: Julie Burke, Sarah van Rooyen CSIRO: Ruth Palmer Department of the Environment: Danielle Harris, James Hill, Sunita Johar, Megan Stanford, Craig Watson Geoscience Australia: Tenai Luttrell
Ecology	CSIRO: Tanya Doody, Brendan Ebner, Kate Holland, Craig MacFarlane, Tracey May, Patrick Mitchell, Justine Murray, Anthony O'Grady, Chris Pavey, Jodie Pritchard, Nat Raisbeck-Brown, Ashley Sparrow, Georg Wiehl
Geology	CSIRO: Deepak Adhikary, Luke Connell, Emanuelle Frery, Jane Hodgkinson, James Kear, Manoj Khanal, Zhejun Pan, Kaydy Pinetown, Matthias Raiber, Hayley Rohead-O'Brien, Regina Sander, Peter Schaubs, Garth Warren, Paul Wilkes, Andrew Wilkins, Yanhua Zhang Geoscience Australia: Tim Evans, Steven Lewis, John Magee, Martin Smith
Geography	Bureau of Meteorology: Natasha Herron
Geographic information systems	CSIRO: Caroline Bruce, Jody Bruce, Malcolm Hodgen, Steve Marvanek, Arthur Read Geoscience Australia: Adrian Dehelean, Katherine Owens
Groundwater modelling	CSIRO: Olga Barron, Russell Crosbie, Tao Cui, Warrick Dawes, Lei Gao, Sreekanth Janardhanan, Luk Peeters, Praveen Kumar Rachakonda, Wolfgang Schmid, Saeed Torkzaban, Chris Turnadge, Binzhong Zhou
Hydrogeology	CSIRO: Konrad Miotlinski Geoscience Australia: Rebecca Cassel, Jim Kellett, Sarah Marshall, Rebecca Norman, Jessica Northey, Tim Ransley, Martin Smith, Baskaran Sundaram, KokPiang Tan, Luke Wallace, Gabrielle Yates
Information management	Bureau of Meteorology: Belinda Allison, Jill McNamara, Brendan Moran, Suzanne Slegers CSIRO: Nick Car, Phil Davies, Andrew Freebairn, Mick Hartcher, Geoff Hodgson, Brad Lane, Ben Leighton, Trevor Pickett, Ramneek Singh, Matt Stenson Geoscience Australia: Luke Caruana, Penny Kilgour, Matti Peljo
Products	CSIRO: Maryam Ahmad, Daniel Aramini, Heinz Buettikofer, Simon Gallant, Karin Hosking, Frances Marston, Linda Merrin, Becky Schmidt, Sally Tetreault-Campbell, Catherine Ticehurst Geoscience Australia: Veronika Galinec, Daniel McIlroy,
Risk and uncertainty	CSIRO: Simon Barry, Jeffery Dambacher, Jess Ford, Keith Hayes, Geoff Hosack, Yang Liu, Warren Jin, Dan Pagendam, Carmel Pollino
Surface water hydrology	CSIRO: Santosh Aryal, Mat Gilfedder, Fazlul Karim, Lingtao Li, Dave McJannet, Jorge Luis Peña-Arancibia, Xiaogang Shi, Tom Van Niel, Neil Viney, Bill Wang, Ang Yang, Yongqiang Zhang

Acknowledgements

This technical product was reviewed by several groups:

- Discipline Leaders: Russell Crosbie (Groundwater modelling), Neil Viney (Surface water hydrology)
- Senior Science Leaders: David Post (Projects Director), Brent Henderson (Science Director, CSIRO), Becky Schmidt (Products Manager, CSIRO)
- Technical Assurance Reference Group: Chaired by Peter Baker (Principal Science Advisor, Department of the Environment), this group comprises officials from the NSW, Queensland, South Australian and Victorian governments.

Introduction

The Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC) was established to provide advice to the federal Minister for the Environment on potential water-related impacts of coal seam gas (CSG) and large coal mining developments.

Bioregional assessments (BAs) are one of the key mechanisms to assist the IESC in developing this advice so that it is based on best available science and independent expert knowledge. Importantly, technical products from BAs are also expected to be made available to the public, providing the opportunity for all other interested parties, including government regulators, industry, community and the general public, to draw from a single set of accessible information. A BA is a scientific analysis, providing a baseline level of information on the ecology, hydrology, geology and hydrogeology of a bioregion with explicit assessment of the potential direct, indirect and cumulative impacts of CSG and coal mining development on water resources.

The IESC has been involved in the development of *Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources* (the BA methodology; Barrett et al., 2013) and has endorsed it. The BA methodology specifies how BAs should be undertaken. Broadly, a BA comprises five components of activity, as illustrated in Figure 1. Each BA will be different, due in part to regional differences, but also in response to the availability of data, information and fit-for-purpose models. Where differences occur, these are recorded, judgments exercised on what can be achieved, and an explicit record is made of the confidence in the scientific advice produced from the BA.

The Bioregional Assessment Programme

The Bioregional Assessment Programme is a collaboration between the Department of the Environment, the Bureau of Meteorology, CSIRO and Geoscience Australia. Other technical expertise, such as from state governments or universities, is also drawn on as required. For example, natural resource management groups and catchment management authorities identify assets that the community values by providing the list of water-dependent assets, a key input.

The Technical Programme, part of the Bioregional Assessment Programme, will undertake BAs for the following bioregions and subregions:

- the Galilee, Cooper, Pedirka and Arckaringa subregions, within the Lake Eyre Basin bioregion
- the Maranoa-Balonne-Condamine, Gwydir, Namoi and Central West subregions, within the Northern Inland Catchments bioregion
- the Clarence-Moreton bioregion
- the Hunter and Gloucester subregions, within the Northern Sydney Basin bioregion
- the Sydney Basin bioregion
- the Gippsland Basin bioregion.

Technical products (described in a later section) will progressively be delivered throughout the Programme.

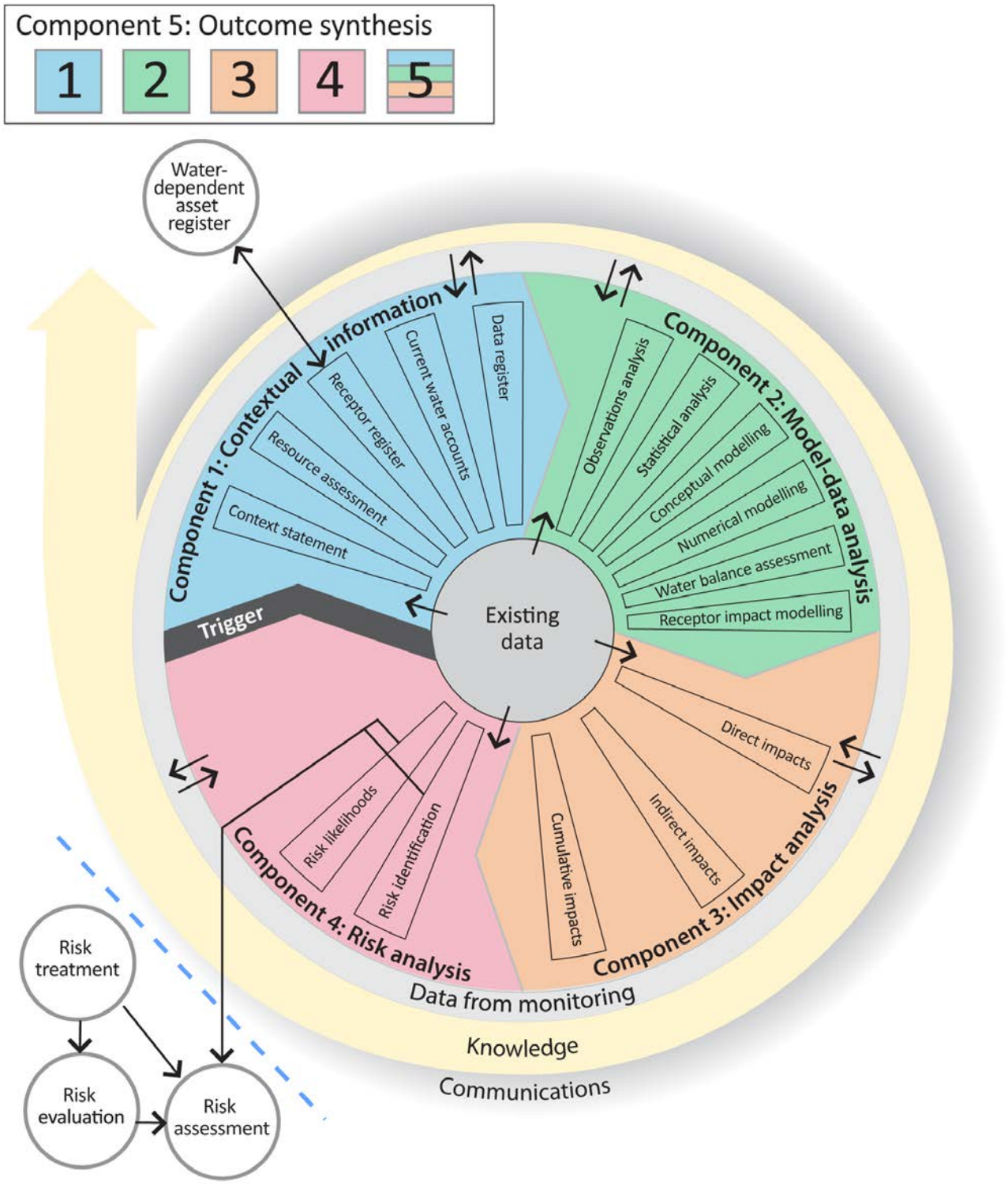

Figure 1 Schematic diagram of the bioregional assessment methodology

The methodology comprises five components, each delivering information into the bioregional assessment and building on prior components, thereby contributing to the accumulation of scientific knowledge. The small grey circles indicate activities external to the bioregional assessment. Risk identification and risk likelihoods are conducted within a bioregional assessment (as part of Component 4) and may contribute activities undertaken externally, such as risk evaluation, risk assessment and risk treatment. Source: Figure 1 in Barrett et al. (2013), © Commonwealth of Australia

Methodologies

For transparency and to ensure consistency across all BAs, submethodologies have been developed to supplement the key approaches outlined in the *Methodology for bioregional assessments of the impact of coal seam gas and coal mining development on water resources* (Barrett et al., 2013). This series of submethodologies aligns with technical products as presented in Table 1. The submethodologies are not intended to be 'recipe books' nor to provide step-by-step instructions; rather they provide an overview of the approach to be taken. In some instances, methods applied for a particular BA may need to differ from what is proposed in the submethodologies – in this case an explanation will be supplied. Overall, the submethodologies are intended to provide a rigorously defined foundation describing how BAs are undertaken.

Table 1 Methodologies and associated technical products listed in Table 2

Code	Proposed title	Summary of content	Associated technical product
M01	*Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources*	A high-level description of the scientific and intellectual basis for a consistent approach to all bioregional assessments	All
M02	*Compiling water-dependent assets*	Describes the approach for determining water-dependent assets	1.3 Description of the water-dependent asset register
M03	*Assigning receptors and impact variables to water-dependent assets*	Describes the approach for determining receptors associated with water-dependent assets	1.4 Description of the receptor register
M04	*Developing a coal resource development pathway*	Specifies the information that needs to be collected and reported in product 1.2 (i.e. known coal and coal seam gas resources as well as current and potential resource developments). Describes the process for determining the coal resource development pathway (reported in product 2.3)	1.2 Coal and coal seam gas resource assessment 2.3 Conceptual modelling
M05	*Developing the conceptual model for causal pathways*	Describes the development of the conceptual model for causal pathways, which summarises how the 'system' operates and articulates the links between coal resource developments and impacts on receptors	2.3 Conceptual modelling
M06	*Surface water modelling*	Describes the approach taken for surface water modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative.	2.6.1 Surface water numerical modelling
M07	*Groundwater modelling*	Describes the approach taken for groundwater modelling across all of the bioregions and subregions. It covers the model(s) used, as well as whether modelling will be quantitative or qualitative. It also considers surface water – groundwater interactions, as well as how the groundwater modelling is constrained by geology.	2.6.2 Groundwater numerical modelling

Code	Proposed title	Summary of content	Associated technical product
M08	*Receptor impact modelling*	Describes how to develop the receptor impact models that are required to assess the potential impacts from coal seam gas and large coal mining on receptors. Conceptual, semi-quantitative and quantitative numerical models are described.	2.7 Receptor impact modelling
M09	*Propagating uncertainty through models*	Describes the approach to sensitivity analysis and quantifying uncertainty in the modelled hydrological response to coal and coal seam gas development	2.3 Conceptual modelling 2.6.1 Surface water numerical modelling 2.6.2 Groundwater numerical modelling 2.7 Receptor impact modelling
M10	*Risk and cumulative impacts on receptors*	Describes the process to identify and analyse risk	3 Impact analysis 4 Risk analysis
M11	*Hazard identification*	Describes the process to identify potential water-related hazards from coal and coal seam gas development	2 Model-data analysis 3 Impact analysis 4 Risk analysis
M12	*Fracture propagation and chemical concentrations*	Describes the likely extent of both vertical and horizontal fractures due to hydraulic stimulation and the likely concentration of chemicals after production of coal seam gas	2 Model-data analysis 3 Impact analysis 4 Risk analysis

Each submethodology is available online at <http://www.bioregionalassessments.gov.au>. Submethodologies might be added in the future.

Technical products

The outputs of the BAs include a suite of technical products variously presenting information about the ecology, hydrology, hydrogeology and geology of a bioregion and the potential direct, indirect and cumulative impacts of CSG and coal mining developments on water resources, both above and below ground. Importantly, these technical products are available to the public, providing the opportunity for all interested parties, including community, industry and government regulators, to draw from a single set of accessible information when considering CSG and large coal mining developments in a particular area.

The information included in the technical products is specified in the BA methodology. Figure 2 shows the information flow within a BA. Table 2 lists the content provided in the technical products, with cross-references to the part of the BA methodology that specifies it. The red rectangles in both Figure 2 and Table 2 indicate the information included in this technical product.

This technical product is delivered as a report (PDF). Additional material is also provided, as specified by the BA methodology:

- all unencumbered data syntheses and databases
- unencumbered tools, model code, procedures, routines and algorithms
- unencumbered forcing, boundary condition, parameter and initial condition datasets
- the workflow, comprising a record of all decision points along the pathway towards completion of the BA, gaps in data and modelling capability, and provenance of data.

The PDF of this technical product, and the additional material, are available online at <http://www.bioregionalassessments.gov.au>.

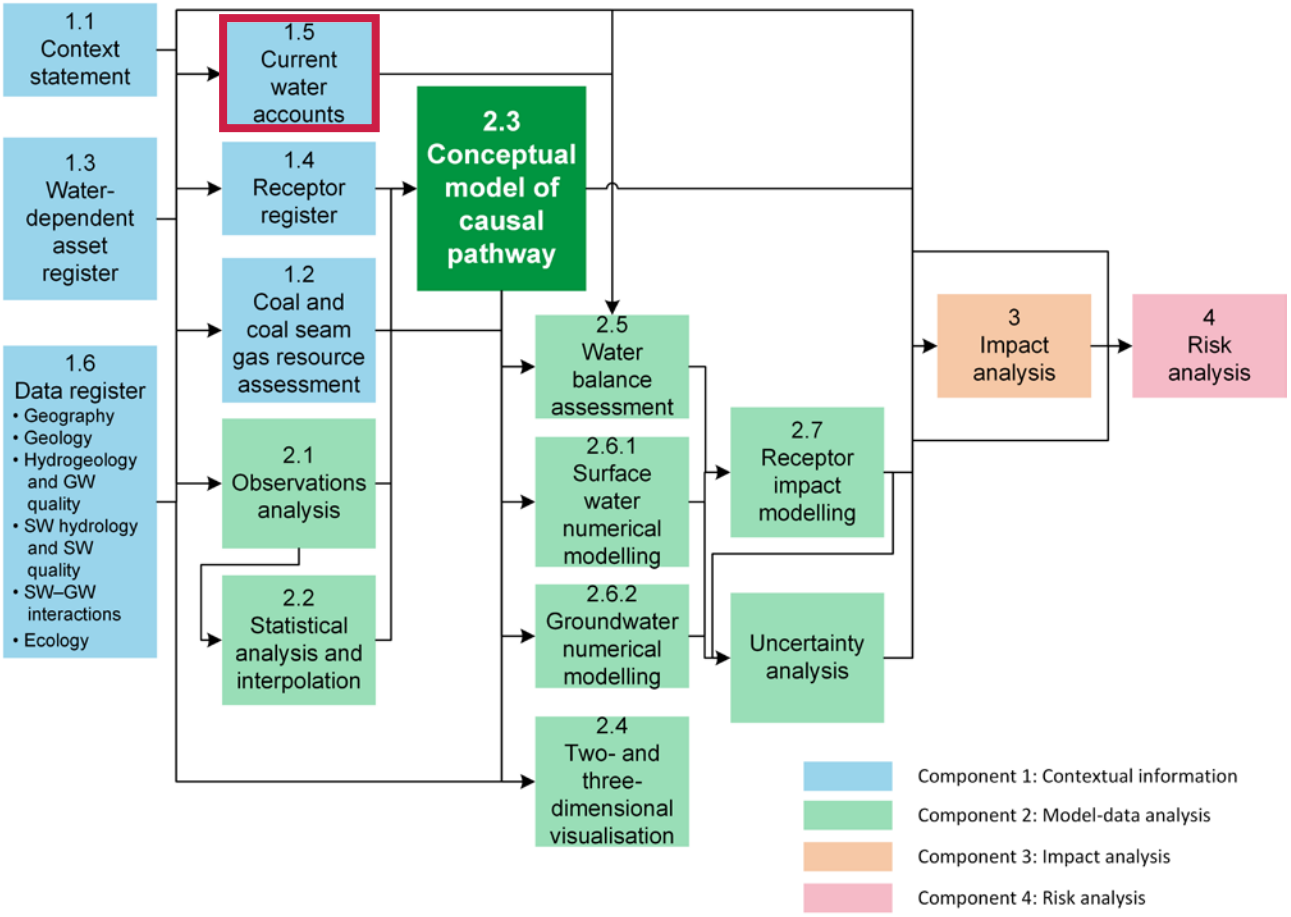

Figure 2 The simple decision tree indicates the flow of information through a bioregional assessment

The red rectangle indicates the information included in this technical product.

About this technical product

The following notes are relevant only for this technical product.

- All reasonable efforts were made to provide all material under a Creative Commons Attribution 3.0 Australia Licence.
- All maps created as part of this BA for inclusion in this product used the Albers equal area projection with a central meridian of 151° East for the Northern Inland Catchments bioregion and two standard parallels of –18.0° and –36.0°.

Table 2 Technical products being delivered as part of the Northern Inland Catchments Bioregional Assessment

For each subregion in the Northern Inland Catchments Bioregional Assessment, technical products will be delivered as data, summaries and reports (PDFs) as indicated by ■ in the last column of Table 2. The red rectangle indicates the information covered in this technical product. A suite of other technical and communication products – such as maps, registers and factsheets – will also be developed through the bioregional assessments.

Component	Product code	Information	Section in the BA methodology[a]	Report
Component 1: Contextual information for the Central West subregion	1.1	Context statement	2.5.1.1, 3.2	■
	1.2	Coal and coal seam gas resource assessment	2.5.1.2, 3.3	■
	1.3	Description of the water-dependent asset register	2.5.1.3, 3.4	■
	1.4	Description of the receptor register	2.5.1.4, 3.5	■
	1.5	Current water accounts and water quality	2.5.1.5	■
	1.6	Data register	2.5.1.6	
Component 2: Model-data analysis for the Central West subregion	2.1-2.2	Observations analysis, statistical analysis and interpolation	2.5.2.1, 2.5.2.2	■
	2.3	Conceptual modelling	2.5.2.3, 4.3	■
	2.4	Two- and three-dimensional representations	4.2	[b]
	2.5	Water balance assessment	2.5.2.4	■
	2.6.1	Surface water numerical modelling	4.4	■
	2.6.2	Groundwater numerical modelling	4.4	■
	2.7	Receptor impact modelling	2.5.2.6, 4.5	■
Component 3: Impact analysis for the Central West subregion	3	Impact analysis	5.2.1	■
Component 4: Risk analysis for the Central West subregion	4	Risk analysis	2.5.4, 5.3	■
Component 5: Outcome synthesis for the Northern Inland Catchments	5	Outcome synthesis	2.5.5	■

[a]Barrett et al. (2013)
[b]The two- and three-dimensional representations will be delivered in products such as 2.3, 2.6.1 and 2.6.2.

References

Barrett DJ, Couch CA, Metcalfe DJ, Lytton L, Adhikary DP and Schmidt RK (2013) Methodology for bioregional assessments of the impacts of coal seam gas and coal mining development on water resources. A report prepared for the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development through the Department of the Environment. Department of the Environment, Australia. Viewed 2 March 2015, <http://www.environment.gov.au/coal-seam-gas-mining/pubs/methodology-bioregional-assessments.pdf>.

1.5 Current water accounts and water quality for the Central West subregion

Coal resource development potential in this subregion is very low. Therefore numerical modelling is not being undertaken for this subregion, and this product only identifies the sources of information known to be available for current water accounts and water quality.

1.5.1 Current water accounts

Summary

Numerical modelling will not be undertaken for the Central West subregion. Consequently, the detailed reporting of current water accounts is not required.

This report describes information and data on current water accounts in the Central West subregion that would be required should numerical modelling be undertaken in the future. The required information and data can be sourced primarily from the Bureau of Meteorology and the NSW Office of Water.

1.5.1.1 Surface water

Data and information required for the water accounts for the Central West subregion are primarily held in the Australian Water Resources Information System (AWRIS) (Bureau of Meteorology, 2014). The information that would be required for a water account includes:

- water volumes held in surface water storages and surface water systems
- surface water diversions
- surface water trading volumes
- surface water entitlement, allocation and use, including surface water for industrial use and town water supply
- location information for all water account data.

Data and information can also be sourced from the continuous monitoring database held by the NSW Office of Water (NSW Office of Water, 2014a) and documented in water sharing plans (NSW Office of Water, 2014b).

1.5.1.2 Groundwater

Data and information required for water accounts for the Central West subregion are primarily held in the National Groundwater Information System (Bureau of Meteorology, 2014). The information that would be required for a water account includes:

- location, elevation and construction information for all groundwater bores
- geological logs of groundwater bores
- groundwater volumes held in aquifers
- groundwater trading volumes
- groundwater entitlements, allocations and use, including groundwater for industrial use and town water supply.

Data and information can also be sourced from the groundwater works database held by the NSW Office of Water (NSW Office of Water, 2014a) and documented in water sharing plans (NSW Office of Water, 2014b).

References

Bureau of Meteorology (2014) Water data online. Bureau of Meteorology. Viewed 22 January 2014, <http://www.bom.gov.au/waterdata/>.

NSW Office of Water (2014a) Continuous monitoring network. New South Wales Office of Water. Viewed 10 December 2014, <http://realtimedata.water.nsw.gov.au/water.stm>.

NSW Office of Water (2014b) Water Sharing Plans. New South Wales Office of Water. Viewed 10 December 2014, <http://www.water.nsw.gov.au/Water-management/Water-sharing-plans/Water-sharing>.

1.5.2 Water quality

Summary

Numerical modelling will not be undertaken for the Central West subregion. Consequently, detailed reporting of water quality is not required.

Information and data on surface water and groundwater quality in the Central West subregion can be sourced primarily from the NSW Office of Water and the Bureau of Meteorology.

1.5.2.1 Surface water

Data and information required to assess surface water quality in the Central West subregion are primarily held by the NSW Office of Water, part of the NSW Department of Primary Industries, in its continuous monitoring database (NSW Office of Water, 2014). The information that would be required for a surface water quality assessment includes:

- location information for all surface water monitoring points
- information on the time of surface water sample collection and analysis
- laboratory results of surface water quality analysis.

An assessment of surface water quality in the Central West subregion would include assessments of temperature, electrical conductivity (EC) and turbidity at least, and these would be compared to water quality guidelines provided by the Australia and New Zealand Environmental and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ, 2000). Data available for any other parameters, such as pH, should also be included if available.

1.5.2.2 Groundwater

Data and information required to assess groundwater quality in the Central West subregion are primarily held by the NSW Office of Water, part of the NSW Department of Primary Industries, in its groundwater works database (NSW Office of Water, 2014). The information that would be required for a groundwater quality assessment includes:

- location information for all groundwater monitoring points, including the aquifer(s) from which samples were collected
- information on the time of groundwater sample collection and analysis
- laboratory results of groundwater quality analysis.

An assessment of groundwater quality in the Central West subregion would include an assessment of temperature, electrical conductivity, pH and total dissolved solids at least, and these would be compared to water quality guidelines provided by the Australia and New Zealand Environmental and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC and ARMCANZ, 2000). Data available for any other parameters, such as

dissolved oxygen, major and minor cations and anions, trace elements and total petroleum hydrocarbons, should also be included if available.

References

ANZECC and ARMCANZ (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand.

Bureau of Meteorology (2014) Water data online. Bureau of Meteorology. Viewed 10 December 2014, <http://www.bom.gov.au/water/groundwater/ngis/>.

NSW Office of Water (2014) Continuous monitoring network. New South Wales Office of Water. Viewed 10 December 2014, <http://realtimedata.water.nsw.gov.au/water.stm>.

www.bioregionalassessments.gov.au

Australian Government
Department of the Environment
Bureau of Meteorology
Geoscience Australia

CSIRO