Agricultural resource assessment for the Gilbert catchment

An overview report to the Australian Government from the CSIRO Flinders and Gilbert Agricultural Resource Assessment, part of the North Queensland Irrigated Agriculture Strategy

December 2013
CSIRO has completed, for the Australian Government, an investigation of opportunities for water and agricultural development in the Flinders and Gilbert catchments of north Queensland. Each catchment offers the possibility of irrigation developments approaching (in Flinders) or exceeding (in Gilbert) the scale of the current Ord River Irrigation Area.

Here we present the key findings of the Assessment for the Gilbert catchment, followed by an overview of the considerations concerning the potential for irrigated and dryland agricultural development. Readers are referred to the full reports for more detailed information.

**KEY FINDINGS**

- Despite their close proximity, the Flinders and Gilbert catchments differ significantly in their physical characteristics and, as a consequence, the extent to and methods by which agricultural development might occur.
- In the Flinders catchment, farm dams could support 10,000 to 20,000 ha of irrigation in 70 to 80% of years; irrigation may not be possible in very dry years. The precise area under irrigation will, in any year, vary depending on factors such as irrigation efficiency, water availability, crop choice and risk appetite.
- In the Gilbert catchment, large instream dams could support 20,000 to 30,000 ha of irrigation in 85% of years. Again, the precise area under irrigation will, in any year, vary depending on factors such as irrigation efficiency, water availability, crop choice and risk appetite.
- Instream dams enable more reliable irrigated production than farm dams, because they can more easily carry water from one year to the next.
- Significant water use would, in the downstream environment, amplify the environmental and social challenges associated with dry years and would have impacts on commercial and recreational fishing catches that have not been quantified in this study.

**CITATION**


Cover image: Tonks Camp, on the Gilbert River, North Queensland.
Key findings for the Gilbert catchment

North Queensland’s Gilbert catchment, comprising an area of approximately 46,000 km², drains into the southern Gulf of Carpentaria. Its population of approximately 1200 people is engaged mainly in pastoralism, but tourism, mining and commercial fishing make important contributions to the economy. Dryland and irrigated cropping currently occupy less than 0.02% of the landscape.

This overview report on the Gilbert catchment seeks to:

- Identify and evaluate water capture and storage options
- Identify and test the commercial viability of irrigated agricultural opportunities
- Assess potential environmental, social and economic impacts and risks.

The Assessment acknowledges that locals have insights, skills and aspirations to contribute to development plans for the benefit of their region, community and environment. Scientific knowledge of the type produced by this Assessment should complement rather than compete with local knowledge.

Water capture and storage options

Two prospective instream water storages (dams) of significant scale have been identified (Green Hills and Dagworth dams). When combined, these two dams are capable of delivering to crops approximately 250 gigalitres (GL) of water in 85% of years. The next four most prospective instream dams add relatively small volumes of water at relatively high cost.

There is more soil suited to irrigation in the Gilbert catchment than there is water to irrigate it. If the most prospective six instream storages were to exist, it would be possible to irrigate approximately 0.6% of the catchment’s irrigable soils.

On-farm dams are considered less prospective because of the catchment’s often sandy soils, though there are locations suited to on-farm water storage.

Agricultural opportunities

Based on the identified water storage and the large areas of potentially irrigable agricultural soils (approximately 2 million ha), there is the potential for an irrigation development of 20,000 to 30,000 ha supporting year-round mixed irrigated and dryland cropping. The precise area under irrigation will, in any year, vary depending on factors such as irrigation efficiency, water availability, crop choice and risk appetite. A development of this scale is larger than the existing Ord River Irrigation Area, and may be sufficient to sustain local processing facilities such as a cotton gin or a sugarcane mill. If crops were grown to their full potential, the regional gross margin of crop production could exceed $60 million/year.

Dryland production is sensitive to the very high year-to-year variability of rainfall in the Gilbert catchment. Break-even yields of most crops can be achieved only two to three years in ten, which precludes commercial returns on development costs such as land clearing. If these costs are ‘sunk’, commercial returns from dryland cropping require that crops approach their full yield potential and that they are grown only in years when cropping opportunity is high. This can be clearly distinguished at sowing time using seasonal rainfall outlooks and information about water stored in dams and in soil. Despite these challenges, dryland cropping is likely to be a component of irrigation development.

Environmental impacts and risks

Irrigated agricultural development has a wide range of potential benefits and risks.

The two most prospective dams would, in the downstream environment, amplify the environmental and other challenges associated with dry years. Critical environmental processes (such as wetland inundation) would not be greatly affected by water extraction in ‘average’ or wet years, largely because the dams would be located in the middle reaches of the catchment and would intercept a mean 14% and median 20% of flow to the Gulf of Carpentaria. Impacts of reduced river discharges to the Gulf on commercial and recreational fishing catches are possible but have not been quantified in this study. Large-scale change of land and water use is likely to require a wide range of regulatory, social and cultural responses, including consideration of native title implications.

Under the development scenarios examined, the high capital costs of dams and water delivery infrastructure (approximately $1 billion) precludes economic returns on combined investment in water assets and irrigated farming. Where third-party investment in water storage and delivery was examined, it was found that commercial returns on irrigated agriculture are possible when crops approached their full yield potential – a condition that becomes more probable with experience.
Overview of the Gilbert catchment

A highly variable climate

Northern Australian graziers are already adept at managing seasonal variability and risk.

This report recognises the skills of pastoralists in managing seasonal risk, and seeks to provide them and others with the information required to assess a set of risk parameters that is new to the Gilbert catchment – those associated with large-scale water storage and crop production.

Climate is a key driver of processes that affect agricultural and pastoral production and risk. The tropical climate of the north, with its alternating periods of extreme wet and dry, also has implications for the location, scale, function and risk associated with industrial and domestic infrastructure.

The climate of the Gilbert catchment is hot and semi-arid. It is a generally water-limited environment and, as such, efficient and effective methods for capturing, storing and using water are at a premium.

The mean and median annual rainfall – averaged across the Gilbert catchment – are 775 mm and 739 mm, respectively.

- 7% of the average annual rainfall occurs in the dry season (May to October). The length and intensity of the dry season limits the choice of crops that can be grown under dryland agriculture and increases the water requirements of irrigated agriculture.
- 93% of the average annual rainfall occurs in the wet season (November to April), during which rainfall can be very intense, increasing the risks of flooding, erosion and soil structural decline.

Rainfall is difficult to capture.

- 84% of rainfall is lost as evaporation; only 13% enters streamflow.
- There is a strong rainfall gradient that runs from the flat coast (1050 mm annual mean) to the more hilly south-east catchment (650 mm annual mean).

Rainfall is difficult to store.

- Evaporation is high (1868 mm annual mean), and exceeds rainfall by a factor of 2.4 to 1.
- For the seven actual and potential instream storages (dams) examined in the Gilbert catchment, water yields at 85% reliability averaged 45% of their storage capacity. Dams are capable of delivering to crops an average of only 25 to 30% of their total storage capacity.

Historical (1890 to 2011) monthly (a) rainfall and (b) potential evaporation averaged across the Gilbert catchment
Rainfall is unreliable, which increases production risks for dryland and irrigated agriculture.

- Annual rainfall totals in the Gilbert catchment are unreliable against both national and global benchmarks; these totals are approximately 1.3 times more variable year-on-year than in comparable parts of the world.
- While rainfall is unreliable, seasonal rainfall outlooks made in February can be made with 75% skill. Important information about water availability (i.e. water in soil and water in dams) is available when it is most important agriculturally – before planting time for most crops. Farmers and water managers can manage risk using seasonal rainfall outlooks.

Droughts are much more intense in the Gilbert catchment than in other agricultural areas of Australia.

- The frequency and duration of droughts in the Gilbert catchment is comparable with other agricultural areas of Australia, such as the Murray–Darling Basin. When drought occurs, however, it is more intense because of the high rates of evaporation and strongly seasonal rainfall.
- To consistently supply water during intense dry periods, dams need to be large enough to contain multiple years of potential water use, and crop areas need to be reduced. Water captured in shallow, offstream storages needs to be used as soon as possible.
- The timing of drought in the Gilbert catchment broadly correlates with drought in most of eastern and northern Australia.

Tropical cyclones bring rainfall but their winds do not tend to have destructive impacts in the Gilbert catchment.

- Tropical cyclones are rare in El Nino years. During La Nina periods they may occur two to four years in ten in the Gilbert catchment.

The historical (1890 to 2011) climate record provides the best available information to support short- to medium-term planning.

- Half of the climate models used in the Assessment indicated an increase in mean annual rainfall of up to 17% and half indicated a decrease in mean annual rainfall of 33%, relative to the historical climate. Importantly, approximately 60% of the models differed by less than ±10% from the historical rainfall. Significant changes in the amount and distribution of rainfall appear unlikely.
Water resources

Groundwater resources in the Gilbert catchment are not well understood, and detailed investigations were beyond the scope of the Assessment. The available evidence suggests that there are limited opportunities for substantial groundwater extraction.

- Bedsands in the Gilbert River have an estimated volume of less than 20 GL, and their groundwater sources have low hydraulic conductivity.
- Recharge rates are likely to be very low (<5 mm/year) in most of the catchment, though areas of much higher recharge (<80 mm/year) occur in the lower reaches of the Gilbert River.
- Baseflow index data (generally <0.2) and chemical analyses indicate that groundwater discharge constitutes a very small proportion of the overall streamflow in most of the rivers.
- Reliable estimates of potential groundwater yield would require further study.

In the absence of substantial groundwater resources, water-based developments will depend on streamflow for access to water, with storage either instream (e.g. dams) or offstream (e.g. ring tanks).

The majority of streamflow within the Gilbert catchment cannot be readily captured or stored.

- The total amount of controlled water releases possible from the six most prospective instream dams in the Gilbert catchment is approximately 630 GL in 85% of years. This is approximately 17% and 25% of the mean and median annual streamflow near the mouth of the Gilbert River, respectively.

Streamflow within the Gilbert catchment is highly variable within and between years. As a consequence, most rivers in the Gilbert are ephemeral, making water storage essential for irrigation during the dry season. For the same area of cropping, water storages in the Gilbert catchment need to be much larger than those in southern Australia (and other countries of similar climate) if they are to consistently meet a given demand. Water storage efficiency is low compared with global averages.

- Mean annual streamflow is approximately 40% greater than median annual streamflow, which means that a small number of large flows skew the distribution of flows.
- Mean annual runoff across the Gilbert catchment averages 140 mm, which is about mid-range for northern Australia. The median annual runoff is 100 mm.
- Approximately 98% of the runoff in the Gilbert catchment occurs during the wet season.
- Annual variability in runoff is comparable with other rivers in Australia that have similar mean annual runoff, but two to three times greater than rivers from other countries with similar climates.

Historical (1890 to 2011) median annual streamflow in the Gilbert catchment
Flooding

Flooding is ecologically critical because it connects offstream wetlands to the main river channel and connects and cleanses waterholes that sustain biodiversity during the dry season.

- Above the confluence of the Gilbert and Einasleigh rivers, where large-scale irrigated agriculture is most promising because of potentially irrigable soils and proximal upstream water storage, the river rarely breaks its banks.
- The coastal floodplain of the Gilbert catchment, downstream of the confluence of the Gilbert and Einasleigh rivers, frequently has floods that extend approximately 5 km either side of the river for a distance of over 100 km.

Flooding is economically critical because they underpin the health of the Gulf of Carpentaria fisheries.

- There is a strong positive relationship between streamflow and fishery catches, especially for species of commercial and recreational importance. Prawn landings in the Gulf of Carpentaria prawn fishery are strongly related to wet-season flows from the Gulf rivers.

Construction of the two most promising instream dams in the Gilbert catchment would have a relatively minor effect on the inundation of the Gilbert floodplain during flood events.

- Construction of major dams in the Gilbert catchment would reduce floodplain inundation during ‘low flood’ years and would have a minor impact on floodplain inundation during average and wet years. Impacts on fisheries are possible but have not been quantified in this study.

The volume and velocity of ‘first-flush’ floods events is critical in renewing water quality and volume of streams and waterholes, so has significant ecological value. A set of rules on what constitutes the first flush and how much water is required to pass in order to renew the aquatic system is very difficult to determine but is critical to water resource planning.

Flooding is ecologically critical because it connects offstream wetlands to the main river channel and connects and cleanses waterholes that sustain biodiversity during the dry season.

- The high biodiversity found in many unregulated floodplain systems in northern Australia depends largely on ‘flood pulses’ that allow fauna and nutrients to be exchanged between the main channel and coastal wetlands (tidal and freshwater). Reductions in floodplain inundation would result in appreciable decreases in aquatic and marine productivity.

- A very high proportion of the coastal floodplains of the Gilbert catchment is dominated by wetland aggregations that are recognised in the national Directory of Important Wetlands, and which contain areas of habitat with an ‘of concern’ conservation status.

* Maximum water cover over a ten-year period
  - 10 to 20%
  - 20 to 50%
  - 50 to 80%
  - 80 to 100%

- Towns
- Rivers

Flood inundation map of the Gilbert catchment (between 2000 and 2010) based on MODIS satellite data.
Water storage potential

Notwithstanding its challenging climate, the Gilbert catchment offers a number of prospective large instream water storages (dams).

Dagworth is a potential dam site on the Einasleigh River that has not been investigated previously. It is located approximately 70 km upstream of a significant area of potentially irrigable agricultural soils.

- The optimum construction for the potential Dagworth dam is a roller compacted concrete gravity dam with an earth and rock embankment saddle dam, both of which could be constructed for an estimated $475 million.
- Dagworth dam could potentially store 498 GL and yield 326 GL at the dam wall with 85% reliability. Approximately half the volume released would be lost as water was transmitted to the most promising delivery point 70 km from the dam wall.
- Water delivered to the dam wall at Dagworth (excluding delivery to farm) is likely to cost approximately $1,450/ML in 85% of years.
- If used to its full extent, the Dagworth dam would reduce flow near the mouth of the Gilbert River by 498 GL, or approximately 19% of median streamflow.

Green Hills is a potential dam site on the Gilbert River, located approximately 15 km from a significant area of irrigable agricultural soils.

- The optimum construction for the Green Hills dam is a roller compacted concrete gravity dam with four saddle dams to contain floods, all of which could be constructed for an estimated $335 million.
- Green Hills dam could potentially store 227 GL and yield 172 GL at the dam wall with 85% reliability. At least 15% of the volume released would be lost as water was transmitted to the most promising delivery point 15 km from the dam wall.
- Water delivered to the dam wall from Green Hills (excluding delivery to farm) is likely to cost approximately $1,950/ML in 85% of years.
- If used to its full extent, Green Hills dam would reduce flow near the mouth of the Gilbert River by 227 GL, or approximately 10% of median streamflow.

Copperfield River Gorge Dam (also known as Kidston Dam) is an existing dam that is 70 km from a potential irrigation development at Einasleigh.

- It is the only large dam currently in the Gilbert catchment and has a storage capacity of approximately 20 GL and a 13 GL yield at 85% reliability.
- A mass concrete extension to the dam wall, raising it by 2 m, would increase the storage capacity of the dam by 5 GL at a cost of $34 million, after which it would yield 17 GL at 85% reliability. At least 25% of the volume released would be lost as water was transmitted to the most promising delivery point 70 km from the dam wall.
- Water delivered to the dam wall (excluding delivery to farm) from an extended Kidston Dam is likely to cost approximately $1990/ML in 85% of years.
- If used to its full extent, Kidston Dam would reduce flow near the mouth of the Gilbert River by 25 GL, or approximately 1% of median streamflow.
Opportunities for agriculture

A large area (1 to 2 million ha) of the Gilbert catchment is classified as moderately suitable (class 3) for cropping, depending on the crop and irrigation methods chosen. These soils have considerable limitations that lower production potential or require more careful management than more suitable (e.g. class 1 or 2) soils. In this respect, they do not differ from many of Australia’s agricultural soils.

The area, location and properties of soil appropriate for agricultural production are critical to determining the types of crops and production methods possible and to setting and realising agricultural production potential.

- Approximately 2 million ha of soils are classified as moderately suitable for production of spray-irrigated cotton or sugarcane; approximately 0.9 million ha may be moderately suitable for furrow-irrigated sugarcane or cotton.
- Approximately 2 million ha of soils are classified as at least moderately suitable for trickle irrigation of intensive horticultural crops such as capsicum, cucurbits and sweet corn; approximately 0.9 million ha may be moderately suitable for furrow-irrigated intensive horticulture.
- Approximately 1.2 million ha of soils are classified as moderately suitable for spray-irrigated root crops such as peanut.
- Approximately 0.9 million ha of soils are classified as moderately suitable for furrow-irrigated horticultural or cereal crops such as sorghum.

Smaller – but still large – areas of the Gilbert catchment (50,000 to 300,000 ha) are classified as suitable (class 2) for production of mainly trickle-irrigated crops. These soils have minor limitations that affect production or require more careful management than class 1 soils to maintain economic production.

Extensive grazing of (mostly) native pasture comprises the vast majority of agriculture in the Gilbert catchment. There is currently virtually no dryland production of food or fibre for human consumption.

A wide range of crops is potentially suited to dryland production in the Gilbert catchment.

- Crops – including cotton, maize, mungbean, sorghum (grain), sugarcane and lablab – can potentially produce profitable yields in favourable seasons. Crops – such as chickpea, peanut and soybean – will be productive in favourable conditions but appear less promising.

High rainfall variability, combined with the relatively small water storage provided by its soils, means that continuous year-on-year dryland cropping is unlikely to be possible in the Gilbert catchment. Opportunistic cropping, pursued in years in which the late wet-season soil profile contains sufficient soil moisture and the outlook for more rainfall is positive, is likely to provide the most profitable and sustainable approach to dryland cropping.

- Analysis of farm gross margins indicates that for dryland crops grown in the Gilbert catchment, break-even yields could be expected more than nine years in ten for dryland mungbean and lablab; approximately three years in ten for dryland sorghum (grain) and sugarcane; and fewer than three years in ten for dryland cotton and maize.

Dryland cropping in the Gilbert catchment has the potential to provide a significantly greater, though much less reliable, source of agricultural production than irrigated cropping.

- If the approximately 2 million ha of potentially arable soil in the Gilbert catchment were, by way of example, devoted to dryland sorghum (grain), median potential regional production of around 7.6 megatonnes and a gross value of production of $1,748 million is theoretically possible. Annual variability in production is likely to place economic limits on the area of dryland agriculture, and actual yields will frequently be lower than potential yields.
Dryland cropping is likely to comprise a component of irrigated farming systems, because the water available to irrigate crops is likely to vary significantly from year to year.

- Because there is more potentially arable soil in the Gilbert catchment than there is water to irrigate it, decisions about the most efficient and cost-effective use of limited irrigation water will need to be made at combinations of regional, farm and paddock scale. From year to year, this will see farmers making decisions about the relative areas of irrigated and dryland cropping and full and partial irrigation employed on their farms.

Opportunistic dryland cropping in the Gilbert catchment is favoured by the fact that information about cropping opportunity and risk is available at the time of planting. This makes it possible to reduce production risk associated with inter-annual variation in rainfall, in a given year. This only partially addresses the business risks associated with intermittent opportunistic cropping because capital, plant and equipment will be under-utilised in drier years.

- February is the time for optimum sowing for many crops as well as the time at which the season’s water supply can be most reliably assessed. Stored soil moisture is readily apparent and the prospects of future rainfall can be assessed with a high degree (75%) of confidence.

Irrigated cropping in the Gilbert catchment currently comprises less that 400 ha of a range of irrigated crops, forage and mangoes. There is potential for significant expansion of irrigated agriculture, on the scale of the Ord River Irrigation Area. The addition of 20,000 ha of irrigated agriculture in the Gilbert catchment would increase the irrigated area of northern Australia by approximately 15%.

A wide range of crops is potentially suited to irrigated production in the Gilbert catchment.

- Crops – including cereals, pulses, forages, vegetables and perennials as well as industrial crops such as sugarcane and cotton – are all well adapted to irrigated production in the climate of the Gilbert catchment.
Fruit trees, such as mango, are well suited to the climate of the Gilbert catchment
Source: Ian Bally, Agri-Science Queensland

- The predominantly sandy and loamy soils of the Gilbert catchment are generally well suited to horticultural production.
- Intensive horticultural production of annual crops such as capsicum, chilli, cucurbit, eggplant, sweet corn, tomato, melon and strawberry and perennial crops such as mangoes is possible and may enable growers to exploit higher prices made possible by harvesting in the off-season of most of Australia’s production areas.

A wide range of crops is potentially profitable when grown under irrigation in the Gilbert catchment.

- For most crops, median yields under irrigation are 30 to 50% higher than ‘break-even’ yields (the yield required to return a positive gross margin). For some crops (industrial crops processed locally), median yields under irrigation are two to three times that required to break even.
- Profitability of industrial crops (such as cotton and sugarcane) is compromised by the cost of transport to distant processing facilities.

Irrigated cropping in the Gilbert catchment has the potential to significantly increase food production in northern Australia.

- If the catchment’s two most prospective instream water storages were developed, it would be possible to irrigate, with 85% reliability, a maximum of approximately 0.6% of the catchment’s irrigable soils, providing production potential of, for example, more than 0.5 million tonnes of grain, grown on more than 70,000 ha, and with a gross value of production of approximately $130 million.
- While the two most prospective instream storages in the Gilbert catchment can together supply water sufficient to irrigate up to 70,000 ha of low-water-use crops annually, a more likely farming systems scenario would see year-round irrigation of a range of crops in rotation (e.g. cotton, sorghum and peanuts), for which a total area of 20,000 to 30,000 ha is most promising. The precise area under irrigation will, in any year, vary with factors such as irrigation efficiency, water availability, crop choice, the balance between single and double cropping, and risk appetite – each of which may vary depending on the circumstances of a given farm enterprise. A development of this scale can generate median regional gross margins of more than $40 million/year.

Irrigated cropping in the Gilbert catchment is likely to rely on instream storage, because the capacity for offstream storage is limited in volume and geographic extent.

- The relative shallowness of on-farm dams, coupled with the high evaporation rates and predominantly sandy and loamy soils of the Gilbert catchment, reduces the efficiency of offstream dams.
- Combined losses from seepage and evaporation mean that, to reduce the price per megalitre (ML) of water, irrigation water stored in offstream dams should be applied early in the irrigation season.
Crops – such as cotton, maize, mungbean, sorghum (grain), sugarcane and lablab – can potentially produce profitable yields in favourable seasons in the Gilbert catchment. Commercial returns on irrigated and dryland agriculture are maximised when crops approach their full yield potential. Yields harvested on-farm are highly dependent on the critically important – yet difficult to define – trait of ‘management skill’, the process by which the best decisions and actions occur at the best time. This grows with experience and, until it reaches a high level, the challenges associated with the relative lack of cropping experience in the Gilbert catchment should not be underestimated.

The ability to enact farm decisions in the most timely manner can be impaired by the extremes of climate in the Gilbert catchment. Protracted wet periods, for example, may prevent sowing and other farm operations from occurring at their optimum time, reducing crop yields and profits. Until a pool of expertise develops and is efficiently able to anticipate challenges, actual crop yields would be expected to be significantly lower than potential crop yields. The difference between actual and potential yields, often referred to as the ‘yield gap’, usually closes slowly over time, and this needs to be factored into individual enterprise plans and cash flows.

Distance from the farm gate to agricultural processing plants places a significant cost burden on industry in the region.

Abattoirs at Townsville, Rockhampton and Biloela are the only export-certified abattoirs in north Queensland; no substantial inland beef processing plants serve northern Australia.

The sugar mill nearest the Gilbert catchment is in Mareeba, a road trip of 350 km from Georgetown. The cotton gin nearest the Gilbert catchment is in Emerald, a road trip of 900 km from Georgetown.

Major sealed roads within the Gilbert catchment are not particularly flood prone.

Pastoral enterprises of the Gilbert catchment require access to new skills and services, and new people, to support the transition to irrigated cropping.

The skills and services required to support pastoralism differ significantly from those required to support intensive irrigated crop production. Prospective irrigators will require expertise and advice regarding regulatory and legal matters as well as specialist technical soil management and irrigation expertise. Implementing irrigation will require agronomy services; equipment suppliers and repairers; input suppliers; and ongoing and timely access to skilled labour. In the first instance these would have to be ‘imported’.

The average pastoral enterprise in the Gilbert catchment supplements family labour with approximately 0.6 full-time equivalent (FTE) staff each year. A 50 ha irrigated forage development is estimated to require approximately 0.5 FTE, while a 1000 ha cotton development is estimated to require 6 FTEs. A 10,000 ha irrigation development would therefore require a minimum of 60 FTEs. Initially these people would need to be ‘imported’ as the requisite skills are not resident and the region’s low unemployment means that there is not an employment pool available.
The Gilbert catchment’s social infrastructure requires investment in the event of a large-scale irrigation development. Even though Georgetown’s population has halved over the last 10 years, there is limited capacity for the community of 250 to 280 people to absorb a rapid increase in population. While approximately 20% of private dwellings are unoccupied, a significant increase in population of the scale accompanying an irrigation development would require upgrades to the existing medical clinic, police and school facilities, and enhancements to the town water supply and sewer.

Indigenous people are represented to a greater extent in the Gilbert catchment than in the wider Queensland population. While their connections with country have been impacted by historical processes such as forced relocation, significant connections remain. As in the broader community, Indigenous groups have a range of aspirations that relate to the opportunities provided by irrigation development. Some Indigenous people are focused on opportunities and resources for existing residential populations, while others are focused on resettlement of those currently living elsewhere. Ongoing Indigenous priorities include securing sufficient water to maintain healthy landscapes, but also sufficient water to support current and future Indigenous needs, some of which relate to economic activity such as pastoralism, ecotourism and agriculture. At present, none of the catchment’s Indigenous groups participate in formal water planning processes.

Protecting cultural heritage is an Indigenous priority, and two major cultural heritage issues include ongoing damage to known existing sites and lack of documented heritage knowledge about traditional lands. Both hamper Indigenous capacity to respond to current development proposals. This is especially significant given that riverine and aquatic areas are known to be strongly correlated with cultural heritage sites and so the areas of development interest in the Gilbert catchment are known to contain important cultural heritage. Indigenous people expect that Indigenous water values will be formalised and refined via their involvement in catchment water planning.
Irrigation development in the Gilbert catchment requires management of a number of considerations relating to the aquatic environment.

Rivers are characterised by their flow regimes, which drive water quality, biodiversity assemblages, aquatic productivity and the physical form of rivers. Relatively minor changes in the amount, timing or location of water flow can significantly affect all of these factors, often unpredictably. Adaptive management is frequently required to address issues as they arise during development. Particular issues relevant to the Gilbert catchment include:

- The waterholes of the Gilbert catchment are largely clear, with low turbidity, making them particularly sensitive to changes in water quality – a small change in sediment or nutrient load, from farm runoff for example, makes a much bigger difference in clear water than in water that is already turbid.

- Stream continuity provides connections between the Gulf of Carpentaria and upper reaches of streams. These connections are important because the relatively brief periods during which most streams flow are the times at which inland waterways and the Gulf of Carpentaria stock each other with the fish, energy and nutrients that support the economically significant tourism and fishing industries. Structures that impede water flow – such as dams, weirs and roads – can be located and designed to minimise the extent to which they disrupt stream continuity and fish passage, but at increased cost.

- The risk of blue-green algal blooms in the most promising dams varies from moderate to very high.

- The majority of waterholes in the Gilbert catchment are replenished by streamflow rather than groundwater, making flow regimes critical to the ‘health’ of most waterholes.

- Water quality in waterholes declines over the dry season as waterhole temperature rises and oxygen levels drop. The first major flood flush needs to be of sufficient volume and velocity to clean out this ‘stagnant’ water.
Irrigation development in the Gilbert catchment requires management of a number of considerations relating to the terrestrial environment.

The two most prospective dam sites contain vegetation communities with an ‘of concern’ conservation status that could be inundated following dam construction. Detailed vegetation surveys would be required to support specific dam proposals.

Removal of native vegetation would occur on sites to be irrigated and for associated infrastructure, which would reduce regional plant species richness and impact species for which that vegetation provides habitat. Linear infrastructure (such as roads and channels) tends to have impacts greater than their area would suggest because of their fragmentation and boundary effects.

Irrigation development is likely to increase the risk of wind and water erosion of soils, and the release of nutrients and agropollutants to the environment. Agronomic and engineering methods can minimise these impacts.

Agriculture necessarily involves the deliberate introduction of novel species to a region, but can also be associated with elevated levels of inadvertent introduction of species via increased traffic and transport. Biosecurity monitoring and management protocols can reduce the likelihood and extent of risk.
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