



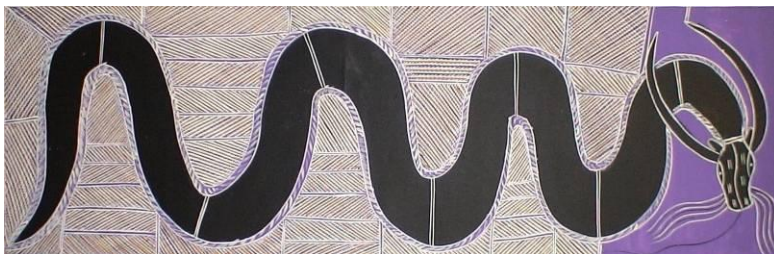
Northern
Territory
Government

**greening the
Territory**

A Territory Government initiative

Gulf Water Study

Final Report



Australian Government
Water Smart Australia

Natural Resources Division

Department of Natural Resources, Environment, The Arts and Sport
PO Box 496
Palmerston NT 0831

Report Number 07/2010D

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ISBN 978-1-921519-68-0

Front cover:

Painting of the Rainbow Serpent by Rex Wilfred.

(A number of water sites in the Gulf region relate to the Rainbow Serpent.)

Tufa dam on Coconut Spring Creek, Pungalina Station

Cattle. Cattle farming is a major industry in the region.

Gulf Water Study: Smart use of scientific and indigenous knowledge systems for effective management of healthy groundwater and rivers

Final Report to the Department of Environment, Water, Heritage and the Arts in relation to funding from the Australian Government Water Smart Australia Program.

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1. Introduction

This report fulfils the reporting requirements from the Northern Territory Government to the Commonwealth of Australia for the project Gulf Water Study: Smart use of scientific and indigenous knowledge systems for effective management of healthy groundwater and rivers.

The study was co-funded by the Australian Government Water Smart Australia Program and the Department of Natural Resources, Environment, the Arts and Sport of the Northern Territory Government. The study began in 2006 and ran for three and a half years.

This report provides an overview of the Gulf Water Study and addresses how the objectives of the study were met. It evaluates the project against performance indicators and describes how the project was achieved.

2. Project Overview

Water reform has established that environmental water provisions should be made prior to allocating to other consumptive uses. This is a key driver to this project. To establish environmental water provisions it is essential to have an understanding of the hydrology of a region, how it interacts with the environment and what ecosystems are dependent upon it. This project has set out to achieve this. The project undertook two major investigations; one was a study of the hydrology of the Gulf Region and the other a more detailed investigation of the Roper River catchment.

The hydrology study of the Gulf region covered the area from the Queensland border to the Roper River, an area of approximately 110,000 km² (Figure 1). That's about half the size of Victoria. The study delivered five 1:250,000 scale maps (Figure 1) detailing the groundwater and Dry season surface water resources of the region, indigenous knowledge and likely groundwater dependent ecosystems. Four reports, six posters and a spatial photographic database (photos and videos) further explain the groundwater resources and their interplay with the environment. All information is presented in a user friendly format and the entire information resource is available on a data DVD.

The methodology encompassed scientific and indigenous knowledge systems. The science provided the quantitative analysis. Local and indigenous knowledge substantiated the science, identified key areas of interest as well as provided historical accounts of the dynamics of water resources and dependent ecosystems. This was critical information for a region where data was scarce. In presenting indigenous perspectives cross-cultural understandings of water and the environment are fostered.

The products provide an easily accessible and quick reference on water resources in the region thereby providing baseline information for catchment management, property planning and for further studies on the connective environment.

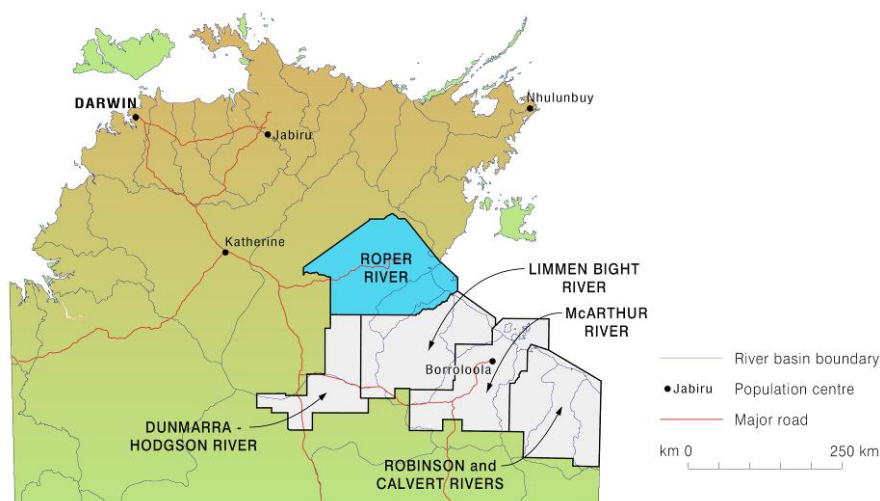


Figure 1 The Gulf hydrology study region showing the 5 mapping regions with the Roper River region highlighted.

The more detailed investigation of the Roper River catchment included the entire groundwater catchment to the Roper River as well as the surface water catchment (Figure 2). The investigation focussed on the development of a coupled surface – groundwater model for the catchment. It utilised cutting edge coupling of the groundwater modelling software, FEFLOW and surface water modelling software MIKE11. The model accounts for the connection between groundwater and surface water so that double accounting does not occur.

The model provides groundwater levels and river flows for various scenarios such as changed climatic conditions or large extractions. Hence the model provides essential data to water allocation planning in the Mataranka region which is currently underway. Through modelling over the historic climate record a better understanding of the behaviour of the Roper River and the aquifers that feed it is attained. Historic knowledge has proven to be critical to understanding the Roper River system as the last decade has been the wettest for the period of record. The model greatly assists with the determination of environmental water provisions as it takes into account the dynamic nature of the river.

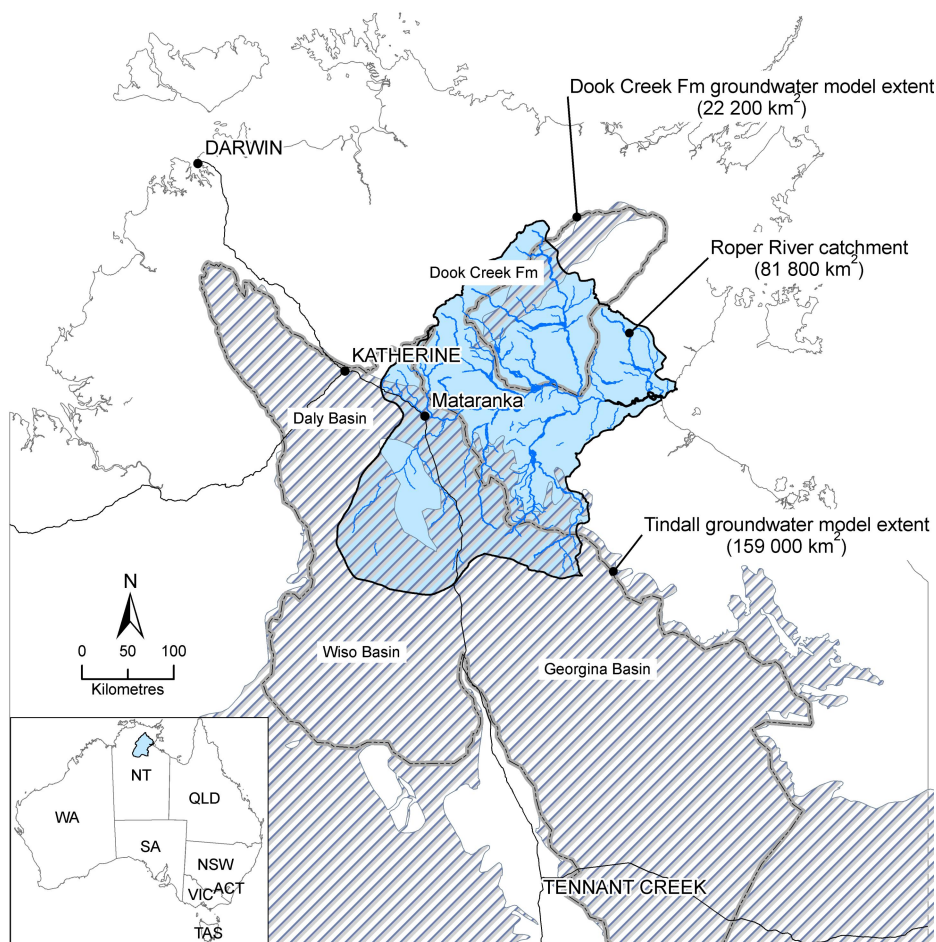


Figure 2 Location of the Roper River catchment with respect to the major groundwater basins (grey hatched regions). The extent of the groundwater models are provided for reference (grey line).

3. Objectives

Below are listed the objectives of the project and how they were achieved.

3.1 Overall Objective

The overall objective of the project is to provide fundamental tools to enable better understanding of how to account for environmental water requirements in water allocation planning in the Gulf region.

The project has implemented a 'smart' approach to understanding how to account for environmental water requirements. It achieved this by broadscale mapping of both groundwater and surface water resources showing their connectivity, by presenting indigenous knowledge on water and by developing a model for the entire Roper River catchment utilising cutting edge software which integrates surface water and groundwater models to eliminate the connectivity and "double accounting issue".

Given the large study area and lack of data in the Gulf region, all sources of information including scientific, indigenous and local have been utilised to develop the maps and ancillary products. These provide readily accessible and easily understandable baseline information on water resources which is essential to their effective management. The maps delineate groundwater according to aquifer type, river flows according to their minimum baseflow, springs, all bores and many surface water sites along with their site numbers. Providing all this information on the one map provides an overview of groundwater availability and shows which aquifers provide baseflow to which rivers which in turn helps identify dependent ecosystems. Further to this likely groundwater dependent vegetation communities are also mapped. Indigenous water site names are shown on the maps and further details provided in the reports. This practice fosters cross cultural understandings of water and the environment, and ensures the maps are relevant and user friendly to all.

The construction, development and application of a catchment wide integrated surface water/groundwater model for the entire Roper River catchment will inform water management and planning, and advise of seasonal allocations to licensees. This project represents only the second instance where coupling between a groundwater model and surface water model using the proprietary software FEFLOW and MIKE11 has been implemented in Australia. It has been an ambitious task with the groundwater model alone covering an area 182 000 km² (that's 80% of the size of Victoria). Utilising daily climate data the model is able to provide groundwater levels and river flows and levels at nominated sites within the catchment. It can then be run for various scenarios, such as changed climatic conditions or larger extractions, and the effects on the groundwater and surface water resources can be predicted. This provides essential information to water allocation planning and will ensure that the current and planned regional water uses remain within sustainable limits.

The Roper River model, the maps and the reports provide a smart planning tool as they directly address connectivity issues between groundwater and surface water.

3.2 Specific Objectives

The specific objectives are addressed following.

a. Encourage participation in on ground natural resource management

Participation has been encouraged by raising awareness about the project and its outputs through extensive liaison. A concerted effort was made to contact and meet with all stakeholders to discuss the project and provide feedback on the water resources in regions relevant to them, as well as elicit information from them. Local knowledge was highly valued and appreciated given the lack of recorded data across the region. In seeking out local knowledge and explaining how that knowledge is relevant and useful to the project provides further encouragement to locals in participation in natural resource management.

Stakeholders included station managers, indigenous ranger groups, traditional owners, rangers, community leaders and mining and mineral exploration companies. Presentations were delivered to the Roper River Landcare Group. People were informed on the project products, what information they deliver and how to use them. At the meetings the characteristics and dynamics of water resources was explained, such as why springs are where they are, why spring and river flows vary, how and why groundwater yields vary and the interrelationship between groundwater and surface water and dependent ecosystems. Indigenous perspectives on water and the environment were also discussed. It is hoped also that by presenting indigenous knowledge that a wider, culturally inclusive perspective on natural resource management is propagated.

Direct participation in on ground natural resource management was also encouraged during field surveys. Station managers and traditional owners provided guidance on field surveys. During these trips they participated in data collection of water quality, quantity and the cultural significance of water. The purpose of the data collection and its relevance to natural resource management was explained to participants encouraging further interest natural resource management practices.



Discussing water resources at Larrpayanji. S. Hester, S. Roberts, R. Roberts



Measuring the water level in a bore at Merlin Mine. U. Zaar, B. Maycour



Examining cutting from the drill hole on Garawa Land. L. Hoosan, S. Tickell

b. Inform property planning

The water resource maps in conjunction with the reports provide essential information to property planning. The maps show property details such as fences, tracks and dams as well as the groundwater and surface water resources.

Groundwater is mapped according to aquifer type and the typical yield range is stated. This provides a clear guide to the expected bore yields within an area. The report further explains the aquifer types and rock formations. The maps also show existing bores and their registration number. In the reports, data tables are provided on every bore listing drill depth, yield, standing water level as well as water quality. The property planner can hence quickly establish the groundwater potential of an area from the existing data and from the regional groundwater mapping.

The maps also show perennial surface water resources. Property planners are usually well aware of these resources however an added feature of the maps is how perennial river flows are delineated. Rivers are categorised according to their absolute minimum flow which is often groundwater sourced. On the maps and in the reports historic flow data is presented for gauging stations showing the dynamic nature of the rivers in the region. This is very pertinent to property planning because there can be large flow variations that are only observed over a historic record. A prime example is the Roper River. Due to high rainfall, this river has not stopped flowing since the early 1970's, however prior to 1970 the river often ceased to flow by the end of the Dry season. Some property owners situated along the Roper River were unaware of this fact.

From the maps and reports, the property planner is provided with a holistic overview of water on their property and within the region, as groundwater and surface water resources and their connectivity is shown. This allows water resources to be utilised most effectively and enables sustainable grazing of pasture.



Shantelle Tapp, from Big River Station, enjoying the Roper River.



Cattle farming is a major industry in the Gulf region.



Breakfast at sunrise at Seven Emu Station.

c. Include Aboriginal perspectives and encourage their involvement in water policy and planning processes

Just as any scientific based management of water requires an understanding of scientific principles and classification, so too indigenous environmental management requires an understanding of indigenous perspectives and classification of the environment. Western science provides a view of water resources in terms of its physical characteristics. Aboriginal people however view and classify the natural environment differently and kinship plays a major role. To comprehend the indigenous perspective is no easy task when coming from a Western European perspective and as John Bradley, an anthropologist who worked in the Gulf region remarks that it was only after he became quite fluent in the local indigenous language that that he began to really understand how these indigenous people view their environment. A synopsis of the indigenous world view of one language group in the region, as documented by

Bradley and others, is presented in the reports so the reader can put the information gathered from indigenous people by the Gulf Water Study team into perspective.

Information was gathered through interviews and whilst traditional owners provided field guidance to water sites. Much of the information collected relates to waterholes. These waterholes are shown on the water resource maps along with the indigenous name. Cultural information pertaining to the waterhole and who provided that information is detailed in the reports. This presents only a fragment of the indigenous knowledge of the vast Gulf region. From the work undertaken on indigenous perspectives a most salient point is made: for indigenous people, every waterhole has a story, a name and a role to play in their interconnected spiritual, social and physical environment. Aside from the maps and reports indigenous perspectives are also portrayed by photos with captions and short videos which are available on the Gulf Water Study data DVD.

Throughout the project period, project officers liaised and presented the work of the project to indigenous people and their representative agencies including the Yugul Mangi rangers, Mabunji Aboriginal Resource Association and the Mimal Rangers encouraging involvement with the project and raising awareness of the project outcomes and how they feed into planning processes. It is hoped that the inclusive, cross-cultural approach which provides common understandings for indigenous and non-indigenous people will encourage further involvement in water planning processes.



R. Raggett with grandson L. Raggett at a spring on the upper McArthur River.



L. Hoosan discussing indigenous knowledge with U. Zaar.



L – R, L. Hogan, J. Mawson, F. Shadforth, C. Shadforth, D. Mawson at Spring Ck Station.

d. Identify where potential impacts on water resources may result from major developments

The intended major development identified in the Gulf region that can impact on water resources pertains to horticulture. There is a foreseeable high demand for groundwater in the Mataranka region by horticulturists for irrigation. The groundwater around Mataranka is sourced from a Cambrian limestone aquifer. Groundwater discharging from this aquifer provides baseflow to the Roper River. It follows that if groundwater is extracted then there is less supply to the river. Springs which discharge from the aquifer include Bitter Springs, the iconic Rainbow Springs as well as other springs located along the Botanic walk in Elsey National Park. The maintenance of these springs and baseflow in the Roper is considered to be of beneficial use to the tourist industry, to indigenous people and to amateur fishing – all are identified as key stakeholders.

The foreseeable high water demand has prompted the undertaking of this project, in particular the modelling work which addresses how water extraction affects groundwater levels and baseflows in the Roper River. The model provides critical information to ensuring that environmental water provisions are made prior to allocating to other consumptive uses. The model is being used to develop a water allocation plan for the Mataranka region.



Rainbow Spring at Mataranka.



Bitter Springs.



Roper River at Roper Bar Crossing.

- e. Provide data on groundwater and surface water and their interrelationship for inclusion into further studies on the connective environment and dependent ecological processes

Effective management of ecosystems requires a sound knowledge of its characteristics and the interrelationship between elements of the hydrologic cycle. In tropical Northern Territory with its Wet and Dry season, groundwater plays a key role in ecosystem survival by the provision of water to wetlands and rivers throughout the Dry season. Therefore there is a high priority to identify groundwater discharges that sustain flows which maintain groundwater dependent ecosystems.

Groundwater and surface water information is readily and easily accessed through the five water resource maps produced at a 1:250 000 scale. The maps cover an area of approximately 110,000 sq. kilometres – that's about half the size of Victoria. Groundwater is delineated on the maps by aquifer type where the typical yield and flow system are described. All together there are seven different aquifer types. Four reports pertaining to the maps describe the aquifer types in each region with the help of diagrams so people unfamiliar with groundwater can begin to understand it. Water quality characteristics are also explained. Groundwater data is also provided through information on water bores. All bores are marked on the maps along with their registration number. Baseline data on each bore is provided in the reports in tabular form and include depth drilled, casing depth, standing water level, yield and up to 17 different water quality parameters.

Surface water is delineated on the maps as waterholes, lakes, springs and rivers classified according to their minimum flow at the end of the Dry season during a dry period. There are four categories that describe flow; from rivers which dry out to perennial rivers with a minimum flow greater than 100 L/s. Many surface water sites are marked on the maps with a unique site number. The report pertaining to each map lists all the surface water sites along with water quality data and water level and discharge data where available.

By mapping and detailing groundwater and surface water in the manner described, the interrelationship between the two can be readily observed on the maps. This is the forte of this

style of mapping. For example, significant groundwater discharges (spring and river flows) are observed emanating from fractured and karstic aquifers and minimal groundwater discharges are observed in areas where aquifers consist of fractured and weathered rocks with minor groundwater resources. Further to this, the reports explain spring types in the region and how they relate to aquifer type. Rainforest vegetation communities associated with riparian zones and springs are also shown on the maps. These are likely groundwater dependent ecosystems.

Aside from the maps and reports which are available in digital format, a GIS has also been produced so the information can be utilised in further studies.

The integrated surface-groundwater model of the Roper River catchment focuses on the interrelationship between groundwater and surface water. A major aquifer in the Top End of Australia is the Cambrian Limestone aquifer system formed in the Wiso, Georgina and Daly Basins. It represents the source of the majority of the baseflow to the Roper River. The Cambrian limestone also provides baseflow to the Katherine, Flora, Daly and Douglas Rivers of the Daly catchment. The groundwater model (FEFLOW finite element saturated flow model) covers approximately 160 000 km² of the Cambrian Limestone aquifer system as well as about 22 000 km² of the aquifer within the Dook Creek Formation which also provides water to the Roper River. The surface water model (MIKE11 1D channel flow model) covers the entire Roper River catchment, an area of about 82000 km². The two models are coupled using the IFMMIKE11 module. The integrated surface-groundwater model accounts for surface-groundwater fluxes: rivers present complex head boundaries to the groundwater model, and the surface-groundwater flux is dependent on the stage height in the river and the groundwater level in the aquifer. The coupling of the models involves passing groundwater discharge at the end of each time step calculated by FEFLOW, to the MIKE11 model, as a baseflow boundary condition at key sites via the coupling module. MIKE11 calculates the river discharge and water levels up to the end of the time step and the actual water levels at the key sites are passed back to the coupled FEFLOW transfer boundary nodes ready for the next timestep. Hence water levels and fluxes are dynamically linked. The coupled model enables modelling of the dynamic interaction between surface and groundwater heads, including the situation where during the wet season the river level exceeds the groundwater level and baseflow is reversed (ie. the river recharges the aquifer). The integrated surface-groundwater model views the resource holistically and ensures there is no 'double accounting' which arises when surface water assessments and groundwater assessments are conducted independently.



Mataranka Falls,
Roper River.



U. Zaar pointing out a rock fracture,
McArthur River Station.



U. Zaar taking a water quality
measurement of Rosie Ck, Lorella
Springs Station.



Lush vegetation
at a spring on
McArthur R. Stn.

f. Provide baseline data for catchment management

As noted above, groundwater and surface water as detailed on the maps, in the reports (in tabular format) and in the GIS provide readily accessible baseline data which can be used in catchment management. Further to this, the dynamics of groundwater and surface water and their interrelationship is explained, flow losses along the major river in the region, the Roper River, are examined, and likely groundwater dependent vegetation communities delineated. The information provided from this project is essential to catchment management: water availability, water sources, water quality, knowledge on the nature and dynamics of water resources and a capacity to predict likely catchment response - all essential to maintaining healthy groundwater and rivers where developments are planned.

g. Provide a predictive model which can show the potential effects on water resources from climate change

The integrated surface-groundwater model of the Roper River described in section e above can be used to simulate the response of the water resources (both groundwater and surface water) from climate change. Climate parameters that can be varied in the model are rainfall and evapotranspiration.

h. Provide a model for the Roper River catchment to inform environmental water provisions

The model developed for the Roper River is described in section e above. Proposed horticultural development of groundwater from the Cambrian Limestone aquifer at the head waters of the Roper River in the area around Mataranka could represent a threat to the environmental flow regime and cultural needs of the Roper River particularly in low flow periods. While perennial rivers, such as the Roper River may be of particular interest to horticultural investors and developers, these rivers support ecological communities that are dependent upon the quantity, quality and timing of these groundwater flows. Because most rivers in northern Australia are ephemeral, these perennial rivers have high ecological significance. Any extraction of groundwater from these systems will most likely result in a reduction in streamflow at some point in time. The impacts of these reductions and whether those impacts are acceptable is a key management question.

In an ambitious attempt to examine and inform some of the management issues with respect to water resource allocation an integrated surface – groundwater modelling approach is adopted. This model includes the entire Roper River catchment with emphasis on the branches identified as having dry season flows and the entire Cambrian Limestone aquifer system with an emphasis on the area surrounding Mataranka and the head waters of the Roper River.

With the use of long term climate data, the model determines long term annual catchment water balances of surface water and groundwater (ie river levels and flows, groundwater levels) which is essential to water allocation planning. The model can quantify the effects of extraction on groundwater levels and baseflow (Dry season flow), that is it can identify where potential impacts on water resources may result from major developments (pumping scenarios).

4. Performance indicators

Following is an evaluation of the project against the listed performance indicators.

- a. Provide water allocation planners with information on water resources and dependent ecosystems that inform long term decision making for the region;

The mapping work and the model achieve this outcome. The mapping work provides information on both groundwater and surface water. Groundwater is spatially delineated by aquifer type, flow system and typical yield. This is baseline data necessary for long term decision making. For instance, knowledge on the location and typical bore yield of aquifers can directly influence where irrigation and other developments can be feasibly located. Surface water is delineated by minimum flow in the rivers during a historically dry period. Hence all perennial rivers are mapped and as their flow is maintained by groundwater, they can be considered groundwater dependent. This provides water allocation planners with a quick reference as to where perennial rivers are located, where baseflow is sourced and where water supplies can potentially be drawn over the long term. All available river discharge information, from gauging stations, is also shown by use of hydrographs in the reports. This provides water allocation planners with an overview of discharge variation at particular sites over the period of record. Where data is available, the relationship between rainfall, groundwater level and minimum river flow (baseflow) is shown graphically and the interrelationships are explained in the reports. Hence water allocation planners are made aware of the nature of these interconnections and how drawing water from an aquifer can reduce baseflow in a river. The reports also list and provide details on all the bores and surface water sites in the region so water planners are made aware of the data available.

The maps show vegetation communities which are potential groundwater dependent ecosystems. The reports explain how the springs arise that provide water to these ecosystems.

The integrated surface-groundwater model of the Roper River feeds directly into the water allocation planning work that is currently underway for the Mataranka region. The model has been developed for the entire Roper River surface and groundwater catchment. The integrated model will provide water allocation planners with quantitative information on the water resources. This has been outlined in section h above. This information will help in long term decision making and identify the areas where further study is required. A strong feature of the model is its ability to undertake scenario modelling with quantitative results which will ensure that the current and planned regional water uses remain within sustainable limits.

There are few reaches of the Roper River that flow year-round due to the high evaporation rates, the distribution of regional aquifers and the long Dry season, and consequently these are of high importance. These perennial river sections can be classified as groundwater dependent. They are sustained through localised groundwater discharge (i.e. discharge occurs where streams intersect aquifers). These localised points of discharge are few and the risk of impact from development is high. In these environments, ecosystems have adapted to stream flow conditions that are rainfall dependent in the wet season and groundwater dependent in the

Dry season. The distribution of vegetation can be controlled by the availability of groundwater; where the water table approaches the surface, a greater density of vegetation is evident and can often be identified using remote sensing products. In the Roper River catchment, a number of potential groundwater dependent ecosystems have been identified and are discussed in the regional reports furnished for this project. They include wetlands within Elsey National Park, Red Lily Lagoon, upper Flying Fox Creek, upper Mainoru River and within the Wilton River catchment.

In the reports (Knapton 2009, Zaar 2009) the dynamics of the Roper River are discussed and the reader is alerted to the fact that even tidal reaches of the Roper River can be considered groundwater dependent. The location of the freshwater – salt water interface varies with freshwater input into the river and during the Dry season, baseflow volume plays a major role in displacing the interface. During dry periods the river can stop flowing and the interface can move upstream to Roper Bar which marks the tidal limit. Hence reaches of the river which are usually fresh become saline. Without the groundwater input into the river, the tidal reach of the river can become more frequently saline. This is the dynamic nature of most Top End Rivers.

- b. [Enable local land managers to apply management strategies relevant and suitable to the land under their control and ensure environmentally healthy management practices;](#)

Land management strategies require baseline knowledge of the land and water. This project delivers such baseline information. The mapping work provides essential baseline data on water resources which is readily accessible and easily understood. They provide a ready reference on basic analytical elements:

who, what, where, why, how,

- Who: who owns the land – land tenure is shown,
- What: groundwater, surface water and likely groundwater dependent ecosystems are delineated (aquifer types, springs, river flows, vegetation communities etc),
- Where: spatial location is provided on the maps and individual sites detailed in the reports,
- Why: reports explain aquifer types and yields and interrelationship between rainfall, groundwater level and baseflow,
- How: the maps give insight on how the landscape works, how springs relate to rock type and geologic structure.

The maps provide a ready reference as to the limits of water availability, sustainability and dynamics. Likely groundwater dependent ecosystems and their groundwater sources are outlined on the maps and the reports explain these sources and dynamics of the groundwater. This is all essential information for environmental management.

Mapping of water resource availability enables land managers to plan and develop properties. Pastoralists may utilise this information to plan a seasonal grazing regime based on sustainable stocking rates, access to watering points and rotating stock through these sources in the dry season.

The integrated surface-groundwater model of the Roper River catchment provides an essential tool to sustainable management of water resources and ecosystems within that catchment.

- c. Ensure the current and planned regional water uses remain within ecologically sustainable limits;

The mapping work provides an overview of the limits of water availability (groundwater and surface water) and likely groundwater dependent ecosystems, and the modelling provides quantitative results on the effects of extraction on groundwater levels and river flows. This information will be used by water allocation planners to ensure regional water use in the Mataranka region remains within ecologically sustainable limits.

- d. Ensure property planning and development opportunities by station managers are informed by the information products; and

All station managers in the region receive a copy of the map relevant to their area as well as the ancillary information products. They are briefed on how to use the maps with particular reference to property planning and development.

- e. Enable Aboriginal people in the region to understand the information provided and aid them with identifying management priorities and plan effectively.

Presentations explaining the information products and their use are undertaken at all indigenous communities to various indigenous representative groups including the Northern Land Council, local council, resource associations and ranger groups. Indigenous land holders are also briefed on the products. The information products have been presented in a user friendly format and the reports contain many diagrams explaining scientific concepts. The project has adopted a multi media approach in conveying water resource information. The data DVD contains not only the maps and reports but six information posters, a GIS and a spatially referenced video and photographic database all presented in an easy to use web type front end.



F. Shadforth & U. Zaar discussing water on Seven Emu Station.



Bubbling Sands spring at Pungalina Station.



R. Walker from Lorella Springs Station at a spring fed creek.



W. Mc Kinnon examining maps for the Gulf region.

5. How the project was achieved

Following is a description of the operation, mechanisms and processes employed by project personnel to perform the project and achieve the objectives.

Two full time staff were employed on the project; the project manager and water resource professional. The project manager undertook the progress reporting and financial management of the project as well as all required work to produce the maps. This included field work, liaison, logistics, analysis of scientific data, production of map drafts, reports, posters and photographic and video database. The water resource professional undertook all work necessary to produce the integrated surface – groundwater model. The work focus was on construction and calibration of the model which necessitated field work to obtain the required data, liaison, logistics and analysis of data. Reports were also written up. These two key personnel were hence involved with every facet of the project; from hands on data collection to reporting. Other personnel involved with the project included scientific, technical and cartographic staff. These people assisted with scientific analysis, field work and DVD and map production.

Field work was undertaken during the Dry seasons. Field surveys involved visiting sites and collecting water flow and water quality data. The field team frequently consisted of two officers who accessed sites via 4WD vehicle, quad bikes, boat, by foot and by helicopter. Traditional owners often accompanied field teams providing guidance and indigenous knowledge. Drilling investigations were undertaken by the NT Government drilling rigs and drilling teams and were largely supervised by the project manager or water resource professional. Drilling investigations were time consuming as they required site clearances (permits), site reconnaissance and track works so that the heavy drill rig could access the nominated site.



R. Metcalfe measuring the flow in the Roper River at Flying Fox Station with an Acoustic Doppler Current Profiler.

Liaison was extensive as all stations, town councils, indigenous representative groups (such as the Northern Land Council, resource associations and ranger groups) mining and mineral exploration companies and Parks and Wildlife rangers in the mapping area were visited by the project manager and informed about the project and its outcomes. Such liaison provided an avenue for project officers to gain knowledge on water resources from the local people. Given the lack of data for the region, this was critical information. Presentations were delivered to the Roper River Landcare Group keeping them updated on progress of the integrated Roper River model.

Data from the field trips was entered into the database and the model as required. The data provided key information to the mapping process. Field survey data is presented in data tables in the reports along with existing data.

Groundwater mapping was achieved through the analysis of geological maps in conjunction with new and existing field data (from drilling investigations and site surveys on groundwater discharges), from desktop study of previous reports, through pier review and from local knowledge. Surface water mapping was achieved by analysis of new and existing field data (essentially water flow and water quality measurements), study of existing reports, examination of satellite imagery and aerial photography and from local knowledge. Local knowledge was essential to this work as not all river reaches and springs were able to be visited in the region given the vast area covered (about half the size of Victoria), the time frame and the resources available. Drafted maps were digitised and formalised by the cartographer.

Indigenous knowledge was attained as traditional owners guided and informed field teams on field surveys and through meetings. The Northern Land Council, local councils and Aboriginal resource associations were helpful in arranging meetings and providing introductions to key elders. Where possible the spelling of indigenous place names was further checked by native speakers and the Ngukurr Language Centre. Indigenous knowledge is documented in the reports, in the photographic database and in video. Key traditional elders were interviewed and a number of short videos feature them talking about water in their country. All this information is readily accessible on the data DVD.

A technical working group was formed to provide advice to the project team. The group consisted of the Project Manager, the Principal Engineer Water Resources, a biodiversity professional and two indigenous land owner representatives. The water resource professional also attended many of the meetings. Aside from the working group meetings, members also provided much individual advice and kept in contact regularly.



Investigation drilling in the Gulf.



M. Gorrige, D. Yin Foo, G. Wightman, A. Knpton reviewing progress at a technical working group meeting.



A. Anderson with son A. Anderson at Manangoora Station

6. Further work

The products have been distributed to stakeholders in the Gulf region and continue to be given to all interested parties. The maps are available over the internet through the NRETAS web site (<http://www.nt.gov.au/nreta/water/index.html>). The Northern Territory Government provides ongoing advice and information to interested parties regarding the project products.

During the course of this project the Daly Roper Water Control District was declared. It included the entire surface water catchment of the Roper River. The declaration provides control of water resources for management purposes. The legislation for this district covers all aspects of sustainable water resource management including the investigation, use, control, protection and allocation. A permit is now required before a bore can be drilled in this area. Within the district is the Mataranka water allocation planning area which encompasses the water from the Tindall aquifer flowing toward the Mataranka hot springs. The planning process for this area is currently on the way and as mentioned earlier the integrated surface-groundwater model of the Roper River catchment is providing key scientific data to the process. A draft plan is expected to be completed by May 2010.

Further work has been identified to improve the integrated model and fill data gaps. It includes studies to:

- continue to assess the performance of the coupled model by comparing predicted groundwater levels and river flows to the observed data;
- improve the understanding of recharge processes and the estimated quantity and spatial distribution of recharge to the groundwater component of the model;
- better define river channel geometry and update cross-section data including levelling to a consistent elevation datum, particularly at river branch junctions this will improve the MIKE11 component of the model;
- improve the understanding of the function of water stored in many of the large perennial pools of the Roper River and their reliance on dry season flows;
- increase the number of flow gaugings along the Roper River up to Red Lily Lagoon to better ascertain groundwater inflows;
- construct new gauging stations to adequately measure flows in the spring sections of the Roper River;
- rate flow from the springs which are key cultural and recreational sites and relate to groundwater levels;
- improve rating tables for the gauge sites in sub-catchments where current data is inadequate to calibrate the rainfall-runoff estimates of the MIKE11 model;
- establish key groundwater monitoring sites ie drill monitoring bores;
- determine the significance of dry season flows to the ecological function of the estuarine section of the Roper River.

7. References

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