



Use of IELab to understand water city- regional water flows.

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**Advanced Water
Management Centre**



Create change

Outline

Application of AUS IELab at UQ....

Steps in the process....

1/ \$'s only....Disaster impact analysis (Cyclone Debbie and related employment, infrastructure and other costs). (*building sub-state financial resolution helped us understand the lab*).

2/ Simple national/global 2-region MRIO with national energy account

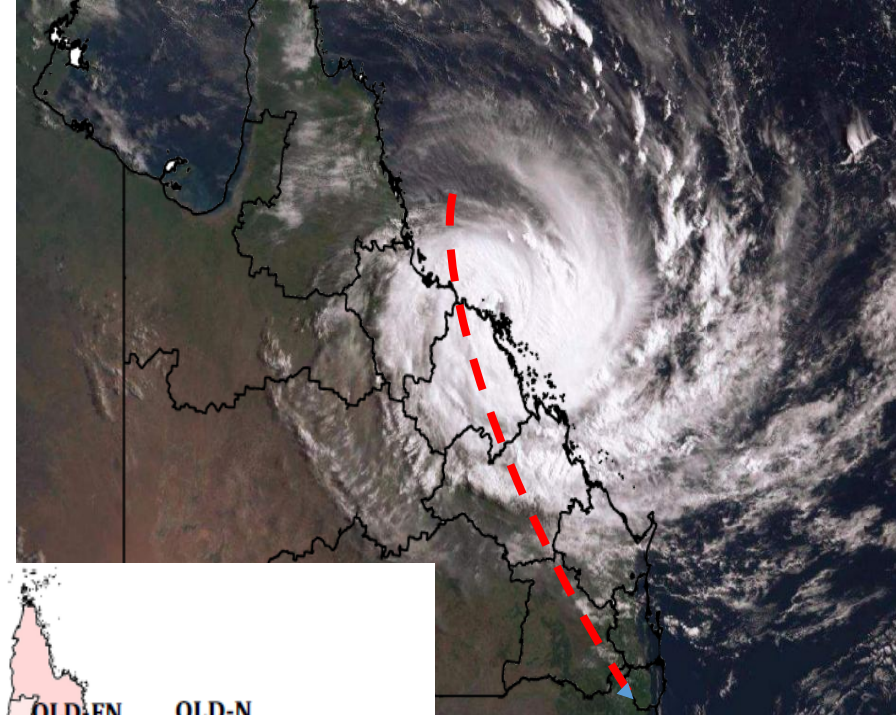
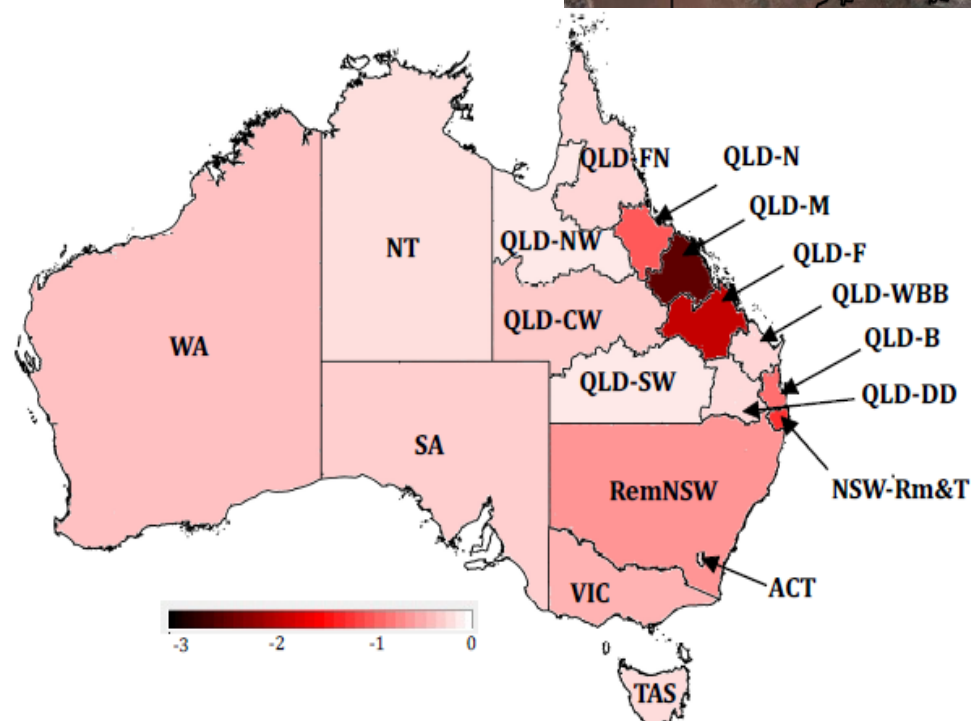
3/ Water flow in Australian cities and regions (spatial analysis). (16 region MRIO with sub-state resolution)

- aim and research questions
- method
- preliminary results

Economic damage and spill-overs from tropical cyclone Debbie 2017. ($\$/\text{jobs}/\text{VA}$)

Approach

1. Create root to study region and sector aggregators.
2. Create base table (IELabAust)
3. Review of cyclone impacts (\$m).
4. Create Gamma Matrix (production possibilities lost)
5. Source superior economic data.
6. Incorporate superior data into IELab to produce final base table...post processing (IELab)
7. Impact analysis, and
8. Interpretation



Results....Spread of the value-added loss from Cyclone Debbie

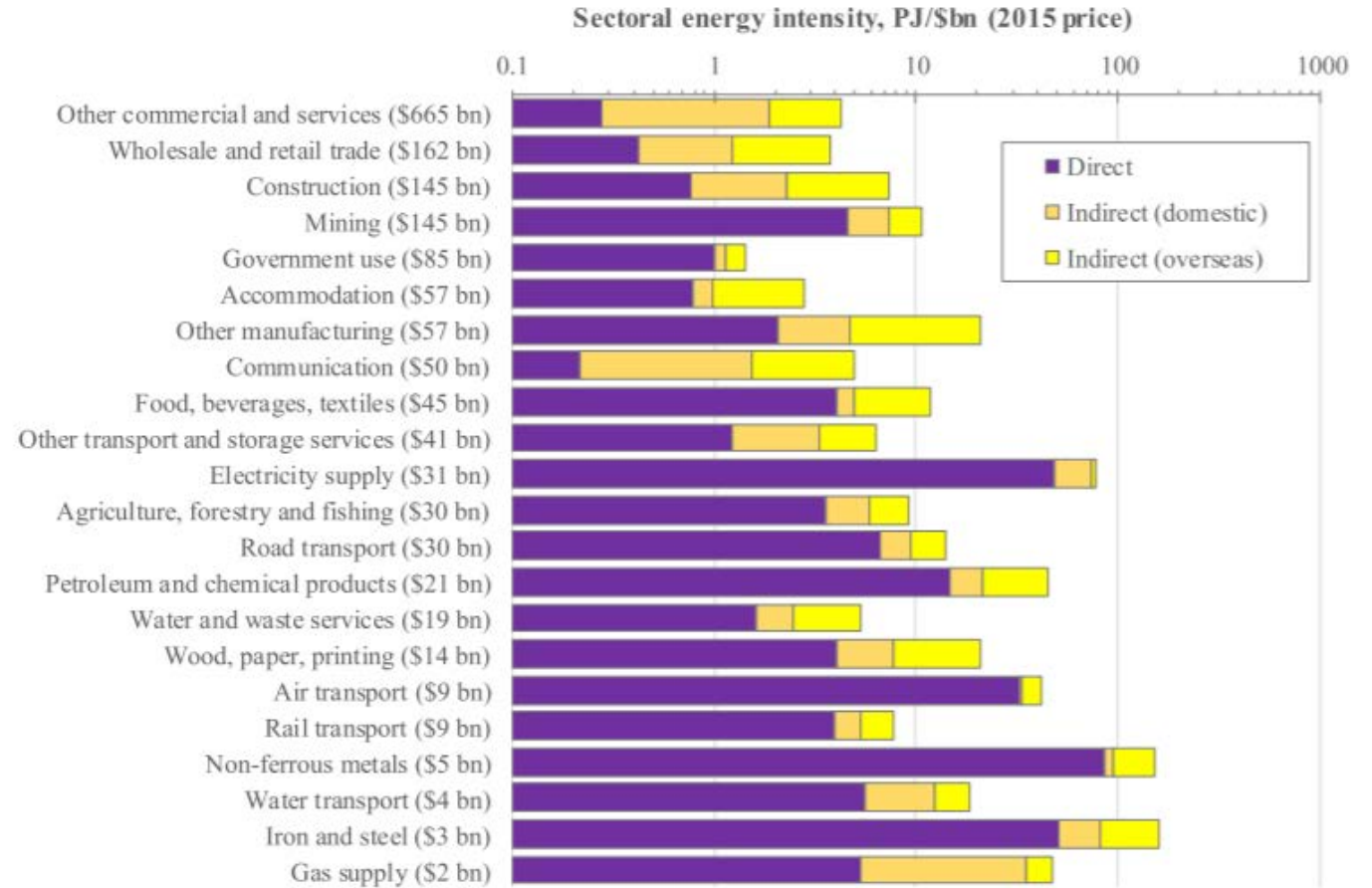
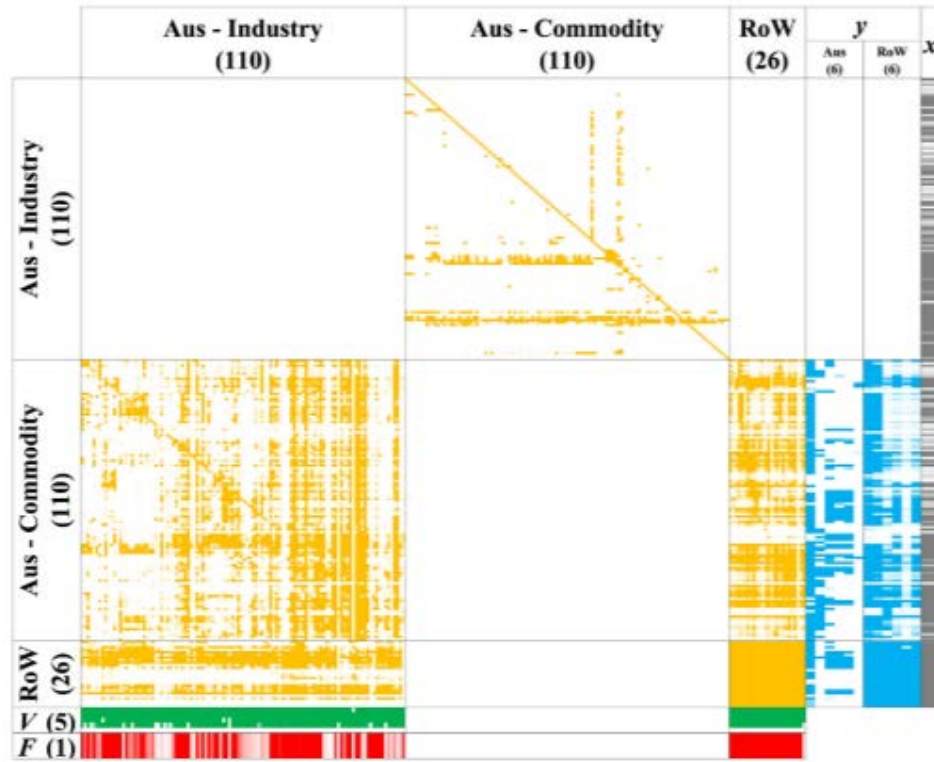
Lenzen, M., Malik, A., Kenway, S., Daniels, P., Lam, K.L. and Geschke, A. (2019) Economic damage and spillovers from a tropical cyclone. *Natural Hazards and Earth System Sciences* 19(1), 137-151. 10.5194/nhess-19-137-2019

Superior Data Identified – and priority data used (code and test)

Data aspect	Region	Sector/s	Years	Example data	Reference
GRP	All Queensland sub-regions.	All	2010-11	GRP Mackay 2011 = \$22 billion	(Queensland Treasury and Trade, 2013)
GRP - Richmond Tweed	NSW - Richmond & Tweed	All	2011-12	GRP > \$8.5 billion	(Wilkinson, 2014)
Coal	QLD – all regions	Coal, oil and gas	2015-16	Production value by SA4** area, eg \$19.437 billion sales for 2015-16 calendar year with \$12.234 billion in SA4 Mackay; and \$6.170 billion in Fitzroy.	(Keir, 2017)
Gross Value and Local Value of Agricultural Commodities	SA4 region	Over 60 agricultural commodities	2007-08 to 2014-15	\$1,119 million gross value of agricultural commodities produced in Mackay in 2014-15	(Australian Bureau of Statistics, 2013a, 2015), (Australian Bureau of Statistics, 2013b), (Australian Bureau of Statistics, 2016b)
Manufacturing sales & service income, wages and salaries, employment	10 QLD regions and NSW-Richmond & Tweed	Food product manufacturing and all other manufacturing	2006-07 is latest	Food product manufacturing in Mackay = \$1,051 million in 2007.	(ABS, 2008)
Manufacturing sales & service income, wages and salaries, employment	QLD – all regions	Food product manufacturing and all other manufacturing	2010-11 to 2014-15	Food product manufacturing in QLD = \$20,131 million in 2015.	(Australian Bureau of Statistics, 2016a), (Australian Bureau of Statistics, 2017)
Import and export of horticulture products	QLD – all regions	Part of Other agriculture	2014-15	\$112.9 million of horticulture products import; \$156.8 million of horticulture products export	(Horticulture Innovation Australia, 2016)

Embodied energy analysis (2 region with satellite)

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2-Region MRIO (Aust IELab and Rest of the World Global IELab (Eora) to get (a) energy intensity of the economy time-series.

Which sectors have high total, domestic or international dependence on energy?

Direct and Indirect flows of water.....Why?

- Cities generate over 70% of GDP, host >50% of, and consume (directly or indirectly) over 75% of worlds water.
- In Australia Water resources management has significant variation (years, seasons, regions) and demand is growing. Climate change-induced water supply shortages will reduce flow by 16 to 48 % by 2100 (Sahin 2015).
- While water footprint management is a goal of many cities, understanding of the total water dependency (ie direct+indirect) of different sectors and cities/regions and their supporting regions is in its infancy.

Research questions of this study are:

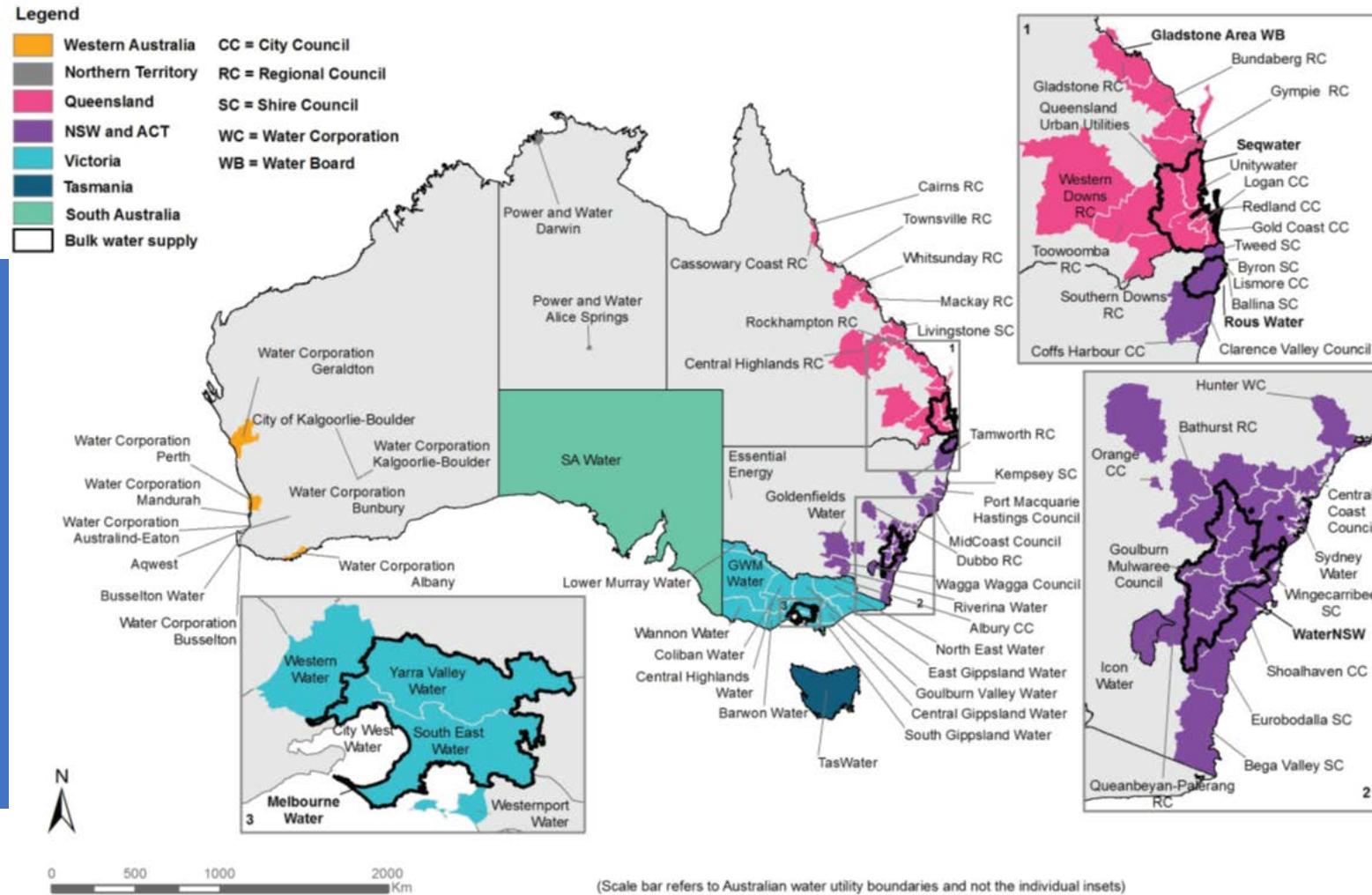
- (1) what is the indirect water flow, and its variation due to final demand across the capital cities in Australia? and*
- (2) which sectors and intersectoral linkages contribute most to indirect water flows?*

Development of GCC regions

Steps to develop “Greater City” regions and direct water use

1.A.1 Defining the spatial boundary of the GCC and rest of states based on ABS 1270.

1.A.2 Developing sector wise direct water consumption data for GCC based on ABS 4610 state level data, ABS 4618 SA2 level data, and BOM city water data for the year 2015 (Supplementary material-1,



(Scale bar refers to Australian water utility boundaries and not the individual insets)

Geographical coverage of the urban water utilities reporting to the Urban national performance report and database [source: (BOM 2018)].

Example – Water Quantifying inter-regional and inter-sector water flows

Data generation: Base table (dimension: 16 regions , 100 sectors)

		Region 1		Region 2		Region 3		Region 16		RoW	Region 1		Region 2		Region 3		Region 16	X
		A	B	A	B	A	B	A	B		Y	Y	Y	Y	Y			
		(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(6)	(6)	(6)	(6)	(6)	(6)	
Region 1	A (100)																	
	B (100)																	
Region 2	A (100)																	
	B (100)																	
Region 3	A (100)																	
	B (100)																	
Region 16	A (100)																	
	B (100)																	
RoW (100)																		
V (5)																		
F (1)																		

Water Data

Account	ABS 4610.0 Water Account, Australia	ABS 4618.0 Water Use on Australian Farms	BOM National performance report database
Data available year	2001-2017 1994-1997	2002/03 – 2014/17	2005-2017
Spatial resolution	State Australia	Natural resources management (NRM) region, SA4 region, Murray Darling Basin (MDB) region, State, Australia	Water utility service providing region, State, Australia
Sectorial resolution	9 sectors (The sectors vary in different year)	14 sectors (The sectors vary in different year)	3 sectors (Residential, Industry & Commercial, Agriculture)
Source of water	3 types (self-extracted, distributed and reused) by State/ Australia	7 types (e.g water extracted form rive, from irrigation pipeline, groundwater, etc) by NRM/ SA4/ State/ Australia.	4 types (Surface water, Groundwater, Desalination, Recycled water)

1.B.1 Direct water consumption data at city level fed as constraint data in IELab (Supplementary material-1, section 3).

1.B.2 Generating 16 region MRIO table with 100 sectors for the year 2015 (Supplementary material-1, section 4, Figure S.3).

1.B.3 Application of Leontief demand-pull model (Equation A.1).

State level data was segregated to **Greater capital cities** and **Rest of states** based on the constraint data from ABS 4618 and BOM data. (lots of checking).

Method (continued)

1.B.1 Direct water consumption data at city level fed as constraint data in IELab

1.B.2 Generating 16 region MRIO table with 100 sectors for the year 2015

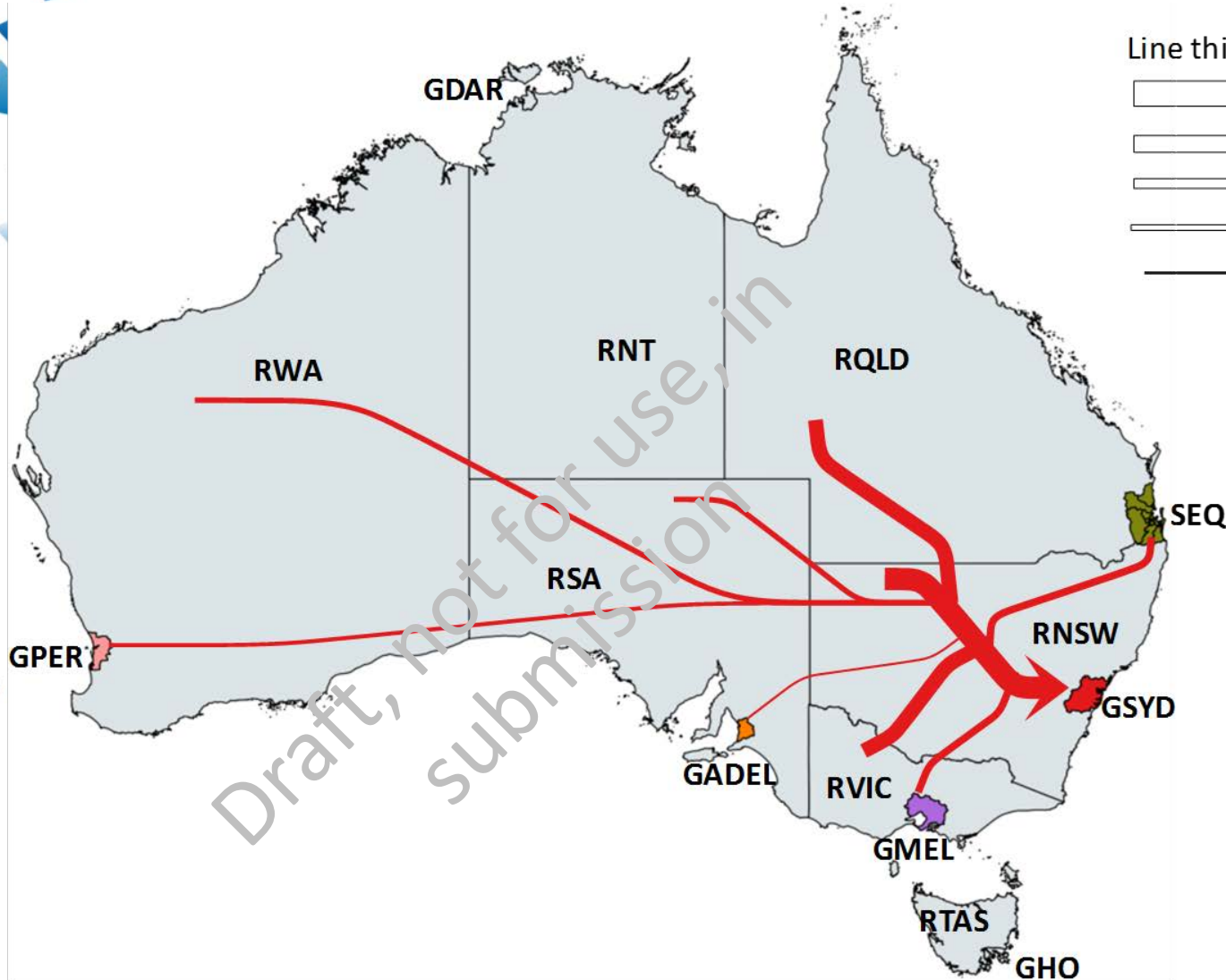
1.B.3 Application of Leontief demand-pull model (Equation A.1).

2.1 Application of MRIO model

2.2 Application of water backward multiplier (WBM) based on Leontief inverse matrix

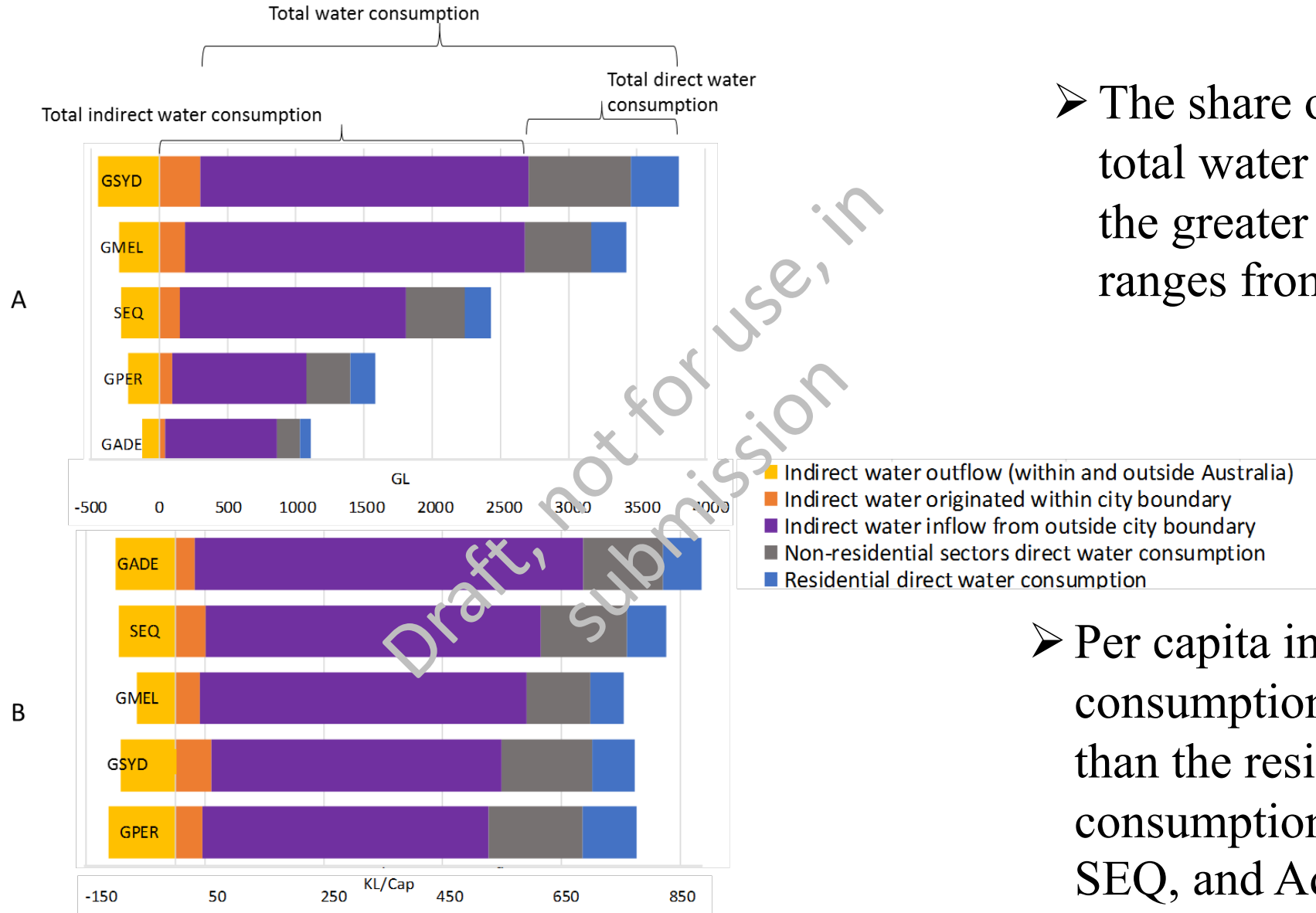
2.2 Application of water forward multiplier (WFM) based on Ghosh inverse matrix.

Interregional indirect water trade pattern for Sydney 2015



- RNSW is the largest indirect water exporter to Sydney (698 GL).
- (It also exports to Melbourne (636 GL), SEQ (418 GL), Adelaide (187 GL) and Perth (203 GL)).

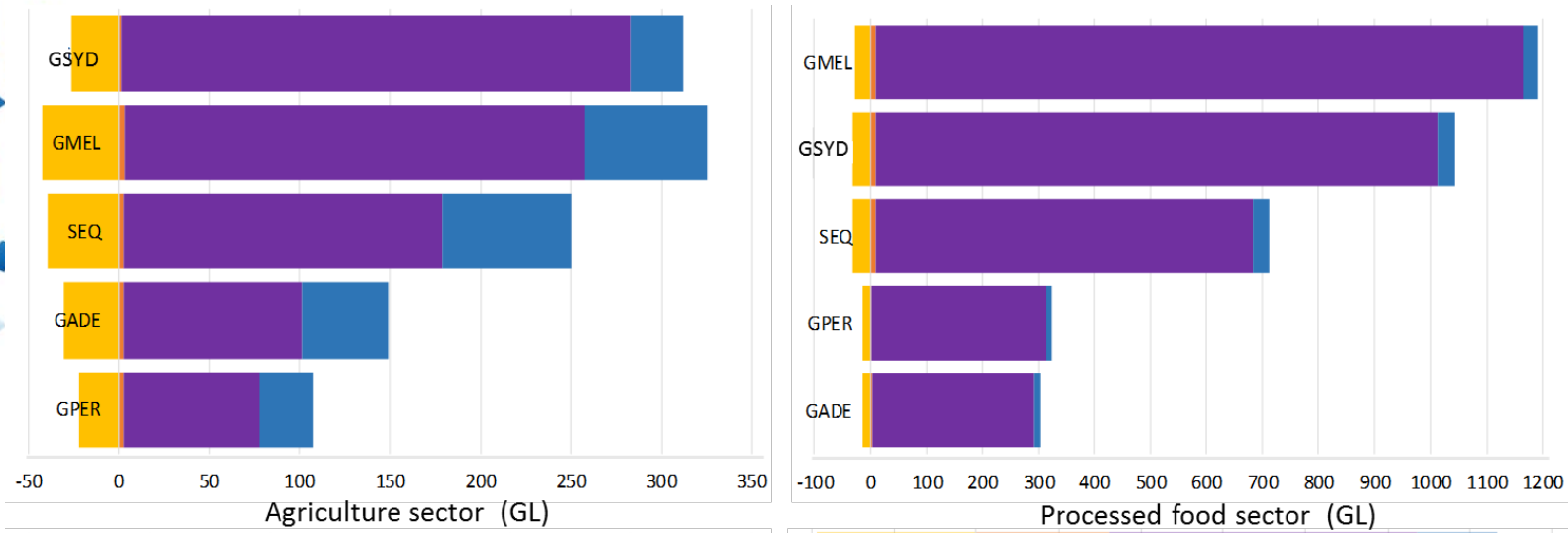
Direct vs Indirect water – flows to greater capital cities



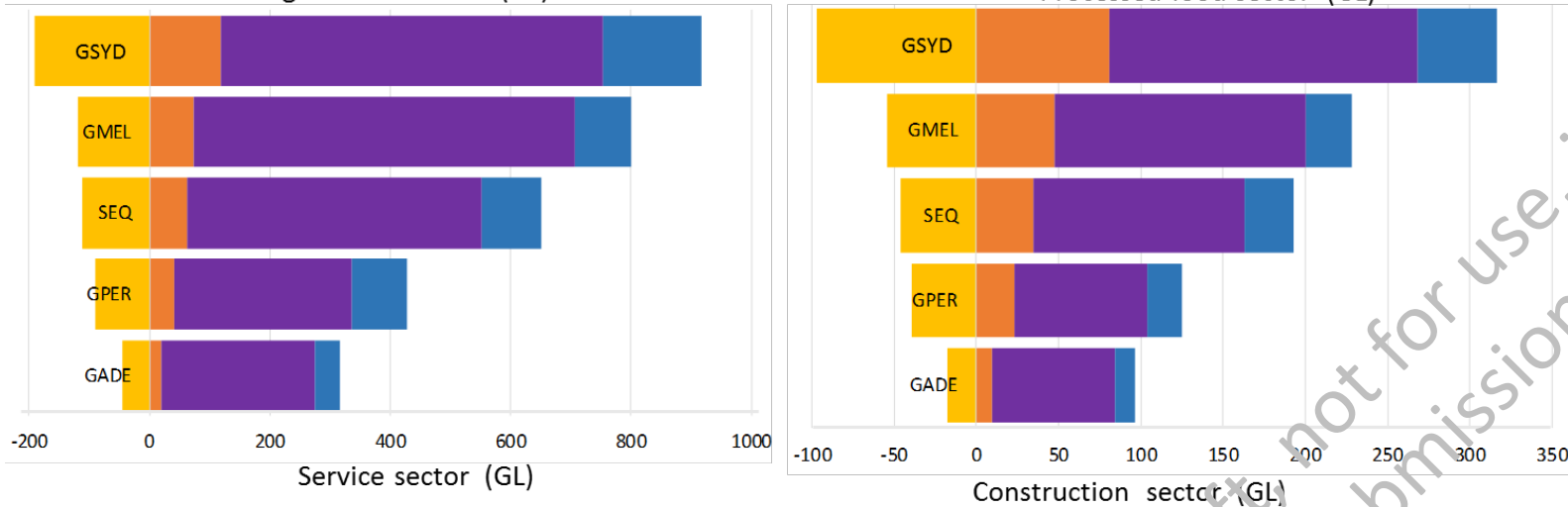
➤ The share of indirect water to total water consumption in all the greater capital cities ranges from 66-77%.

➤ Per capita indirect water consumption is 10 times higher than the residential direct water consumption in Melbourne, SEQ, and Adelaide.

Direct vs Indirect water-Sectoral breakdown at greater capital cities



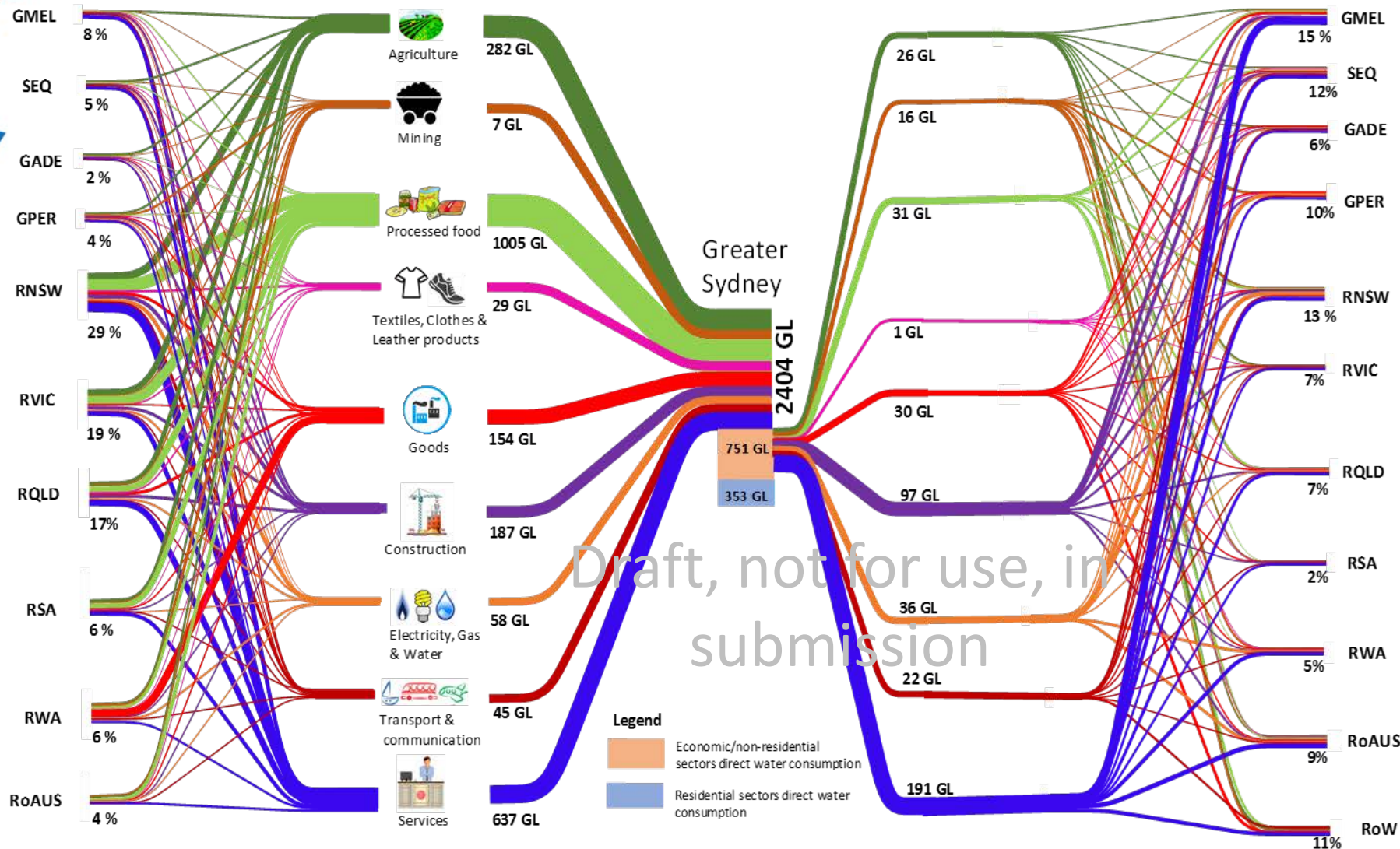
➤ Indirect water flow from outside city boundary for agriculture sector is highest for Sydney (~285 GL), followed by Melbourne (~255 GL).



➤ In the construction sector, total water consumption ranged from 87 to 236 GL in five GCC, of which over 80% is indirect water consumption.

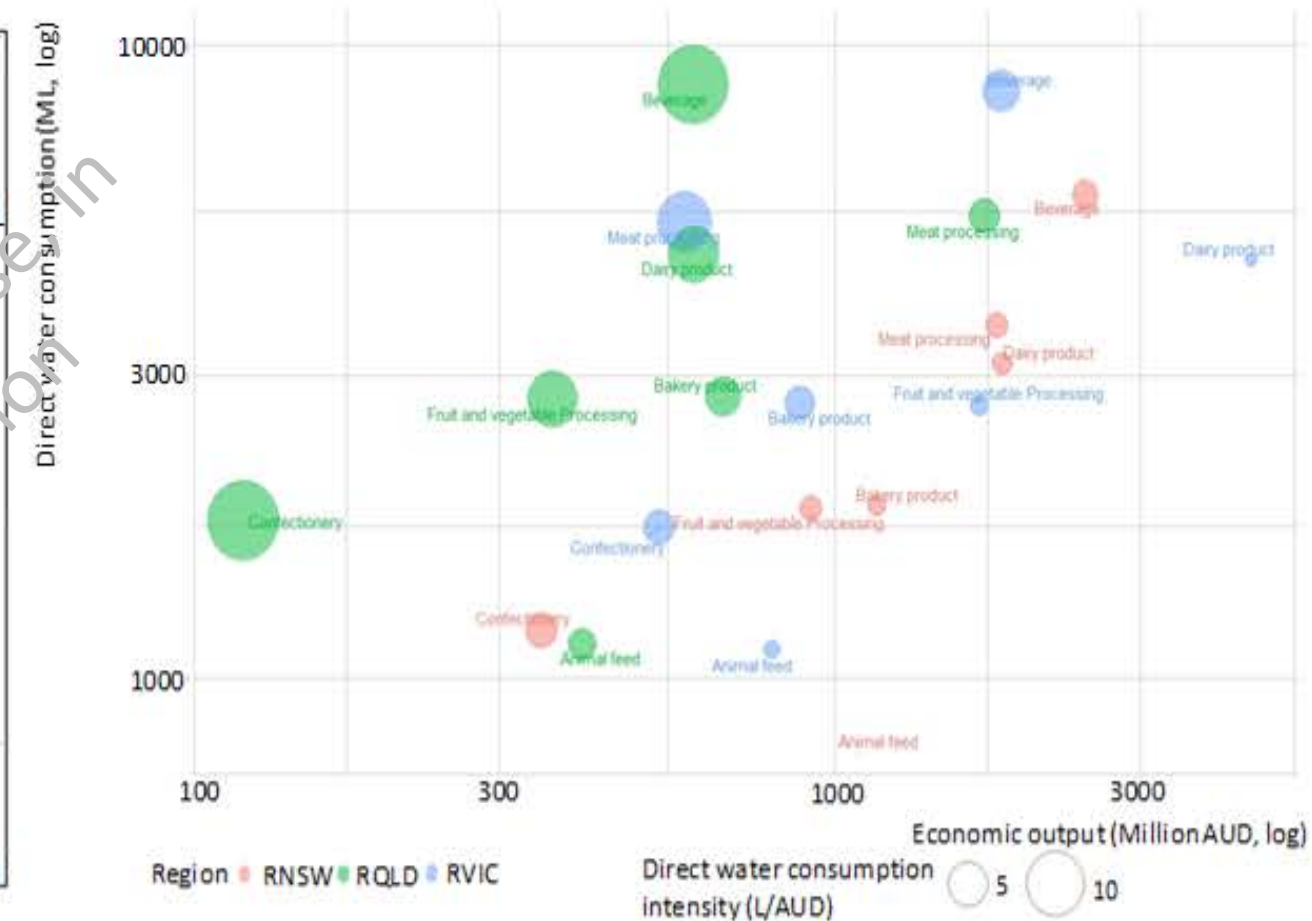
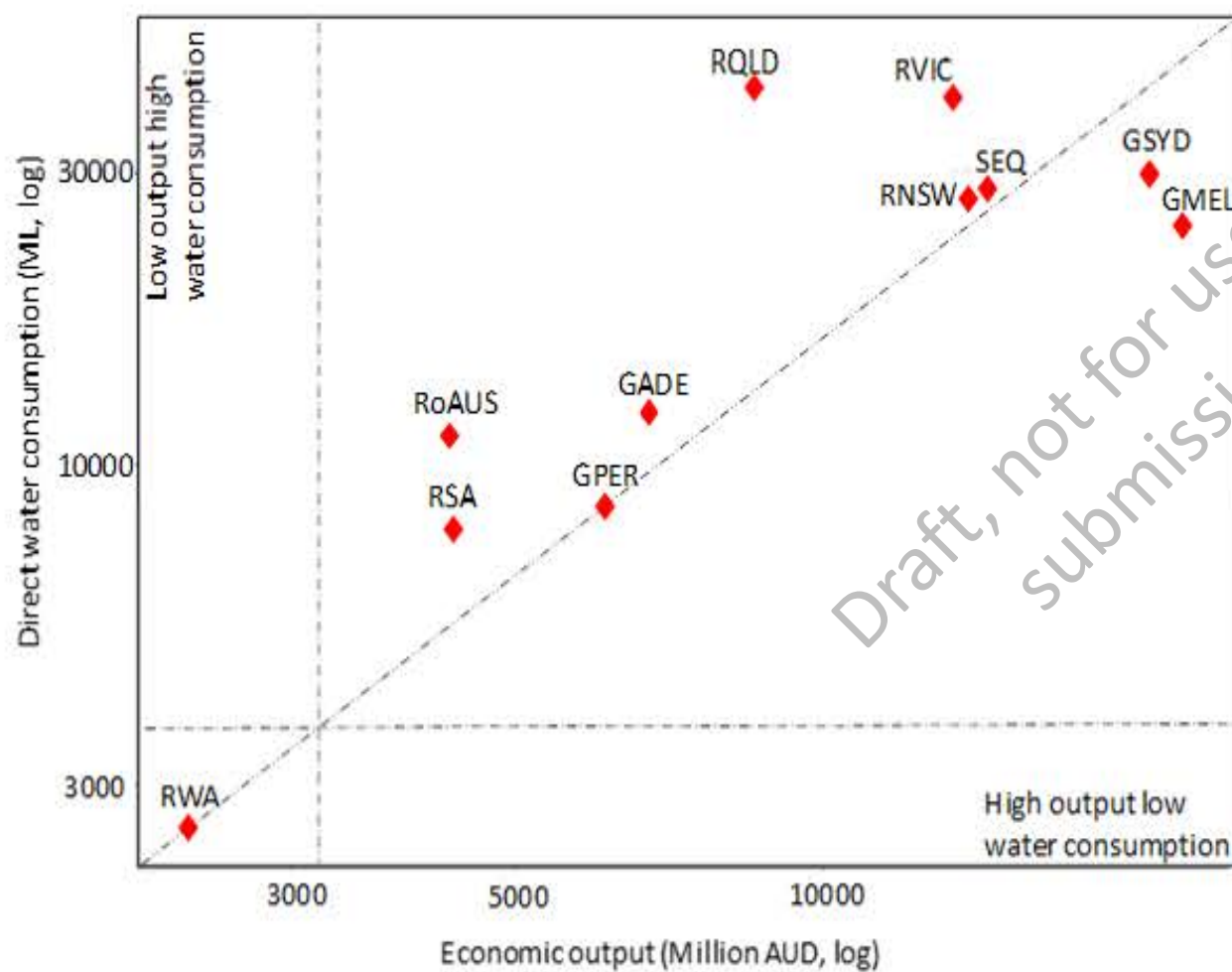
■ Indirect water outflow (within and outside Australia)
■ Indirect water originated within city boundary
■ Indirect water inflow from outside city boundary
■ Economic sector direct water consumption

Direct vs Indirect water-Sectoral breakdown at greater capital cities



- Altogether, 65% of indirect water flows through different products and services finally consumed in Sydney originated from three regions (RNSW, RVIC, and RQLD).
- Indirect water flows through processed foods and agricultural commodity constitute more than 50% of the indirect water flow to Sydney.
- Similar trend is also observed for other greater capital cities.

Water consumption of processed food (final demand within GCC). Policy implications...(a) relative rate of water conversion to economic output (economic security) (b) can be considered at regional level or sub-regional (ie sectoral within state)



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Amanda Binks



Marguerite Renouf



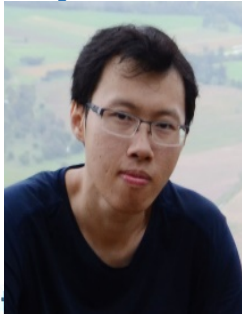
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