Multi-scale approaches to the up-scaling problem

Determining ecosystem–groundwater interactions with limited data and resources

HydroEco 2011

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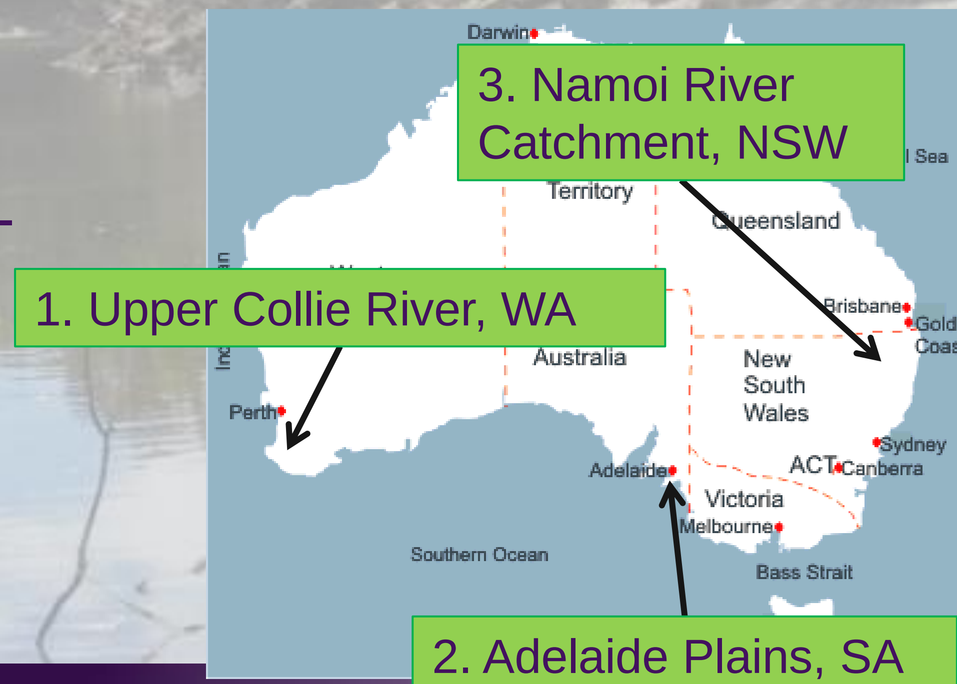
Introduction

- Drivers – COAG 1994 reforms, National Water Initiative
  - The environment as a user of groundwater in water management and allocation planning
- Numerous associated challenges
  - Focus here - **Where are potential GDEs?**
- **Three case studies**
- Focus on dependence on surface presence and sub-surface expression of groundwater



Case study 1 – Upper Collie River, WA

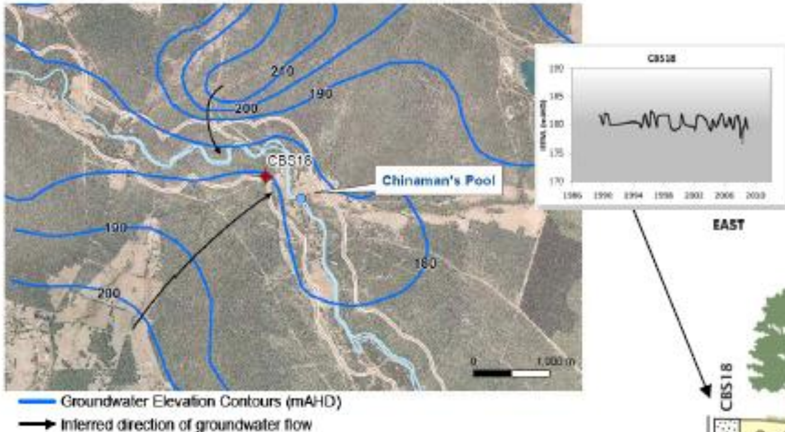
- Objective: conceptualisation of river pools and identification of potential terrestrial GDEs in study area
- Study area
  - 300m-wide strip either side of the Upper Collie River
  - Over 65km stretch of the river

Case study 1 – Upper Collie River, WA

(Prepared for Department of Water, Western Australia. SKM, 2010a)

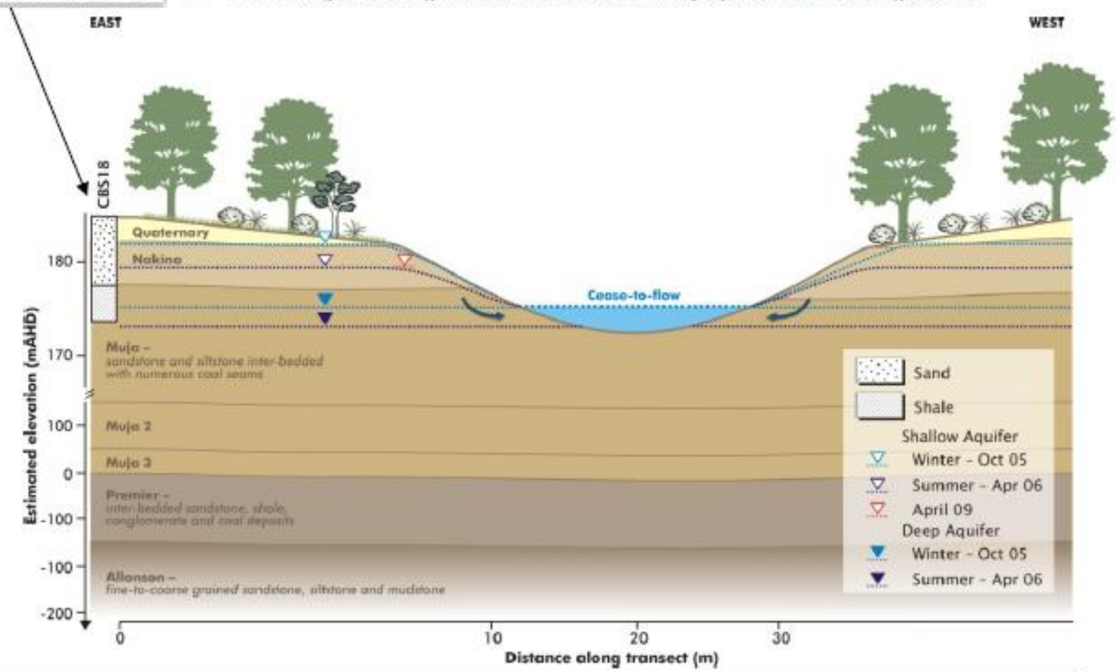
Methodology

- Collation of existing data and conceptualisation of individual river pools
  - Lithology
  - Groundwater monitoring
  - Hydrogeology
  - Surface water levels
  - Bathymetry
  - Topopgraphic contours
- Further enhanced by inclusion of ecological survey data
  - Aquatic faunal surveys and literature review
  - Vegetation transects recording community composition



Description:

- Located in an area which is a regional groundwater discharge zone
- 2009 groundwater level is similar to 2006 level (at 179 mAHD)
- Groundwater levels are above the base of the pool and above the cease-to-flow level – connected and gaining when pool levels are at cease-to-flow level
- Potential for perching of water in the sandy layer that sits above the shale. Water from this perched layer would re-enter the pool on the recession
- Downward groundwater gradient between shallow and deep aquifers inferred from regional data



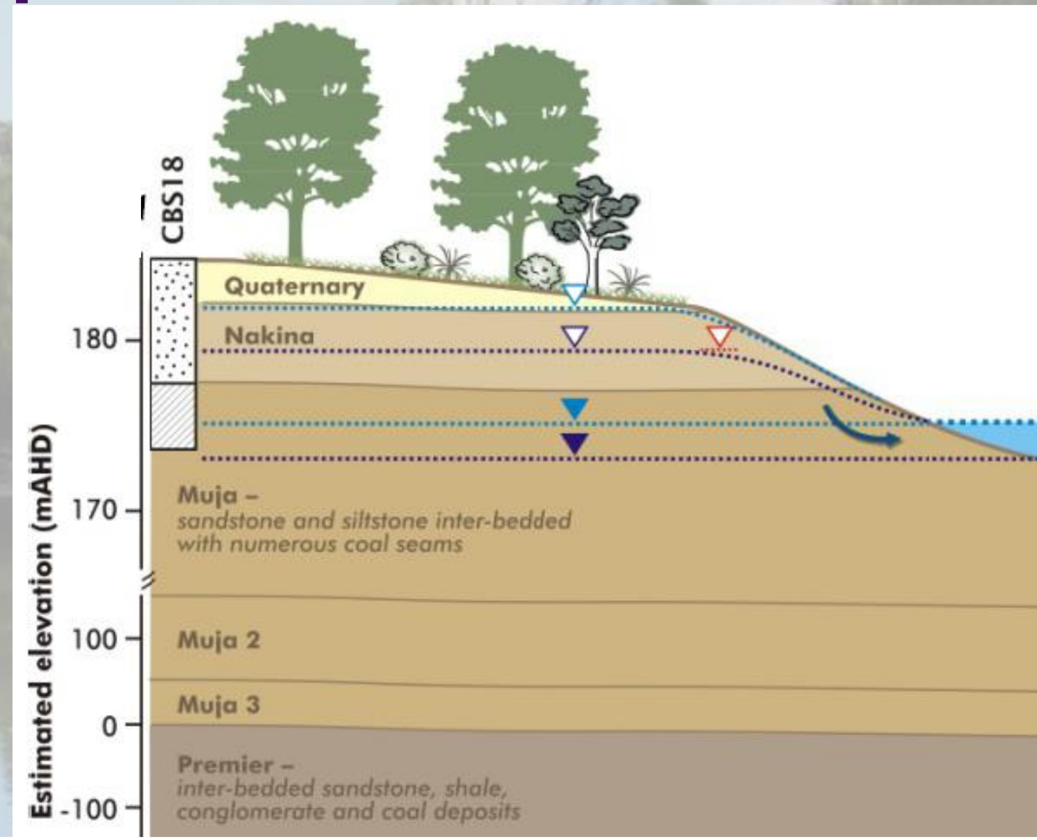
Vegetation type	Open woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* over *Astartea scoparia* over *Watsonia meriana* var. *bulbillifera* and pasture grass.	Pool – Aquatic. Refer **Table 4.4** for species	Short vegetation strip, surrounded by paddocks.
Soils	Loams to Sandy Loams		Loams to Sandy Loams
Groundwater	Groundwater level in CBS18 in April 2009 was 179.1 mAHD. Depth to watertable likely to be 0 - 3 m end summer and 3 -6 m end winter.	Connected - gaining	Depth to watertable likely to be 0 - 3 m end summer and 3 - 6 m end winter.
GDE potential	Potential for larger trees and some shrubs with deeper roots to be impacted by shifts in groundwater levels. **Moderate to High**	**Very High**	Potential for larger trees and some shrubs with deeper roots to be impacted by shifts in groundwater levels. **Moderate to High**

Figure 5.8 Chinaman's Pool

(Prepared for Department of Water, Western Australia. SKM, 2010a)

Case study 1 – Upper Collie River, WA

- Groundwater dependence inferred from comparison of surface water and groundwater levels
- …and from life histories and physiological requirements of species
- …and soil properties
- Informed rules developed for extrapolation



Vegetation type	Open woodland of *Eucalyptus rudis* and *Melaleuca rhaphiophylla* over *Astartea scorparia* over *Watsonia meriana* var. *bulbillifera* and pasture grass.	Pool – Aquatic Refer
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Case study 1 – Upper Collie River, WA

Methodology - potential terrestrial vegetation GDEs

Data: regional vegetation mapping, inferred DTW, soil mapping and knowledge of soil properties

Assumptions and rules of GW dependency:

- Communities over shallow water tables are more likely to be GW dependent (using inferred DTW)
- Vegetation growing on low water-holding capacity soils are more likely to be GW dependent
- Certain species and communities

Outcome: Level of potential GW Dependence for each vegetation community in study area

Level of potential dependency on groundwater matrix

		Depth to groundwater			
		> 10m	6-10 m	3-6 m	0-3 m
Soil water-holding capacity	High	Low	Low	Mod	High
	Medium	Low	Mod	Mod	High
	Low	Low	Mod	High	High

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Case study 2 – Adelaide Plains

(Prepared for AMLRNRM, South Australia. SKM, 2010b)

- Objective: provide baseline information on potential GDEs amongst identified ecological assets
- Study area:
  - Two groundwater management areas (PWAs) incorporating the city of Adelaide and surrounds in SA
  - Lowland plains, bounded by hills face zone

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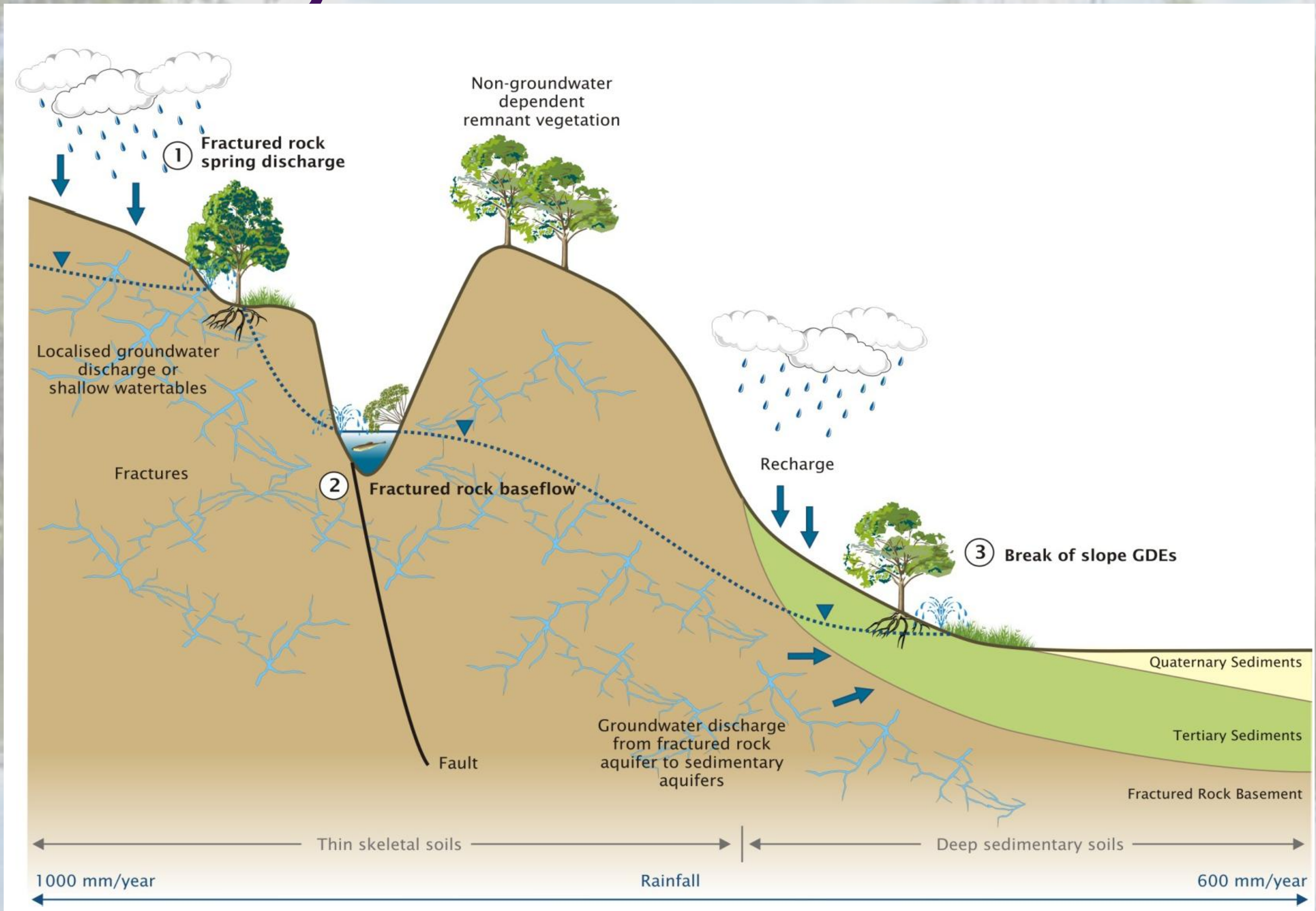
Case study 2 – Adelaide Plains

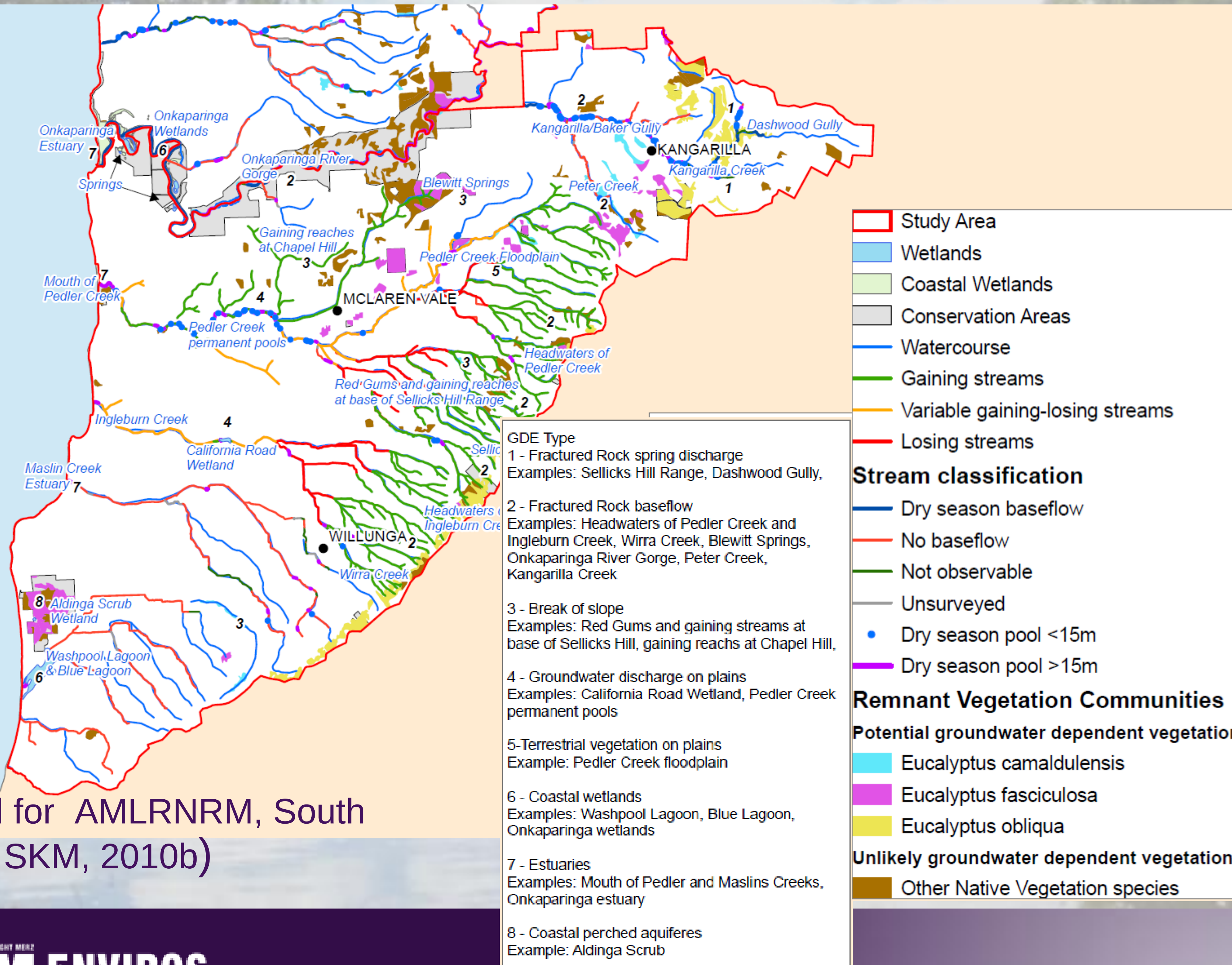
Methodology

- Data collation and literature review
  - Broad-scale conceptualisation or area
  - Identified GDEs in literature used as indicators for extrapolation
- Detailed conceptual modeling
  - Identify areas of similar biophysical settings that may support GDEs
  - Identification of certain GDE types – “Functional groups”
- Extrapolation to similar biophysical settings – informed by GIS modeling
  - Data - geomorphology, DTW, hydrogeological units, ecological datasets, topography

Case study 2 – Adelaide Plains



- GDEs of the upper catchment.
  (Prepared for AMLRNRM, South Australia. SKM, 2010b)



(Prepared for AMLRNRM, South Australia. SKM, 2010b)

Case study 3 – Namoi River Catchment

(Prepared for the Namoi CMA. SKM, 2010c)

- Objective: identification and verification of terrestrial vegetation and wetland GDEs
- Study area:
  - Catchment in northeast NSW
  - ~42,000 km^2

Case study 3 – Namoi River Catchment

Methodology – Remote sensing and GIS analysis

- Based on premise that ecosystems with evapotranspiration (ET) trend indicating access to water stores other than rain-fed infiltration or irrigation are likely to be GDEs
- SEBAL 2009 remote sensing application used to generate ET
- Combined with rainfall data to identify areas of high ET in low rainfall periods
- Rationalised with vegetation and wetland mapping

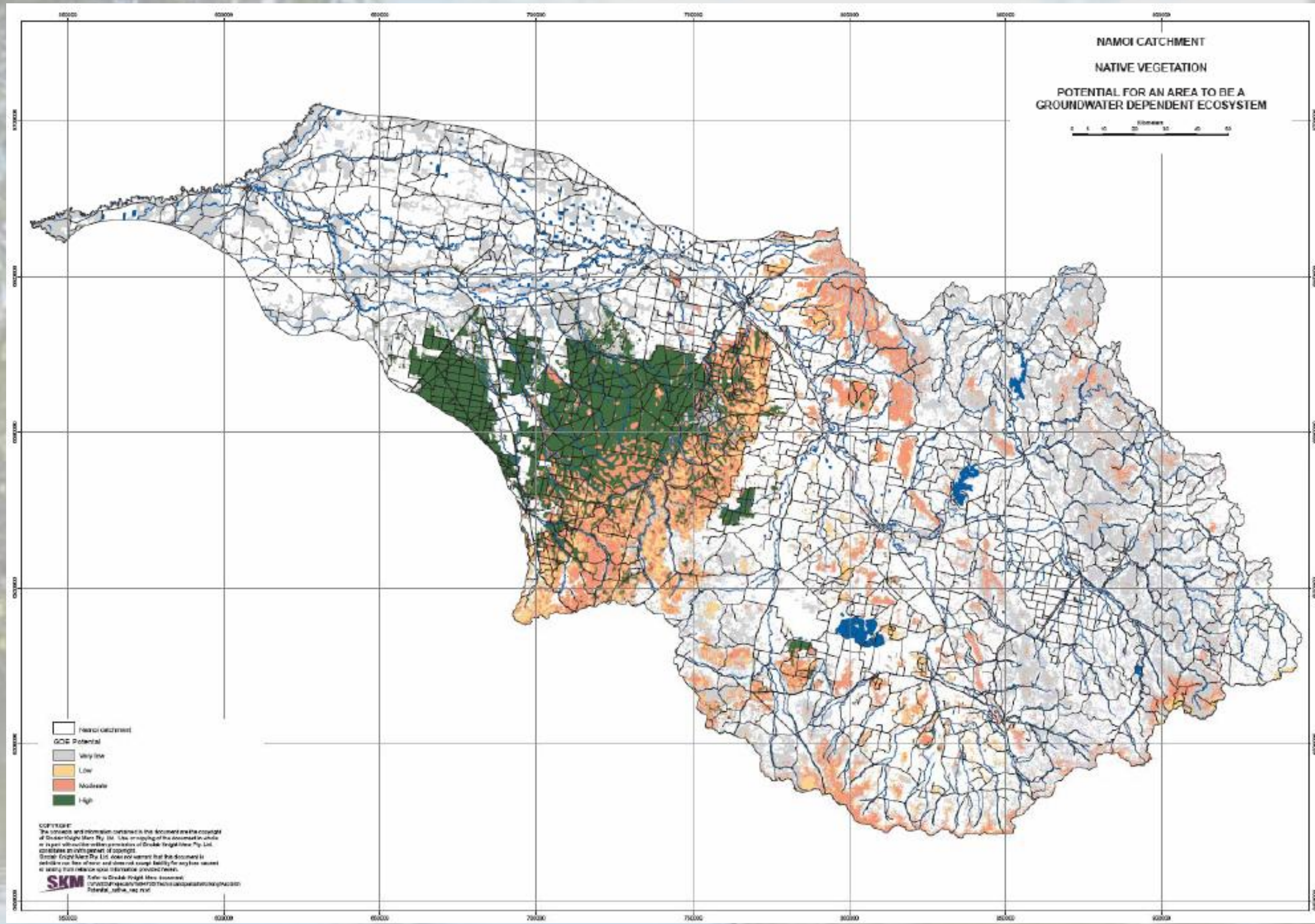
Case study 3 – Namoi River Catchment

Assumptions

- ET>rainfall for
  - 9 months of year (terrestrial vegetation)
  - Annually (riparian vegetation and wetlands)
- Vegetation growing on low water holding-capacity soils have higher likelihood of GW use
- Ecosystems above shallow water tables more likely to access GW or receive GW inputs

E.g. Terrestrial vegetation ⟶

Soil water holding capacity	Depth to groundwater: Deep	Moderate	Shallow
High	L	L	M
Moderate	L	M	H
Low	M	H	H



(Prepared for the Namoi CMA. SKM, 2010c)

- Field verification at 36 sites – 71% were accurately identified as likely GDEs (based on visual indicators)

Common themes in approaches

- Collation of several datasets and conceptualisation of the study area
- Use of indicators and /or representative biophysical settings
- Concepts and information from smaller-scale studies inform broader-scale approaches
  - **Provide indicators and hence inform rules for extrapolation across existing broad-scale datasets**
  - Use in verification of extrapolations as well as of spatial datasets

Conclusions

- **There are approaches available** to identify potential groundwater dependent ecosystems.

  Importantly:
  - At timescales necessary
  - At management scales
- **These are largely preliminary studies** - precursors to more detailed assessment
  - Allow prioritization and risk assessment
  - Provide targets for future investigations / at which to direct resources
  - Preliminary estimates of potential management rules
- **Inherent uncertainty**
  - Several assumptions
  - Inferred and extrapolated spatial datasets
  - Reduced by ecosystem-scale studies. As investigations at an ecosystem-scale increase, the conceptual models and the rules of extrapolation can be further enhanced/verified

Thank you for listening

Case studies:

SKM, 2010a. Identification and mapping of groundwater dependent ecosystems associated with the Collie River. Prepared for the Department of Water, Western Australia. April 2010.

SKM, 2010b. Groundwater-dependent environmental assets of the Adelaide Plains and McLarenVale (Stage 1). Prepared for the Adelaide and Mount Lofty Ranges Natural Resources and Managment Board. November 2010.

SKM, 2010c. Mapping Groundwater Dependent Ecosystems in the Namoi Catchment. Prepared for Namoi Catchment Management Authority. May 2010.