- Very grateful for the invitation to address you
- My riding instructions were attractively broad, so if you don't mind I'll try to take you on a wander through a few things that I hope will interest you....
- I'm not a recorded message, and I'm here to help, so if you have Qs or comments, feel free to speak up as I go along.

- Given the significant current interest in developing the north, something I know you've already done, I thought it might be useful to fill you in on how people in Canberra think about it. I'm not from there, but I spend more time there than is good for me or anybody, and you might find it useful to know what they think because they have about $5b that they'd like to spend here. If you know how they'd like to spend it, you might increase your chances of getting some!

- It may also be useful to know what is or could be happening in other parts of the north, as it could assist or compete with your plans.

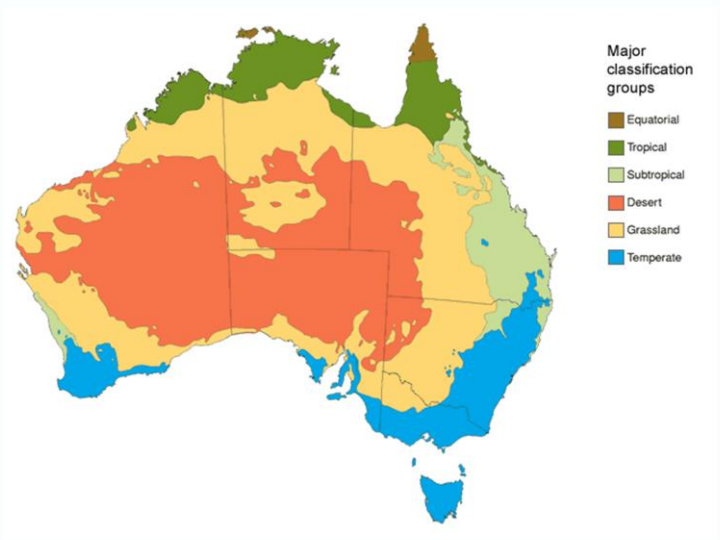
What is northern Australia...?

Figure 1: Population density of northern Australia (2011)

- About 40% of Australia's land mass
- about 5% of our people (1.3 million)
- about 12% of the nation's GDP – you're doing more than twice as well as the rest of the country!
- about 30% of Australia's indigenous people
- about 10% of Australia's agricultural production - $5 billion

- All of these are significant in informing consideration of the north and its development

What is northern Australia...?



We could get complicated about the north's climate, but let's keep it simple.

There's two northern Australias.

1. Both of them are often hot
2. One is the perpetually lush green of the east coast's tropical rainforest – about 10% of the area
3. The other 90% has rainfall that is amongst the most variable in the world, within the year, and especially between years

- This is also significant, because it poses challenges and opportunities that a lot of people don't understand

What is northern Australia...?

Table 6: Top 10 northern Australian agricultural commodities by gross value of production (GVP), 2010-11

RANK	COMMODITY	GVP ($ million)
1	Cattle	2,897.1
2	Sugar cane	762.4
3	Bananas	286.5
4	Mangoes	89.9
5	Tomatoes	86.4
6	Cotton	79.7
7	Melons	78.5
8	Wheat	71.6
9	Sorghum	63.6
10	Hay	55.8

Source: ABARES, 2015

- Agriculture is the dominant land use – over 60% of the area
- The gross value of agricultural production is about $5b, or about 3% of the north's ca $180b economy
- So while agriculture's important, it's not the only show in town
- And that's shown by the fact that…

The north has many development options

- tourism
- mining
- energy
- defence
- cultural & environmental economy
- agriculture
- aquaculture
- others

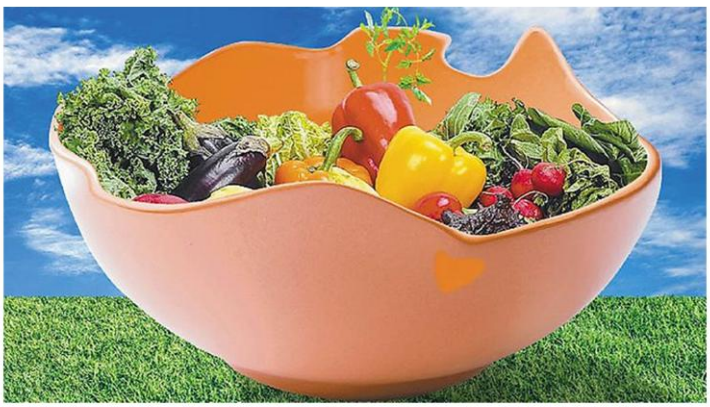
Potential to unlock value from a wide range of resources for a wide range of purposes

- The north's economy is growing in richness and complexity
- Tourism, mining, energy and defence are already well established, making a 100 billion dollar plus contribution to the north's GDP which, incidentally, accrues at roughly twice the per capita rate than the rest of Australia
- The north' s ca $180 billion economy generates about 12% of Australia's $1.6 trillion GDP
- Its $120 billion in exports is about 30% of the Australian total

- Tourism – >$8 biillion ($6 billion reef + $2 billion NT, NA WP)
- Mining - >$75 billion - $50 billion iron, $25 billion coal
- Energy (LNG) - $25 billion now projected $45 billion 2020
- Defence - >$2 billion
- Agriculture - $5 billion
- Fisheries - $250 million

- So while agriculture gets most of the airtime – presumably because it uses most of the land – it's not the main economic game

Agricultural development opportunities



- There's lots of talk about turning the north into a food bowl...
- But the truth is...

- Image source: http://www.heraldsun.com.au/news/opinion/top-end-key-for-food-bowl/story-e6frfhqf-1226142167581

The north is already a food bowl

- Northern Australia has been a food bowl for more than 130 years.
- In 1880, there were 3 million head of cattle north of the Tropic of Capricorn.
- Today, there are over 12 million head, or about 45% of the nation's beef herd.
- If northern Australia were a country, it would be the world's fifth largest beef exporter.
- So northern Australia is already a food bowl, with an extensive value chain of global reach
- What's really up for discussion is the size of the side salad that it offers....

- Growing that side salad, whatever it looks like, will require suitable climate, soils and water. Let's look at what's available....

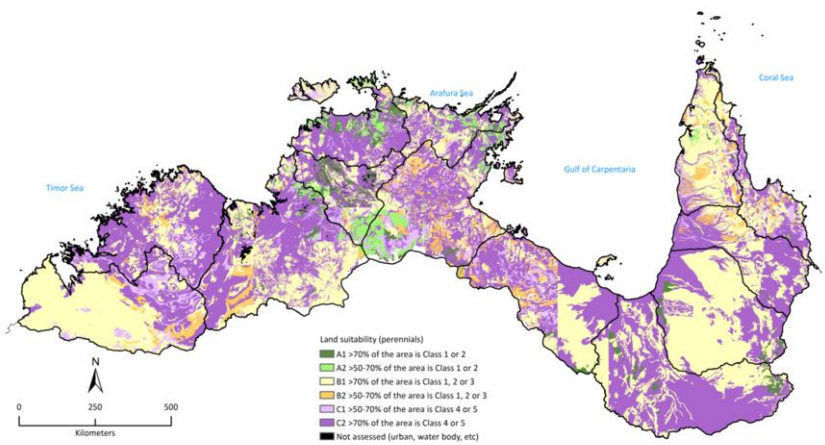
The north's climate can support virtually all sorts of agriculture & horticulture

LAND USE CATEGORY	CROP EXAMPLES
Cereal crop	Maize/corn, millet, oats, rice, sorghum (grain), wheat
Citrus	Lemon, lime, citrus
Food legume (pulse crop)	Chickpea, mungbean (black), navy bean, soybean
Forage grazing, hay, silage	Rhodes grass, sorghum (forage), millet, maize (forage), bambatsi
Forage legume	Lablab, lucerne, cavalcade
Industrial	Coffee, cotton, sugarcane, guar
Intensive horticulture (vegetables)	Capsicum/chilli, cucurbit, eggplant, sweet corn, tomato, melons, pineapple, strawberry
Oilseed crop	Sunflower
Root crop	Cassava, peanut, sweet potato
Silviculture (plantation)	African mahogany, Caribbean pine, Indian sandalwood, spotted gum, teak
Tree crop/horticulture (fruit)	Avocado, banana, carambola, custard apple, lychee, mango, pineapple
Tree crop (nuts)	Cashew, macadamia
Vine	Grape

- Climate isn't a limiting factor for most forms of agriculture or horticulture in the north
- CSIRO has analysed the north's climatic potential for over 40 crops, and has shown that pretty well everything that can be grown in southern Australia can be grown in the north
- The exception would be prunus types, that require a long chilling period to flower...

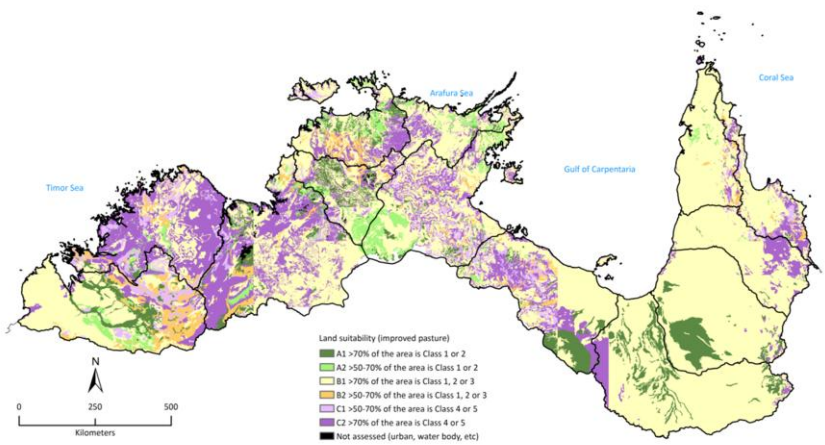
- Source: Agricultural Resource Assessment for the Gilbert Catchment. Petheram, Watson & Stone (2013). p. 181

6.5 Mha soil suitable for perennial production



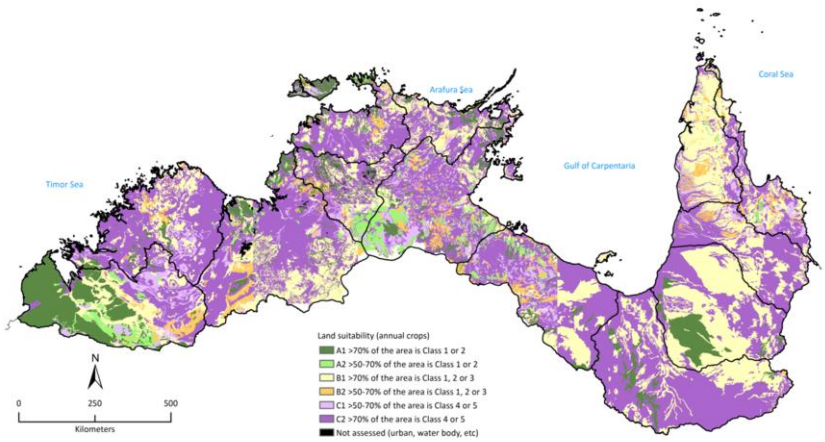
- There's about 6.5 million ha of soil that's potentially suitable for production of perennials
- The areas most suitable for production are shown in green

14 Mha suitable for improved pasture production



- There's about 14 million ha of soil that's potentially suitable for improved pasture production
- The areas most suitable for production are shown in green

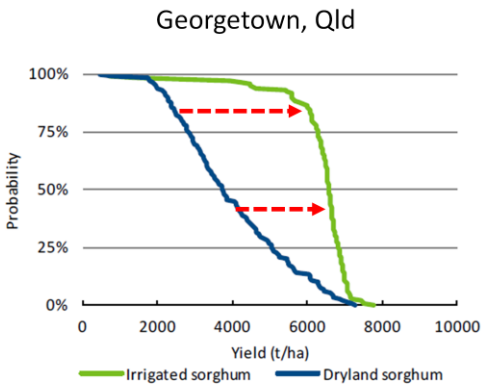
16 Mha suitable for irrigated arable production



- There's about 16 million ha of soil that's potentially suitable for irrigated arable production
- And there's contiguous areas of most suitable soil (the green stuff) in almost every catchment

- But soil isn't enough...

Irrigation is helpful



- increases yield >2x

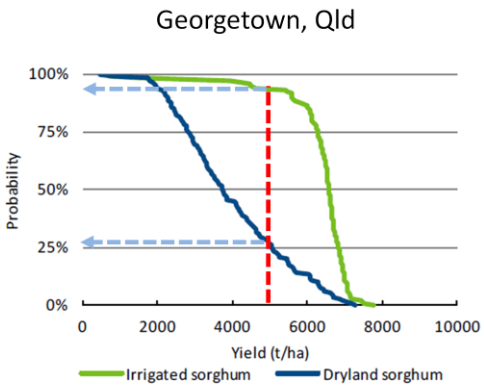
- As you'd know, water is pretty useful

- This figure shows some fancy science for irrigated and dryland sorghum crops grown in Qld's Gilbert catchment near the Gulf of Carpentaria
- The details don't matter – the main points are that...

- Water increases the yield of many crops, most often by a factor of two to three

Image: Petheram et al (2014). Gilbert Catchment Report p. 178

Irrigation is helpful



- break-even yield 3x

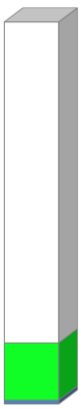
water is required for the north to reach its potential

- Water increases the profitability of many crops, often by a factor of at least 3

- Water is essential for the north to reach its agricultural potential
- How much is there to go around?

Image: Petheram et al (2014). Gilbert Catchment Report p. 178

Water availability in northern Australia



evapo-transpiration (ca 90%)

stream flow (ca 10%)

groundwater (<2%)

2,000,000 GL of rain falls on NA each average year

- On average, 2 million GL of rainfall lands on northern Australia each year
- 2m GL is 4000 times the volume of Sydney Harbour. If placed on the MCG it would make a bucket reaching 1/5th the way to the moon (80,000 km high). More excitingly, if placed on Tasmania it would cover it with 30 m of water.

- So if the north gets so much water, why isn't more available for use by irrigators?

- Well, 90% evaporates before we can grab it
- Only about 10% enters streamflow where we can capture it via dam, pumping and and other means
- And less than 2% enters groundwater

- Plus…all of that water's already doing something before we get to it – feeding fish, providing recreation and amenity and a host of other things

- Let's do some sums that show why the water available for irrigation is a small proportion of all the water that we see
- I'll use surface water as an example, but the story for groundwater is similar…

Rainfall

2,000,000 GL
rainfall

100%

- Let’s start with the full 2 million gigalitres of northern Australia’s rainfall...

Rainfall-streamflow

200,000 GL
streamflow

10%

- In most of the north it's often 10% of that water enters streams, where it presents itself for capture and subsequent use

Rainfall-streamflow-storage

40,000 GL
dam storage

2%

can store more water, but reliability drops

- Of the total streamflow, an average of about 20% can be stored with acceptable (ca 80%) reliability.
- Attempts to store more than 20% of the streamflow will, in most locations, simply reduce the reliability with which water can be stored – that's an engineering fact that we can't wish away

Rainfall-streamflow-storage-yield

30,000 GL
dam yield

1.5%

- The yield of a dam is often about three-quarters of its total storage volume – because dams aren't instantly filled the moment we use water, and there are losses to things like evaporation

Rainfall-streamflow-storage-yield-loss

15,000 GL delivered

0.75%

- It's not uncommon to lose about half the dam's yield between the dam wall and the paddock, because there are all sorts of transmission and application losses along the way

- Following this line of logic, only about 0.75% of the total rainfall received in northern Australia can be applied to crops using irrigation

- And that's before one's considered other users of the water, such as indigenous interests or the environment – all of which are correctly the subject of regulation

Most water can't be delivered to crops

water sufficient for 0.4% of NA – 10% of suitable soil

- So we can see that most of the water that we see in the landscape can't be delivered to crops
- If all of northern Australia's raiinfall could be used for irrigation, there's enough water to irrigate 200 million hectares, or ca 55% of the north
- As it stands, it's probably possible to deliver an upper limit about 15,000 gigalitres of new water to crops grown in the north
- That's enough to irrigate about 1.5 million ha, which is 0.4% of northern Australia, or about 10% of the suitable soils
- In most places, there's more soil than there is water to irrigate it.

- Water is clearly the most limiting of the north's biophysical resources.
- I must stress, the 1.5 million ha figure is an upper limit for irrigated area, based on physical constraints.
- Regulatory and other constraints would significantly reduce that to a smaller area.

- It's just a guess, but one might expect the application of water plans to bring the water availability figure down to about 25% of the total – rendering enough water to irrigate about 400,000 ha. Just a guess based on contemporary allocations in the north.

What would that require?

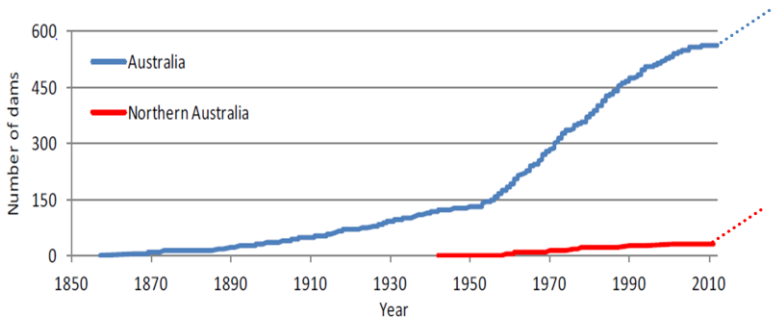


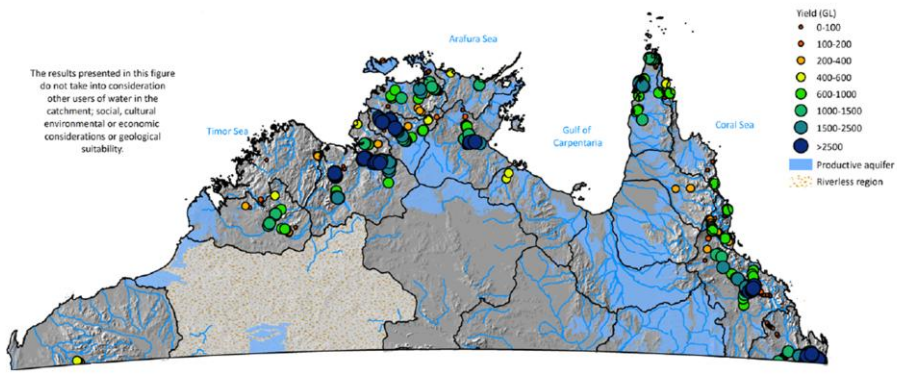
Figure 1-1 Cumulative number of large dams (>10m wall height) in Australia and northern Australia over time since European settlement

90 new dams - cost >$45b

If we put aside everything else, and concentrate on the water storage alone...

- Capturing the water required to develop 1.5 million ha of land would require 90 new dams
- That would require a return to Australia's dam building heyday (1950-1990) when we could knock over 90 dams every 15 years
- It would also require us to increase the number of large dams in northern Australia 4 fold, from the present 30 to 120
- It would require about $45 billion expenditure on dams, about $45 billion on water delivery, and about $180 billion on supporting infrastructure

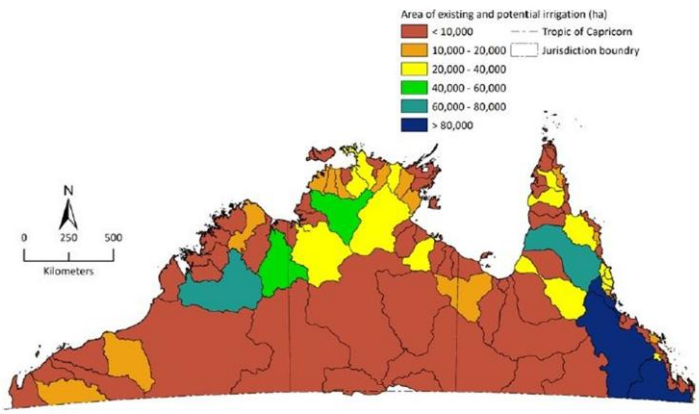
Where could dams be located?



rainfall reliability an important factor

- The sites best able to provide the physical conditions for a dam are shown here
- If a place has a dot it doesn't mean a dam will be built, and if it doesn't have a dot it doesn't mean one won't
- This analysis doesn't exclude any site on the basis of political, cultural or environmental sensitivity – it's a purely physical analysis

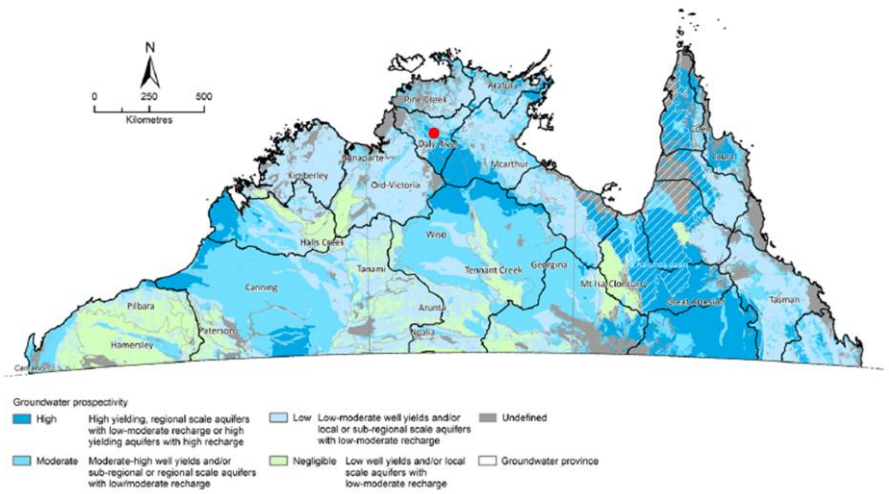
How might irrigation be distributed?



...but co-location of soil and water also important...

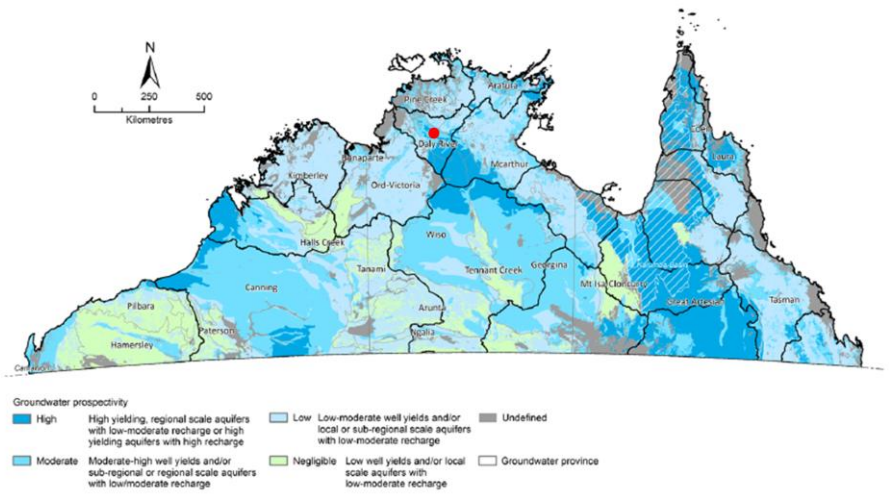
- If you put suitable soils and potential dams locations together, you get a picture of the areas of irrigation that might be possible across the north...an upper limit

What about groundwater?



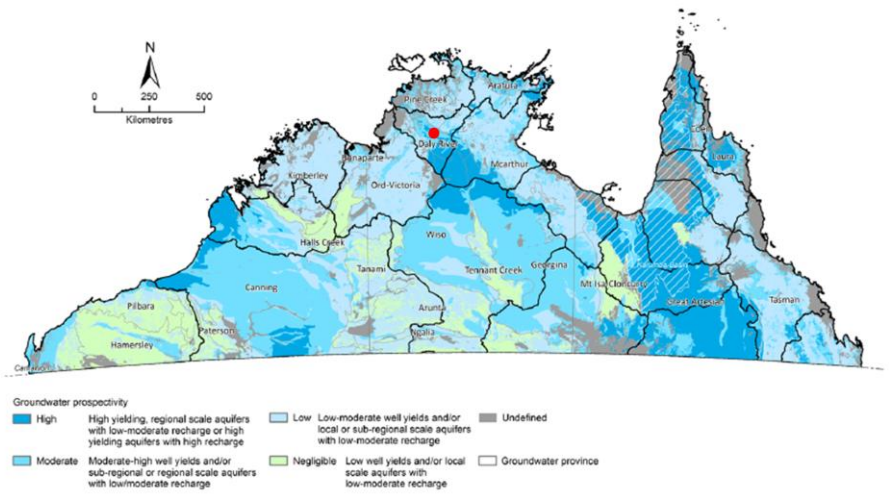
- Now that's all been about surface water, which gets a lot of the attention, but you're probably more interested in groundwater....
- We've looked at groundwater across the north, and think that the scale of opportunity is about 10% of that for surface water
- That's a helpful fact for a national policy maker, but if you live where the groundwater is, it's 100% of your opportunity!
- Let's see what's there...

What about groundwater?



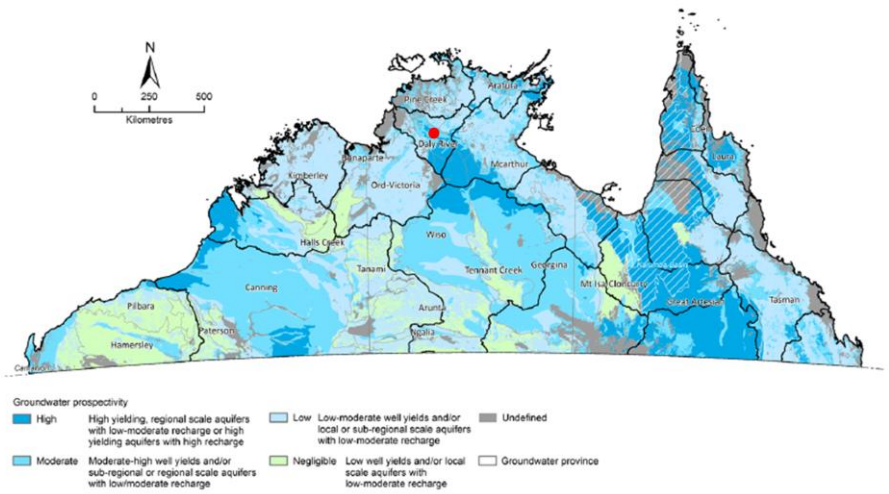
potential >100 GL pa (>10,000 ha) from
coastal Canning, central Daly-Wiso/Georgina, GAB

What about groundwater?



potential 10-100 GL pa (1,000 – 10,000 ha) from inland Canning, non-central Daly-Wiso/Georgina

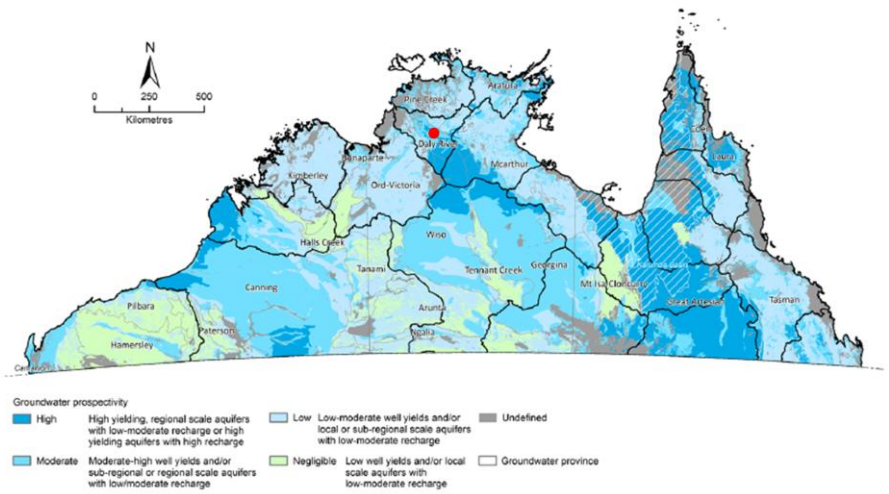
What about groundwater?



potential <10 GL (1,000 ha) pa remainder;
possibly more in Fitzroy alluvium & Koolpinyah dolomite

- XX

What about groundwater?



...enough across NA for ca 120,000 ha irrigation

- Accessing that water, turning it from potential to allocated resource, requires decision by state and territory government
- They have the difficult job of balancing competing demands for water
- The sustainable allocation and management of groundwater resources in northern Australia requires sufficient understanding of recharge locations, processes and rates, aquifer flow paths and flow rates, and discharge locations, mechanisms and rates. This can only be attained through on-ground studies.

are physical resources enough to secure development?

- The intensification of agriculture required to grow that food requires more than physical resources – it also requires money, as an input and so ultimately as an output.

- For most crops, median yields under irrigation are 30-50% higher than required to break-even
- For some crops – such as sugar and cotton – median yields under irrigation could be 2-3 times that required to break even.
    - These high-margin crops require local processing facilities because transporting raw goods erodes their margin advantage
    - That requires agricultural development at a scale sufficient to 'feed' processing facilities
- So gross margins for irrigation are attractive to highly attractive
- Is that enough to stimulate investment?

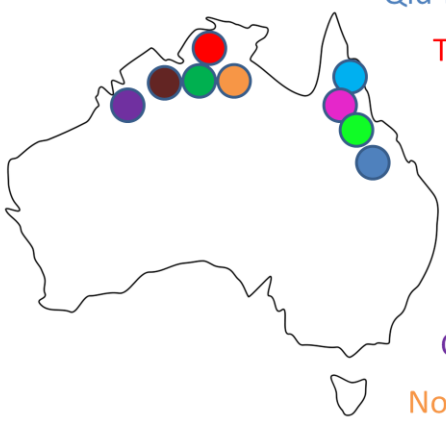
'whole of development' economics have proven challenging

- Gross margins aren't, on their own, enough to stimulate investment
- They show what's possible when you're up and running, not what's required to get there
- It costs about $1000/ha to develop ground for dryland agriculture
- On-farm irrigation schemes where water storage and delivery are scaled to land development cost about $10,000/ha
- Off-farm irrigation scheme where water storage and delivery are scaled to land development cost about $40,000/ha
- It costs $300-500 million to build an in-stream dam of significant volume, and roughly as much again to deliver water to users

- In our analyses, we couldn't find realistic combinations of price and yield that could generate returns large enough to cover these development costs

- That doesn't mean that it's not possible, but the historical record suggests that it's proven challenging in the past...

A history of irrigated development attempts



Qld-British Food Corporation (1948)

Territory Rice Limited (1955)

Mareeba-Dimbulah (1958)

Ord River Irrigation Area (1960)

Tipperary Land Corporation (1967)

Lakeland Downs (1968)

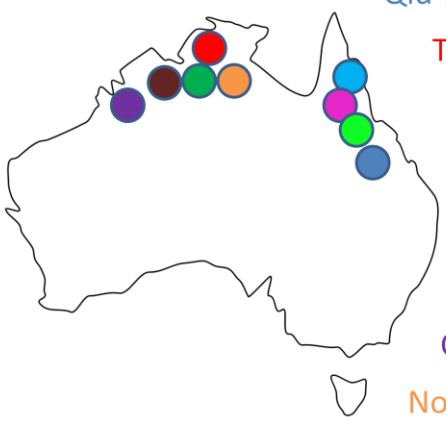
Camballin Irrigation Area (1969)

Northern Agricultural Development Corporation (1970)

Burdekin River (1987)

- Intrepid developers have sought to establish no fewer than nine major irrigation developments in the 70-odd years since 1948.
- The total proposed area of these developments exceeded 565,000 ha, or 1.2 million acres
- The total realised and sustained area was 146,000 ha – around 25% of that planned

A history of irrigated development success



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Camballin Irrigation Area (1969)

Northern Agricultural Development Corporation (1970)

Burdekin River (1987)

- And 100% of the persistent area was found in three of the nine developments
- I want to emphasise that my point isn't that greenfield developments have a slim chance of success – I don't think that's necessarily the case
- My point is that there's a rich history of both unrealised aspirations and success – and we can acquire valuable lessons from both.
- What can we learn?

Anatomy of failure

- natural environment challenging but not main source of failure
- management, planning & finances most important
- overcapitalising early, before lessons learned

impatience costly

- Why didn't some things work?
  - Natural environment is challenging but not the main source of failure
  - Management, planning and especially finances were most important factor – particularly the problem of overcapitalising early, before the wrinkles have been ironed out of production and marketing systems
- I think we've learned that 'patient capital' is required to capitalise on the north's agricultural opportunities

Anatomy of success

- climate, soils, farm operations, markets & supply chains viewed as an inter-dependent system
- up-scaling occurs at a considered pace
- allow for lags before investment returns

patience a profitable virtue

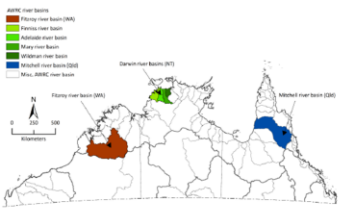
- I think that also we've learned that persistent developments:
  - Consider climate, soils, farm operations, markets and supply chains as part of an inter-dependent system
- They also:
  - Scale up at a considered pace that allows for reasonable lags before positive investment returns occur

Unlocking development in northern Australia

- the basic resource base is plentiful
- the physical environment is challenging but not decisive
- soft and hard infrastructure are limiting; variously shrinking/growing
- investment horizons are extended and less certain

planned and patient capital is key

So where does NAWRA fit in?



1. evaluate the soil and water resources
2. identify and evaluate water capture and storage options
3. identify and test the commercial viability of irrigated agricultural, aquaculture and other opportunities
4. assess potential environmental, social and economic impacts and risks of water resource and irrigation development.

informing regulation, investment, debate

- Fitzroy; Finniss, Adelaide, Mary and Wildman ; Mitchell
- Together that's an area of about 200,000 km^2, or about 7% of the area of northern Australia. Put another way, it's about 7 times the size of Belgium, or about the area of the UK. So it's a large slab of land.

Why those areas – Fitzroy?

Currently extensively grazed by beef cattle

- groundwater and off stream capture of overland flow enable up to 60,000 ha of irrigated agriculture
- large contiguous area of suitable soil
- 7,000 people in the catchment, 80% indigenous
- appetite to explore development opportunities

large resource base, appetite for development

- XX

Why those areas – Darwin?

Currently ca 3,000 ha irrigated ag & hort worth >$200 million pa

- opportunity to increase that to 30,000 hectares
- expansion based on small to moderate sized dams, groundwater
- utilise existing soft and hard infrastructure

build on existing industry strengths

- XX

Why those areas – Mitchell?

Currently ca 17,000 ha irrigated ag & hort in Mareeba Dimbulah scheme

- catchment is mainly agricultural land use; grazing
- opportunity to add ca 60,000 ha, drawing on water stored in new in-stream or off-stream dams

leverage existing soft and hard infrastructure

- XX

What do we do?

1. **Surface water modelling** to assess the volume and reliability of river flows and the extent, magnitude and duration of floods
2. **Topographic mapping** and automated terrain analysis to identify and evaluate water storage and development options
3. Quantifying the scale of available **groundwater resources** and examining opportunities for managed aquifer recharge
4. **Mapping land and soil suitability** and production risks (e.g. floods and salinity) across agricultural, horticultural and pastoral systems and for aquaculture developments

locate & quantify the resource base

What do we do?

5. Assessing cropping and **crop-forage-livestock systems** with potential to generate attractive investment returns
6. **Cost-benefit analysis** for multiple uses and users of water
7. Identifying logistical and **value chain** assets, opportunities and bottlenecks
8. Understanding the **trade-offs** between water resource development and freshwater and marine environments

identify systems & systems links

What do we do?

9. Identifying **Indigenous aspirations** and water values
10. Information **and data distribution** through web-based information products, reports and regular community-based information sessions.

connecting with people

Why do we do it?

- explicitly address local needs and aspirations
- meet the needs of governments as they regulate the sustainable and equitable management of public resources with due consideration of environmental and cultural issues
- meet the due diligence requirements of private investors, by addressing questions of resource reliability and profitability at a broad scale.

it's all about unlocking potential

How do we do it?

The Northern Australia Water Resource Assessment project is part of the Australian Government's Agricultural Competiveness White Paper, the government's plan for stronger farmers and a stronger economy

Thank you

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How might irrigation be distributed?

Table 2-3 Estimates of annual groundwater availability from northern Australia at the intra-basin scale
Source: Modified from Turnadge et al., (2013)

GROUNDWATER RESOURCE		DEVELOPMENT POTENTIAL	ESTIMATED AVAILABLE EXTRACTION (GL/Y)
(1)	Daly, Wiso and Georgina basins (central)*	high	> 100
(2)	Canning Basin (coastal)#	high	> 100
(3)	Great Artesian Basin	high	> 100
(4)	Daly, Wiso and Georgina basins, excluding (1) %	moderate	10 - 100
(5)	Canning Basin, excluding (2) ^	moderate	10 - 100
(6)	Fitzroy River alluvium## ^	moderate	10 - 100
(7)	Koolpinyah Dolomite	Moderate	10 - 100
(8)	Other groundwater resources	low	< 10

*refers to the area encompassing the southern region of the Daly Basin and the northern regions of both the Wiso and Georgina basins;

#refers to the area of the Canning Basin located less than 100 km from the coast;

%refers to the combined area of the Daly, Wiso and Georgina basins excluding (1);

^refers to the area of the Canning Basin located more than 100km from the coast

under normal flood conditions it has been estimated the alluvium may be able supply 200 GL of water, but actual yield will be limited by the quality of groundwater and low flow years in the Fitzroy River (i.e. need to maintain dry season waterholes).

...but co-location of soil and water also important...

- The sustainable allocation and management of groundwater resources in northern Australia requires sufficient understanding of recharge locations, processes and rates, aquifer flow paths and flow rates, and discharge locations, mechanisms and rates. This can only be attained through on-ground studies.