GISERA
Gas Industry Social and Environmental Research Alliance

Project Order

Proforma 2020

1. Short Project Title

Decision support framework for future groundwater development scenarios in the southeast SA

Long Project Title	Creating an integrated model and multi-criteria analysis framework to prioritize future groundwater balance and development scenarios in the southeast SA
GISERA Project Number	W.23
Proposed Start Date	15/07/2020
Proposed End Date	30/08/2022
Project Leader	Sreekanth Janardhanan and Rebecca Doble

2. GISERA Region

- ☐ Queensland
- ☐ New South Wales
- ☐ Northern Territory
- ☒ **South Australia**
- ☐ Western Australia
- ☐ Victoria

3. GISERA Research Program

- ☒ **Water Research**
- ☐ GHG Research
- ☐ Social & Economic Research
- ☐ Biodiversity Research
- ☐ Agricultural Land Management Research
- ☐ Health Research

4. Project Summary

Objective

The study will develop and test a decision support framework that integrates predictive modelling and multi-criteria analysis (MCA) with stakeholder participation to optimize groundwater development scenarios considering probable future groundwater balance accounting the water use for irrigation, forestry, onshore gas and other industries in southeast SA. The framework will have capability to account for the effects of climate change and variability over time. The framework will enable evaluation of groundwater development scenarios considering both the quantitative assessment of the resource as well as a stakeholder evaluation of alternatives considering socioeconomic and environmental sustainability criteria. The project will deliver a selected number of scenarios, which, combined with the mechanisms/processes that are in place, will provide an understanding of the dynamics of each scenario.

Description

Water allocation within the Lower Limestone Coast prescribed wells area is currently within sustainable limits although hotspots with over-extraction/over-use exists (SENRMB, 2019). The potential demands on the unconfined aquifer exceeds the capacity of the resource in several management areas and the capacity of the resource is insufficient to meet demand on a continuing basis (SENRMB, 2019). The increasing stress on available water resource and challenges to address sustainability principles would have implications on the amount of water available for irrigation and forestry uses in the future and possibly affect the social license to operate for other existing or new industries like onshore gas that have some water requirements.

This study will develop a decision support framework that assesses the probable status of the groundwater resource for a future management period and systematically elicits stakeholder evaluation of alternative plausible strategies against multiple criteria to facilitate devising optimal management strategies. A time horizon between 2020 and 2050 will be used to gain insights for planning groundwater use and allocations while also considering a longer period (2020 to 2100) to assess the climate change and climate variability impacts to ensure that the management strategies are not myopic and long-term sustainability is also considered while evaluating alternative strategies. The alternative strategies considered in the study will comprise different combinations of water use, abstraction (or interception) for irrigation, forestry, stock and domestic, onshore gas and other industries considering multiple development pathways. MCA provides a decision model which comprises (Hajkowicz and Collins, 2007):

- A set of groundwater development scenarios that need to be scored by the stakeholders
- A set of decision criteria often measured in different units
- A set of performance measures which are raw scores for the development scenarios.

The development scenarios in this study will comprise different levels of groundwater development for irrigation, forestry, onshore gas and other industry uses including potential development of the Tertiary Confined Sand Aquifer. Evaluation criteria for the MCA will include socioeconomic and environmental sustainability conditions in addition to the hydrological responses of the aquifer to developmental scenarios and climate change.

Scenarios of developmental pathways of the groundwater system in the region will be developed in consultation with stakeholders. Predictive modelling for will be undertaken accounting for the developmental pathways of major industries in the region and other stressors including climate change and variability. These predictive simulations for the plausible developmental scenario will be used for the MCA to evaluate against several criteria in consultation with stakeholders. Relevant hydrological, socioeconomic and environmental criteria will be applied to evaluate future groundwater scenarios. While selection of the best scenario is often the objective of MCA, it is also a useful tool for engaging with stakeholders and enabling a participatory approach in water management decision making.

The study aims to achieve answers to the following questions.

1) How does the current water use by agriculture, forestry and onshore gas industry affect the groundwater balance in the southeast SA? How might the development pathways of these industries affect the groundwater balance in the future?
2) How would scenarios considering development pathways of the agriculture, forestry and onshore gas industry influence the sustainability of groundwater use in the southeast? What are the impacts/returns per Water Footprint by each user class?
3) Can water balance assessments, together with quantification of their unavoidable uncertainties, be used for planning decisions and more risk-averse allocation decisions for groundwater management? How do different stakeholders evaluate these plausible future developmental scenarios in terms of multiple hydrological, environmental and socioeconomic criteria? Stakeholders include the industry, Government and community members from forestry, agriculture and onshore gas, and NRM groups.
4) How can the non-linear interaction between climate, recharge processes and consumptive demand (e.g., agricultural and forestry vegetation water use) be adequately incorporated in groundwater models so that they can be applied for assessing future groundwater balance in the region for the coming decades for plausible developmental pathways?

Need & Scope

The Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area (SENRMB, 2019) identified that the sources of risk to groundwater resources and uses in the region comprise groundwater extraction or interception, climate variability, drought and climate change. Among these, groundwater extraction and interception largely depend on the agriculture and forestry industries and to a lesser extent by other industries, new or existing, in the region that have some groundwater demand (Pulp and Paper Mill, Onshore Gas, mining). Increasing stress on groundwater may detrimentally impact the social license to operate for new or existing industries like onshore gas even if water footprint is low.

Increasing stress on groundwater resource in some management areas also warrant adaptation of water management strategies to ensure sustainability of the resource. Given the complex nature of hydrological, socioeconomic and environmental impacts of future water management strategies it is important to underpin these decisions with scientific evaluation of the future status of the resource together with adequate consultation of stakeholders to ensure participatory approach in decision making. This study will demonstrate the methodology that combines (i) predictive analysis of groundwater balance with (ii) participatory Multi-Criteria Analysis of alternative development scenarios. This will provide a useful exploratory and communication tool to evaluate and refine development pathways and water management strategies.

Primary Industries and Regions SA (PIRSA) of the Government of South Australia is envisaging to release their Regional Development Strategy in 2020 (PIRSA, 2019). The community engagement report produced as part of this identified that water security, use and allocation are important challenges for regional development. The Limestone Coast Regional Growth Strategy (LCLGA, 2018) also identified that climate change adaptation is one of the key challenges for the resilience of the region. The project addresses some of these critical goals of balancing regional development with stakeholder preferences, environmental sustainability and climate adaptation from a groundwater management perspective.

Methodology

This study will focus on the unconfined Tertiary Gambier Limestone aquifer and Tertiary Confined Sand Aquifer in southeast SA and groundwater use for irrigation, forestry, onshore gas and stock and domestic use. A baseline assessment of the status quo of groundwater resources for the study area will be undertaken using the groundwater models available for the study area. The groundwater balance model developed in the previous GISERA project will be adapted for this purpose. This baseline scenario will enable evaluation of future scenarios and management strategies relative to this one. The scenarios of future development for major water users in the study area will be explored in consultation with relevant stakeholders. ‘Design scenarios of plausible development will be formulated based on this to demonstrate the methodology proposed in this study. This design scenarios will be used for the predictive simulation of groundwater balance, and groundwater use trends for different water users. Predictive simulations will be performed incorporating a range of hard and soft data sources and applied to simulate the dynamic interaction of climate like rainfall volume and distribution, Potential Evapotranspiration (PET), groundwater recharge, evapotranspiration from groundwater, vegetation response as Leaf Area Index (LAI) and groundwater balance. A scenario-based approach will be used to explore future groundwater balance under a plausible range of confounding climatic and hydrological variables. The details of the modelling approach are presented in the following sub-section.

Multi-criteria Analysis will be undertaken for the plausible scenarios considering selected criteria pertaining to socioeconomic, environmental sustainability returns and/or impacts. Multi-criteria Analysis offers a decision support methodology that is primarily used to rank or select options from a given portfolio of alternatives based on an assessment of how they would perform according to a range of relevant criteria and assumptions. When implemented with the participation of relevant stakeholders, it equips decisions makers to understand interests and preferences of stakeholders while also imparting knowledge based on the scientific understanding of the resource. This builds legitimacy of decisions, as well as, supports formulation of decisions with higher chances of implementation success (Foran et al, 2019). The overarching methodology is show in the diagram in figure 1.

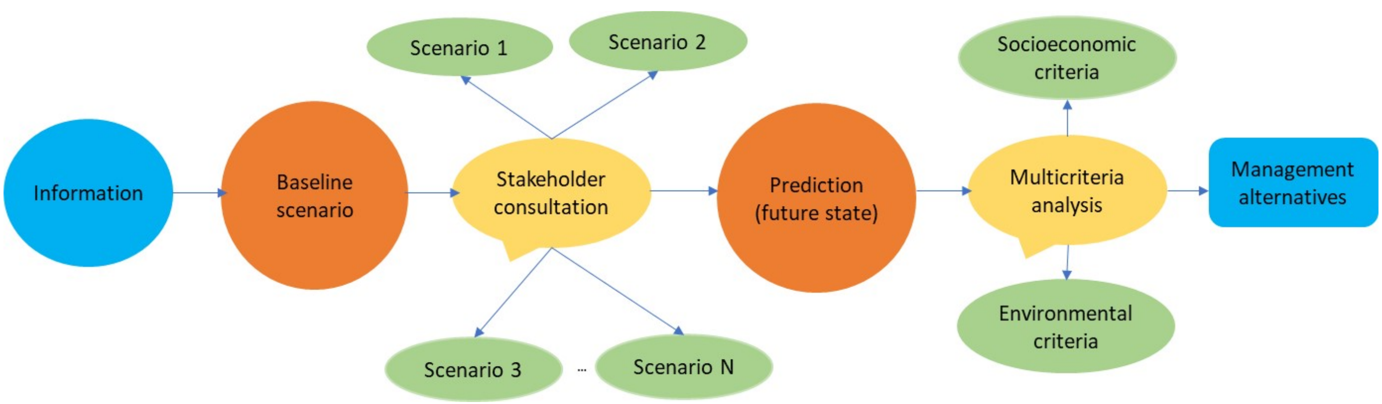

Figure 1: Conceptual diagram illustrating the proposed methodology

Modelling approach

The baseline groundwater balance will be established by using historical estimates of recharge, evapotranspiration and groundwater use and incorporated in the regional and local scale groundwater models available for southeast South Australia. The climate change scenarios studied will use the SA Climate Ready data which has been downscaled for 15 GCMs and 2 RCPs for a series of locations in the South East out to 2100 (Charles and Fu, 2014). This is an agreed set of future climate data for water resource planning in SA.

The WAVES model (Zhang et al, 1996) will be used for the simulation of the vertical movement of water in the soil column under the influence of energy-water-carbon balance and dynamic plant growth resulting in groundwater recharge. An important advantage of the WAVES model is the ability to couple the energy-water-carbon balances. This enables the model to simulate Carbon assimilation and respiration from roots, stems and leaves using an empirical representation of the vegetation response allowing the leaf area to change dynamically with environmental conditions like soil moisture, solar radiation and atmospheric temperature.

This is vital when the vegetation response, evapotranspiration and groundwater recharge needs to be simulated for future climate scenarios.

The resulting groundwater recharge and evapotranspiration will be used to compute the net groundwater recharge corresponding to the future climate scenarios. The net recharge at any point of time is a function of the groundwater level especially in areas like southeast SA where water table is shallow. This means that estimation of recharge corresponding to different climate scenarios also requires the groundwater level corresponding to the future state as an input. This necessitates the evaluation of a feedback loop in the workflow of the simulation models. A novel algorithm and workflow will be developed and tested in this study for computationally efficient characterization of the dynamic interaction of water-energy-carbon balances in quantifying climate impacts of groundwater balance. The method will use, as its basis, the WAVES model (Zhang et al, 1996) and the net recharge package for MODFLOW developed in CSIRO (Doble et al, 2017, Doble et al., 2009). Previously the net recharge (netR) package was tested and proven successful to quantify the net flux at the water table due to the combined effect of recharge and evapotranspiration for historical scenarios. The simple and easy-to-use linkage between the WAVES model and MODFLOW enabled by the net recharge package enables computationally efficient implementation of evapotranspiration and recharge for future climate and developmental scenarios for this study. Computational efficiency in modelling the dynamic linkage between net recharge and groundwater balance will be achieved by using the look-up table approach developed for the netR package.

Calibration will be undertaken simultaneously for all elements in the model suite to ensure that observed and forecast trends in water-energy-carbon balances are maintained while the estimated future groundwater levels are also accounted for when estimating revised net recharge. The groundwater flow models available from SA Department of Environment and Water and/or CSIRO (past GISERA study) will be used for this purpose. Formal uncertainty analysis will be undertaken to quantify both the hydrological uncertainty and the deep uncertainty caused by significantly diverse climate outcomes.

The revised rates of groundwater recharge, evapotranspiration (and hence the net recharge) will be estimated for a range of selected climate, land use and development scenarios and used in conjunction with the groundwater model to estimate plausible states of future groundwater balance. Scenarios other than climate may include plausible developmental scenarios for gas development, forestry, irrigated agriculture and other industries and potential coordinated response to hydrological impacts of climate change for a period 2020 to 2050. All selected scenarios will be used to estimate changes in groundwater levels, flows and water balance components for the selected aquifer, and will be developed in conjunction with regional stakeholders.

Multi Criteria Analysis

A Multi Criteria Analysis will be undertaken to evaluate sustainable future use of the groundwater resource in the Tertiary Gambier Limestone and Tertiary Confined Sand aquifers for the plausible developmental and climate scenario in consultation with the stakeholders. Quantitative/qualitative ranking of the strategies against socioeconomic and environmental sustainability criteria. The numerical groundwater model predictions and uncertainty analysis will be undertaken to quantitatively assess the hydrological/environmental impacts for the chosen scenarios and management strategies. This will take the form of uncertainty-based risk analysis. For example, the hydrological modelling can be used to answer questions like:

- Can we say with 95% confidence that a warmer drier future climate, and same-as-current extent of agriculture, forestry and gas industry will not result in a specified percentage reduction in the number of annually inundated wetlands in the southeast by the end of the century irrespective of development scenario?

MCA will be used to further evaluate the development scenarios in the light of broader socioeconomic and environmental sustainability criteria in consultation with relevant stakeholders. The design scenarios of future groundwater use will be used for illustrating the MCA methodology. Quantitative assessment of performance measures against criteria will be undertaken where the relevant data is available. For example, the sustainability of groundwater development scenarios will be quantified using the numerical model simulations. Performance measures against socioeconomic criteria like growth, employment, productivity relevant to water development scenarios will be considered either quantitatively or qualitatively. Other measures like equity and fairness in allocations and reliability in supply will be considered in the participatory evaluation process.

This participatory approach of evaluating the scenarios against objective criteria provides the negotiators with a decision tool to devise equitable and amenable solutions for water sharing.

5. Project Inputs

Research

The climate change scenarios studied will use the SA Climate Ready data which has been downscaled for 15 GCMs and 2 RCPs for a series of locations in the South East out to 2100 (Charles and Fu, 2014). This work was done in CSIRO through the GOYDER Institute for Water Research. This is an agreed set of future climate data for water resource planning in SA. The groundwater flow models available from SA Department of Environment and Water and/or CSIRO (previous GISERA project) will be used and adapted for doing the integrated water-energy-carbon and groundwater balance analysis using the workflow and algorithms developed in this project.

Resources and collaborations

Researcher	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Sreekanth Janardhanan	50 days	Groundwater modelling and uncertainty analysis	12	CSIRO Land and Water
Rebecca Doble	71 days	Recharge, evapotranspiration, groundwater modelling	15	CSIRO Land and Water
Russell Crosbie	25 days	Recharge	16	CSIRO Land and Water
Trevor Picket	25 days	Software engineering	15	CSIRO Land and Water
Tira Foran	40 days	Social Scientist	17	CSIRO Land and Water
Stephen Charles	5 days	Future climate projections	20	CSIRO Land and Water
PhD/ visiting student	6 -12 months	Numerical modelling and uncertainty analysis	NA	To-be-confirmed

Subcontractors (clause 9.5(a)(i))	Time Commitment (project as a whole)	Principle area of expertise	Years of experience	Organisation
Dr Matt Knowling	20 days	Optimization modelling and management		University of Adelaide
Dr Glenn Harrington	5	Hydrogeology of southeast SA		Innovative Groundwater Solutions

Budget Summary

Source of Cash Contributions	2020/21	2021/22	2022/23	% of Contribution	Total
GISERA	$87,998	$181,207	$5,950	75%	$275,154
- Federal Government	$65,282	$134,431	$4,414	55.64%	$204,128
- SA Government	$22,715	$46,776	$1,536	19.36%	$71,026
Total Cash Contributions	**$87,998**	**$181,207**	**$5,950**	75%	**$275,154**

Source of In-Kind Contribution	2020/21	2021/22	2022/23	% of Contribution	Total
CSIRO	$29,333	$60,402	$1,983	25%	$91,718
Total In-Kind Contribution	**$29,333**	**$60,402**	**$1,983**	**25%**	**$91,718**

6. Project Impact Pathway

<table>
<tr><th>Activities</th><th>Outputs</th><th>Short term Outcomes</th><th>Long term outcomes</th><th>Impact</th></tr>
<tr><td>Stakeholder workshop and scenario development</td><td>Elicitation of plausible developmental scenarios in the southeast</td><td>Elicitation of developmental pathways that may potentially impact hydrological balance in the southeast</td><td rowspan="2">Reinforcing the need to include climate impact considerations in the policy and planning decisions around management of water resources for beneficial anthropogenic uses</td><td rowspan="5">Accounting for impacts from climate change and associated hydrological changes will create Environmental Impact by helping to better cope with the changes.

Elicitation of future pathways of development and state of water resources and likelihood will help communities

Provide informed inputs into planning decisions for the future.

By providing scientific data about water resources and informing social license to operate will create economic impact in the long term.</td></tr>
<tr><td>Climate scenario and weather generation</td><td>Datasets collated and generated from downscaled climate models that may be potentially used for a wider range of hydrological analysis for the region by industry and government agencies</td><td>Climate scenario analyses become more regular activity by the government and other agencies in their cumulative impacts' assessments</td></tr>
<tr><td>Model development scenario and uncertainty analysis</td><td>Provides information and datasets about the state of groundwater resources and confidence levels corresponding to plausible future states of climate and developmental scenarios</td><td>Better planning and decision making about water resources management and developmental plans accounting for likely future state of the resource</td><td rowspan="3">The analyses will give the community an overarching impression about plausible changes and pathways of development for plausible scenarios of future that will enable informed opinion about natural resource management by community groups.</td></tr>
<tr><td>Multi Criteria Analysis</td><td>Quantitative and Qualitative evaluation of management alternatives against socioeconomic and environmental criteria</td><td>Stakeholder participation in evaluation of management alternatives, imparting knowledge about potential future status of the resource</td></tr>
<tr><td>Knowledge transfer, journal papers and other publications</td><td>Journal paper in high-ranking international journal</td><td></td></tr>
</table>

7. Project Plan

Project Schedule

ID	Activities / Task Title (should match activities in impact pathway section)	Task Leader	Scheduled Start	Scheduled Finish	Predecessor
Task 1	Stakeholder workshop	Rebecca Doble	15/07/2020	30/09/2020	None
Task 2	WAVES modelling	Russell Crosbie	1/10/2020	15/04/2021	None
Task 3	Integrated analysis of groundwater with water-energy-carbon balance	Rebecca Doble	15/04/2021	15/08/2021	Task 2
Task 4	Propagation of uncertainty through the model chain	Sreekanth Janardhanan	15/06/2021	15/12/2021	Task 3
Task 5	Scenario analysis and optimisation	Sreekanth Janardhanan	15/10/2021	15/02/2022	Task 3, 4, 5
Task 6	Multi Criteria Analysis	Tira Foran	15/01/2022	15/06/2022	Task 6
Task 7	Final Report, Knowledge transfer, Journal paper	Sreekanth Janardhanan	15/03/2022	30/8/2022	Tasks 7

Task description

Task 1

TASK NAME: Stakeholder workshop and scenario elicitation

TASK LEADER: Rebecca Doble, Sreekanth Janardhanan

OVERALL TIMEFRAME: July-September 2020

BACKGROUND: A stakeholder workshop will be conducted at the start of the project with key stakeholders identified from the Government, Industry and other relevant stakeholders to discuss the overarching goals of the project and intended outcomes. The stakeholder workshop will facilitate an initial elicitation of scenarios, including climate and other developmental scenarios of future groundwater use for agriculture and other industrial purposes in the southeast including those that the stakeholders consider as potential responses to climate change.

TASK OBJECTIVES: Establish the project commencement and elicit the scenarios

TASK OUTPUTS AND SPECIFIC DELIVERABLES: List of scenarios to be modelled

Task 2

TASK NAME: Simulation of water-energy-carbon balances for future climate scenarios using WAVES model

TASK LEADER: Russell Crosbie and Rebecca Doble

OVERALL TIMEFRAME: October 2020 to April 2021

BACKGROUND: The WAVES model (Zhang et al, 1996) will be used for the simulation of the vertical movement of water in the soil column under the influence of energy-water balance and dynamic plant growth resulting in groundwater recharge. An important advantage of the WAVES model is the ability to couple the energy-water-carbon balances. This enables the model to simulate Carbon assimilation and respiration from roots, stems and leaves using an empirical representation of the vegetation response allowing the leaf area to change dynamically with environmental conditions like soil moisture, solar radiation and atmospheric temperature.

TASK OBJECTIVES: Simulation of water-energy-carbon balance for the southeast SA using Waves model

TASK OUTPUTS AND SPECIFIC DELIVERABLES: WAVES model outputs

Task 3

TASK NAME: Integrated water-energy-carbon and groundwater balance analysis

TASK LEADER: Rebecca Doble and Sreekanth Janardhanan

OVERALL TIMEFRAME: April-August 2021

BACKGROUND: Groundwater recharge rates and evapotranspiration will be quantified in conjunction with the simulation of groundwater levels and fluxes using the groundwater model. A novel algorithm and workflow will be developed and tested in this study for computationally efficient characterization of the dynamic interaction of water-energy-carbon balances in quantifying climate impacts of groundwater balance. The method will use, as its basis, the WAVES model (Zhang et al, 1996) and the net recharge package for MODFLOW developed in CSIRO (Doble et al, 2017, Doble et al. 2009). Computational efficiency in modelling the dynamic linkage between net recharge and groundwater balance will be achieved by using the look-up table approach developed for the netR package

TASK OBJECTIVES: Integrated analysis of groundwater balance together with water-energy-carbon balance

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Finalized workflow for simulation model, algorithms, computer programs; Chapters 1,2 and 3 of the report

Task 4

TASK NAME: Propagation of uncertainty through the model chain

TASK LEADER: Sreekanth Janardhanan and Rebecca Doble

OVERALL TIMEFRAME: June-December 2021

BACKGROUND: Calibration and uncertainty analysis will be undertaken simultaneously for the model suite in such a way that parameters that influence the net recharge and hydraulic properties that affect groundwater levels and fluxes will be simultaneously estimated to ensure that observed and forecast trends in water-energy-carbon balances are maintained while the estimated future groundwater levels are also accounted and honored when estimating revised net recharge. The groundwater flow models available from SA Department of Environment and Water and/or CSIRO (GISERA project W14) will be used for this purpose. Formal uncertainty analysis will be undertaken to quantify both the hydrological uncertainty and the deep uncertainty caused by significantly diverse climate outcomes.

TASK OBJECTIVES: Quantifying the climate impact and hydrological uncertainties

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Posterior distribution of parameters and state variables for use in scenario analyses

Task 5

TASK NAME: Scenario analyses and optimisation

TASK LEADER: Sreekanth Janardhanan

OVERALL TIMEFRAME: October 2021 to February 2022

BACKGROUND: The revised rates of groundwater recharge, evapotranspiration (and hence the net recharge) will be estimated for a range of selected climate and developmental scenarios and used in conjunction with the groundwater model to estimate plausible states of future groundwater balance. Scenarios other than climate may include plausible developmental scenarios for agriculture and industry and potential coordinated response to hydrological impacts of climate change. All selected scenarios will be used to estimate changes in groundwater levels, flows and water balance components for the selected aquifer. An optimisation model will be developed to investigate optimal groundwater management for chosen scenarios.

TASK OBJECTIVES: Quantify the groundwater response to scenarios

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Groundwater levels and water balance components for selected scenarios; chapter 4, 5 of the report

Task 6

TASK NAME: Multi Criteria Analysis

TASK LEADER: Tira Foran

OVERALL TIMEFRAME: January-June 2022

BACKGROUND: Multi-criteria Analysis offers a decision support methodology that is primarily used to rank or select options from a given portfolio of alternatives based on an assessment of how they would perform according to a range of relevant criteria and assumptions. Hydrological, socioeconomic and environmental sustainability criteria will be selected, then weighted by stakeholder participants in order to assess development scenarios comprising three combinations of groundwater use for onshore gas, forestry and irrigation uses. This final task will result in at least three selected scenarios of development, the corresponding groundwater balance and dynamics and stakeholder evaluation of these scenarios in terms of hydrological socioeconomic and environmental sustainability criteria.

TASK OBJECTIVES: Undertake multi-criteria analysis

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Participatory MCA workshop and chapter for the final report

Task 7

TASK NAME: Final report, Knowledge transfer and Journal papers

TASK LEADER: Sreekanth Janardhanan and Rebecca Doble

OVERALL TIMEFRAME: March-August 2022

BACKGROUND: Consolidate the developed methodology for integrated modelling analysis in the final report and a high-ranking international journal paper.

TASK OBJECTIVES: Dissemination of the scientific method and key findings

TASK OUTPUTS AND SPECIFIC DELIVERABLES: Final report and Journal paper manuscript

Project Gantt Chart

			2020-21												2020-22												2022-23	
Task	Task Leader	Task Description	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Mar-21	Apr-21	May-21	Jun-21	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22	Jun-22	Jul-22	Aug-22
1	Rebecca Doble	Stakeholder workshop	■	■	■																							
2	Russell Crosbie	WAVES modelling				■	■	■	■	■	■	■																
3	Rebecca Doble	Integrated analysis of groundwater with water-energy-carbon balance										■	■	■	■	■												
4	Sreekanth Janardhanan	Propagation of uncertainty through the model chain												■	■	■	■	■	■	■								
5	Sreekanth Janardhanan	Scenario analysis and optimisation																■	■	■	■	■						
6	Sreekanth Janardhanan	Multi Criteria analysis																			■	■	■	■	■	■		
7	Sreekanth Janardhanan	Final report, Knowledge transfer, Journal paper																					■	■	■	■	■	■

8. Technical Reference Group

Representative from the SA Department of Environment and Water and SA Department of Energy and Mining. Preferable to have people whom we are talking to in the current projects – some possible candidates are listed below:

- Dr Juliette Woods, DEW
- Mr Jarrod Spencer, DEM
- Dr Glenn Harrington

9. Communications Plan

Stakeholder	**Objective**	**Channel** (e.g. meetings/media/factsheets)	**Timeframe** (Before, during at completion)
Regional Community/Wider public	Communicate project objectives and key findings from the research	Fact sheets (including development of one at commencements of project which will explain the objective of the project – this will be updated towards completion Project progress reported on GISERA website to ensure transparency for all stakeholders including regional communities.	From commencements of project and with an update towards completion As required.
Government	Present key findings	Knowledge Transfer Session	At the end of the project

10. Budget Summary

Expenditure	2020/21	2021/22	2022/23	Total
Labour	$114,330	$194,609	$7,933	$316,872
Operating	$3,000	$12,000	$0	$15,000
Subcontractors	$0	$35,000	$0	$35,000
Total Expenditure	**$117,330**	**$241,609**	**$7,933**	**$366,872**

Expenditure per Task	2020/21	2021/22	2022/23	Total
Task 1	$25,801	$0	$0	$25,801
Task 2	$53,634	$0	$0	$53,634
Task 3	$27,827	$20,898	$0	$48,725
Task 4	$10,067	$39,519	$0	$49,586
Task 5	$0	$63,575	$0	$63,575
Task 6	$0	$83,923	$0	$83,923
Task 7	$0	$33,695	$7,933	$41,628
Total Expenditure	**$117,330**	**$241,609**	**$7,933**	**$366,872**

Source of Cash Contributions	2020/21	2021/22	2022/23	Total
Federal Government (55.64%)	$65,282	$134,431	$4,414	$204,128
SA Government (19.36%)	$22,715	$46,776	$1,536	$71,026
Total Cash Contributions	**$87,998**	**$181,207**	**$5,950**	**$275,154**

In-Kind Contributions	2020/21	2021/22	2022/23	Total
CSIRO (25%)	$29,333	$60,402	$1,983	$91,718
Total In-Kind Contributions	**$29,333**	**$60,402**	**$1,983**	**$91,718**

	Total funding over all years	Percentage of Total Budget
Federal Government Investment	$204,128	55.64%
SA Government Investment	$71,026	19.36%
CSIRO Investment	$91,718	25%
Total Other Investment		
TOTAL	**$356,872**	**100%**

Task	Milestone Number	Milestone Description	Funded by	Start Date (mm-yy)	Delivery Date (mm-yy)	Fiscal Year Completed	Payment $ (excluding CSIRO contribution)
Task 1	1.1	Stakeholder workshop completed	GISERA	15/07/2020	30/09/2020	2020/21	$19,351
Task 2	2.1	WAVES modelling completed	GISERA	1/10/2020	15/04/2021	2020/21	$40,226
Task 3	3.1	Integrated analysis of groundwater with water-energy-carbon balance (Chapters 1, 2 and 3 of the final report)	GISERA	15/04/2021	15/08/2021	2021/22	$36,544
Task 4	4.1	Propagation of uncertainty through the model chain	GISERA	15/06/2021	15/12/2021	2021/22	$37,190
Task 5	5.1	Scenario analysis and optimisation (Chapter 4 and 5 of the final report)	GISERA	15/10/2021	15/02/2022	2021/22	$47,681
Task 6	6.1	Multi Criteria Analysis	GISERA	15/01/2022	15/06/2022	2021/22	$62,942
Task 7	7.1	Final report, Knowledge transfer, Journal paper	GISERA	15/03/2022	30/8/2022	2020/23	$31,221

11. Intellectual Property and Confidentiality

Background IP (clause 11.1, 11.2)	**Party**	**Description of Background IP**	**Restrictions on use (if any)**	**Value**
				$
				$
Ownership of Non-Derivative IP (clause 12.3)	CSIRO			
Confidentiality of Project Results (clause 15.6)	Project Results are not confidential.			
Additional Commercialisation requirements (clause 13.1)	Not Applicable			
Distribution of Commercialisation Income (clause 13.4)	Not Applicable			
Commercialisation Interest (clause 1.1)	**Party**		**Commercialisation Interest**	
	CSIRO		Not Applicable	
	Other		Not Applicable	

12. References

Charles S.P., Fu G. (2014) Statistically Downscaled Projections for South Australia – Task 3 CSIRO Final Report. Goyder Institute for Water Research Technical Report Series No. 15/1 Adelaide, South Australia.

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