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Daly River Catchment – towards an integrated catchment management

Andrew S Wygralak

Affiliation: Post-Graduate Student; School of Resources, Environment & Society, Australian National University

Address: PO Box 4353, Darwin, NT 0801

E-mail: Andrew.Wygralak@nt.gov.au

SUMMARY

The Daly River is the largest perennial river in the northern part of the Northern Territory. Its catchment has good soils and is earmarked for the future agricultural development. Recognising the nearly pristine character of the catchment, the NT Government placed a Moratorium on major developments, pending completion of an Integrated Regional Land Use Plan. The aim of such plan, based on analysis of hydrological, biological, environmental and social (including Indigenous people) studies, is to develop a balanced holistic catchment management approach. Despite the extensive research, significant knowledge gaps still exist. Most of the multidisciplinary studies of the catchment completed till now were conducted without sufficient attention paid to the interconnection between economic, environmental, social and cultural aspects of the river catchment management. As a result no integrated catchment management plan has as yet been proposed. Further research is needed to fill the existing knowledge gaps.

Key words: Daly, River, Catchment, Management, Development

INTRODUCTION

Northern part of the NT (commonly known as the Top End) contains 28 river catchments (FIGURE 1). Major waterways are being used for recreation, pastoralism, cropping, horticulture and mining. River flow regimes in the Top End are highly seasonal, with more than 95% of the flow volume occurring during the wet season (November to April). Most rivers and streams cease flowing during the dry season (May to October). Some rivers, however, are perennial, being supplied by groundwater throughout the dry season. One such perennial stream is the Daly River.

Due to vast underground aquifers the Daly River has reliable flows of good quality water throughout the year. This, combined with good soils, makes the Daly River region highly prospective for the future development of the Territory's primary industries, including pastoral, cropping, irrigated agriculture and horticulture.

In November 2003 the NT Government proposed the development of an integrated natural resource plan for the Daly River region, to be prepared under the guidance of the Daly River Community Reference Group. The Group was established to help to develop an Integrated Regional Land Use Plan (IRLUP), based on an analysis of issues and inclusion of all the stake holders. The aim of the plan was to propose ecologically friendly development achieved by conservation of biodiversity and sustainable use of natural resources.

To be proactive with regard to the river management issues and recognising nearly pristine state the Daly River catchment, the NT Government placed a Moratorium on a large scale development in the central part of the catchment, pending the completion of an IRLUP. The draft IRLUP was completed in November 2004 (DRCRG, 2004).

Although completion of IRLUP is a milestone towards the best practice catchment management, significant knowledge gaps still exist and further integrated research is needed to develop a holistic and balanced management plan for the Daly River catchment. This paper will discuss some of the issues which need to be addressed in order to achieve this goal.

PHYSIOGRAPHY OF THE DALY RIVER CATCHMENT

The Daly River is one of the NT's largest rivers. Its catchment covers ~52,500km^2 and supports some 3,500 km^2 of wetlands. Its main tributary is the Katherine River, contributing ~41% of the mean annual discharge of the Daly River[I] (Faulks 1998). Other important tributaries are Flora (~14%), Fergusson (11%) and Douglas (8%) rivers. Less significant are the King and Dry rivers, located in the lower rainfall areas and, inspite of large sub-catchments, providing only 3.5 % of the annual discharge of the Daly River (op. cit.).

The Daly River catchment area covers several geological units (FIGURE 2), of which by far the most important for the water regime is the Daly Basin. This unit covers central part of the catchment and consists of ~800 m thick sequence of mostly carbonate Cambrian rocks divided into three formations: Tindal Limestone, Oolloo Dolostone and Jinduckin Formation (FIGURE 3). The first two formations form major groundwater aquifers sustaining base flow of the Daly River during the dry season.

Summer monsoonal rains regularly flood rivers in the Daly River catchment. Since 1897, there have been five flood events, with a peak level higher than 19 m recorded at the old Railway Bridge gauge in Katherine (TABLE 1).

Date	Flood level (m)	Flow (m^3/sec)
December 1897	19.0-19.5	4,800-6,500

[I] The mean annual discharge of the Daly River is 6,400 GL (Faulks, 1998).

April 1931	19.05	4,828
January 1940	19.26	5,500
March 1957	19.29	5,677
January 1998	20.40	12,000

TABLE 1. Recorded flood events on Katherine River since 1897 (after Faulks, 1998).

The concentration of rainfalls during the wet season is reflected in significant seasonal changes in stream flows (FIGURE 4). During a typical wet season the rainfall is nearly uniformly distributed from December through March, but river discharges increase with progression of wet season (Chappell and Bardsley, 1985).

There is a close interaction between surface and groundwater systems. During a dry season, the base flow of streams is largely attributed to the groundwater discharge.

Jolly (2001, 2002) studied the water balance of the Daly River catchment. Mean annual runoff for most of the catchment varied from 119 to 294 mm[II]. At the most downstream gauge (Mount Nancar – gauge G140003 on Figure 4), the mean annual runoff of the Daly River was 148 mm, of which 135 mm was surface runoff and 13 mm was regional groundwater discharge. Sustained base flow of 7 to 20 m^3/sec persists right through the dry season in the Daly River at Mount Nancar (Chappell and Bardsley, 1985).

Seasonal changes in water quality are a feature of streams in the Top End. The dry season water quality in the prevailing part of the Daly River catchment is influenced by groundwater discharge from largely carbonate aquifers and has high calcium and magnesium contents (Water Resources Branch, 1975). This contrasts with most Australian river waters which are dominated by sodium and chloride.

Beginning of the wet season introduces inflow of very turbid surface wash water and water high in decayed organic matter flushed from stagnant pools. Such input results in fish kills and rapid deterioration of water quality (Townsend et al, 1992).

TABLE 2 provides an example of water chemistry from the Daly River at Mount Nancar; the sample was collected during dry season (August), when flow was ~20 m^3/sec (Tickell et al, 2002).

Parameter	mg/L	Parameter	mg/L
TDS	310	Biocarbonate	339
Alkalinity	278	Sulphate	23
Hardness total	283	Chloride	16
Calcium	46	Fluoride	0.2
Magnesium	46	Iron – total	0.1
Sodium	11		
Potassium	3		

TABLE 2. Water chemistry. Daly River, Mount Nancar (afterTickell et al, 2002). Conductivity of this sample was 540 µS/cm, pH (lab) 7.7.

[II] Except for the Dry River, where it was only 23 mm.

Extraction of water from rivers and creeks for stock and domestic purposes occurs in the Daly River catchment. In most cases, data on the actual amounts of water used are unavailable. Only if larger volumes of surface water are needed, for example for mining or irrigation purposes, a Water Extraction Licence is required. Currently such Licences exist on the Daly, Katherine and Edith Rivers, and the Green Ant Creek (TABLE 3). Price et al (2002) estimates that for the Daly River current extraction does not exceed 12% of the base flow[III].

Stream	Number of Licences and purpose	Max. total extraction allowed during May-October (ML)
Daly River	4 – irrigation	1,613
Edith River	1 – irrigation 1 – mining	572 variable
Katherine River	12 – irrigation 1 – domestic	3,199 2,269
Green Ant Creek	1 – irrigation	400

TABLE 3. Water Extraction Licences within the Daly River catchment (after Faulks, 1998).

At least 100 water bores exists in the central part of the catchment. However, because the majority of bores are unmetered, the total groundwater extraction rates are largely unknown.

DEVELOPMENT OF THE DALY RIVER CATCHMENT

History

The Daly River catchment has been shaped by thousands of years of Aboriginal occupation and management. Natural ecosystems changed during this time (for example as a result of bush fires), but retained an outstanding array of wildlife.

The Daly River itself was discovered in 1865 by BT Finniss and named after the Governor of South Australia – Sir Dominic Daly (National Trust of Australia, undated). An early European settlement (Daly River) was established 100 km from the river mouths and the first major attempt to farm in the area was made in the 1880's. A sugarcane plantation was established, but was abandoned after a few years because of to dry weather conditions. More successful was cattle farming introduced at the same time.

After taking control over the NT in 1911, the Commonwealth Government encouraged settlers into the region by offering free land and financial benefits. Unfortunately this attempt was also a failure and the scheme ended in 1916. Most of the settlers had left the area by 1920. A small number of remaining settlers developed moderately successful peanut farming.

In 1955 a Catholic Mission was established in the Daly River settlement providing, among other services, schooling for Aboriginal children and developing agriculture. During the

[III] Jolly (2001, 2002) estimates current water extraction from the Daly River at less than 0.2% of mean annual runoff.

1960's Daly River became an important agricultural community.

White settlement brought significant changes into this region by introducing animals, changed fire regimes and new forms of land use. These changes presented threats to the biological diversity of the area (DIPE, 2003). Despite this, in comparison with other areas, the Daly River region's natural systems are largely intact.

Current Status

Currently, the main industrial developments in the Daly River catchment include tourism and conservation, primary industries (pastoral, cropping and horticulture production), mining and the military. Pastoral activity involves mostly extensive cattle grazing. The majority of properties are pastoral stations engaged in grazing cattle on natural and improved pastures. There is also a small number of arable farms. The agricultural development is concentrated around the township of Katherine, the Tipperary group of stations, Douglas Daly Farms and the Scott Creek.

Until now a total of 2,158 km^2 of land (4.1% of the catchment area) has been cleared. The distribution of the cleared land is, however, uneven. For example, the sub-catchment of the Green Ant Creek has a clearance rate of as much as 59%.

Future plans

Potential for the agricultural development of the central part of the Daly River catchment has been closely examined by the NT Water Resources Division. Irrigation is seen as a tool to significantly increase development and, as a result, several large dam sites were proposed (Begg et al, 2001).

DLPE studied potential irrigable areas for major rivers within the central part of the catchment assuming 80% allocation for the environmental flow. Under such conditions only the Daly, Flora and Katherine Rivers have potential for irrigation using dry season river flows. The irrigation potential of these rivers is 12,000 ha, 4,800 ha and 960 ha respectively, assuming water requirements of 10 ML/ha/yr (DLPE, 1999).

Particularly favourable for the future development is the central part of the catchment (Daly Basin), covered by the Cambrian carbonate rocks, providing ample groundwater. The current development proposal identifies 1,104 km^2 of land as suitable for development and clearing. Further 770 km^2 is also identified as a potentially arable land (Kennedy, 2004).

IMPACT OF THE PROPOSED DEVELOPMENT

Environmental concerns

Large scale development is likely to affect the recharge of groundwater resources. Removal of native vegetation will also increase overall catchment runoff, amplify flood events and initiate soil erosion, leading to increase of sedimentation in the river. Dilshad et al (1996) estimated mean annual soil loss for undisturbed areas within the Daly River catchment at 0 to 2.8 t/ha/yr. The corresponding rate for tilled areas within the catchment ranged from 1.9 to 8.1 t/ha/yr.

Land clearing kills significant portion of wildlife by the action of bulldozers and by loss of food and shelter. Kennedy (2004) estimates that more than 20 million of vertebrate animals would be killed as a result of the proposed clearing.

Land clearing may also trigger invasion of noxious weeds. In particular ecologically aggressive Gamba Grass (*Andropogon gayanus*), which rapidly replaces other grass. Gamba Grass increases intensity of savanna fires resulting in decimation of many flora and fauna species (Kean and Price, 2003). Such 'hot' bushfires also initiate soil erosion during the following wet season.

Finally, naturally very low levels of nitrogen (0.004-0.04 mg/L) and phosphorus (>0.005 mg/L) make the Daly highly susceptible to pollution from fertilisers (Rea et al, 2002).

Social aspect

The Daly River is a significant social asset (Young, 2004). The river is the spatial focus of public use of the area. Tourism, recreational fishing and leisure use are the dominant activities. A market research based on interviewing focus groups in Katherine and Darwin and designed to explore the broader value of the Daly River to a broader public revealed that, while agricultural development is accepted in principle, there are concerns about inappropriate land use, land clearing and over-allocation of water from the Daly River (Market Equity, 2004; Young, 2004).

Indigenous views

Earlier research work on the Daly River catchment (eg. Faulks 1998; Erskine et al, 2003), was conducted without engaging Aboriginal communities.

Jackson (2004) studied Aboriginal prospective of land use and water management in the cental part of the Daly River catchment. Aboriginal people represent a significant proportion of the population in this region. Their values are distinct from a broader society at large. They consider as the most important the social values that promote a sense of security, self-expression, belonging, identity and spirituality. An important aspect is also Aboriginal cultural value of water. Unlike in Western societies, perception of water resources by Aboriginal communities is different. Water has sacred quality and plays significant cultural role.

Aboriginal communities have expressed their concern about the environmental health of the Daly River, particularly from over-use of water, land clearing, and declining water quality in the creeks and rivers; especially from soil erosion resulting in already noted siltation of the lower part of the river. Increased visitation to the area was also a point of concern.

KNOWLEDGE GAPS

Despite of extensive studies of the Daly River catchment, there are significant knowledge gaps requiring further research before the best management practice can be implemented. Many of the gaps are discussed by Begg et al (2001), Blanch (2004), Erskine et al (2003) and Gregores et al (2003). They include:

- Better understanding of hydrology of wetlands;
- Collection of baseline data documenting current bio-diversity as a benchmark to monitor future development impact;
- Study of the effects of proposed land clearing on transport of sediment into the rivers;
- Monitoring movement of agricultural chemicals into rivers;
- Study of flow regimes of the Daly River and its tributaries to set appropriate environmental flows and water licence conditions for large scale agricultural development;
- Research to determine the width of no groundwater extraction zone as a buffer along the river preventing an immediate impact of groundwater extraction on the river flow;
- Review of legal framework for managing and conserving aquatic ecosystems.

In this author's opinion further work should also include:

- Better control on extraction of surface and underground water (metered bores);
- Detailed study of relationship between increased surface runoff and development of sinkholes in the Daly Basin.[IV,V]

CONCLUSION

The NT Government plan to pursue agricultural development in the central part of the Daly River catchment (Daly Basin) initiated a multitude of studies of resource capability and natural values of this region, with an aim to realise its agricultural potential of this in a sustainable manner.

Although a large number of studies addressing a range of issues involving the Daly River catchment have been completed, most of the studies were carried out in a 'parallel' way, without sufficient attention being given to the mutual inter-relation between economic, environmental, social and cultural aspects of the catchment management.

An integrated, holistic catchment management approach needs to recognise such inter-relations and propose a balanced approach. In particular, there is a need for better understanding of the interactions between people and their biophysical environment. Interactions which – on one hand – are driven by human aspirations, but – on the other hand – are ultimately constrained by the low of nature.

Such holistic approach is needed if the integrated management of the proposed developments in the Daly River catchment is to be achieved. For the good of the river and the people associated with it.

[IV] Karp (2002) described 283 karst sinkholes in the Daly Basin. Sinkholes are the points of aquifer recharge, they introduce nutrients to the groundwater which subsequently flows to the rivers. Because of very low nitrates and phosphorus contents in the Daly River such inflow can significantly disturb the river's ecosystem.

[V] My study of karst in the Daly Basin shows recent removal of sediment from previously filled karst caves. This probably reflects recent climate change and will further affect water regime.

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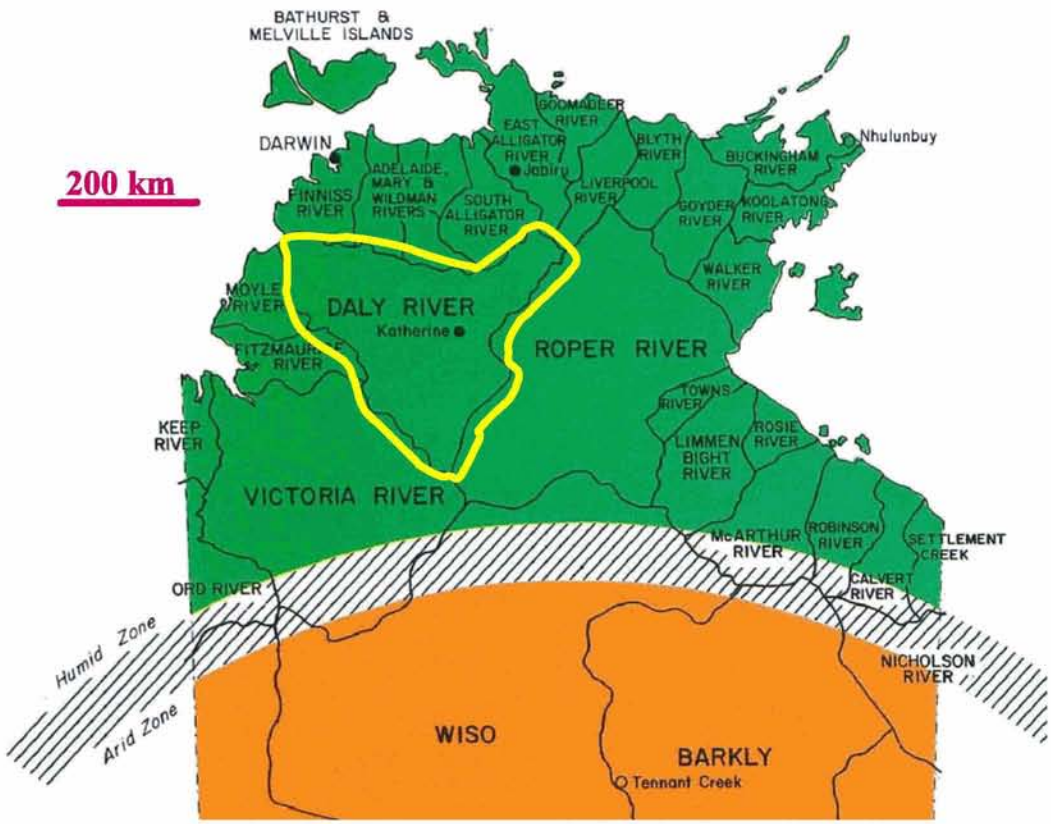


FIGURE 1. River catchments of the northern part of the Northern Territory. The Daly River catchments is highlighted yellow.

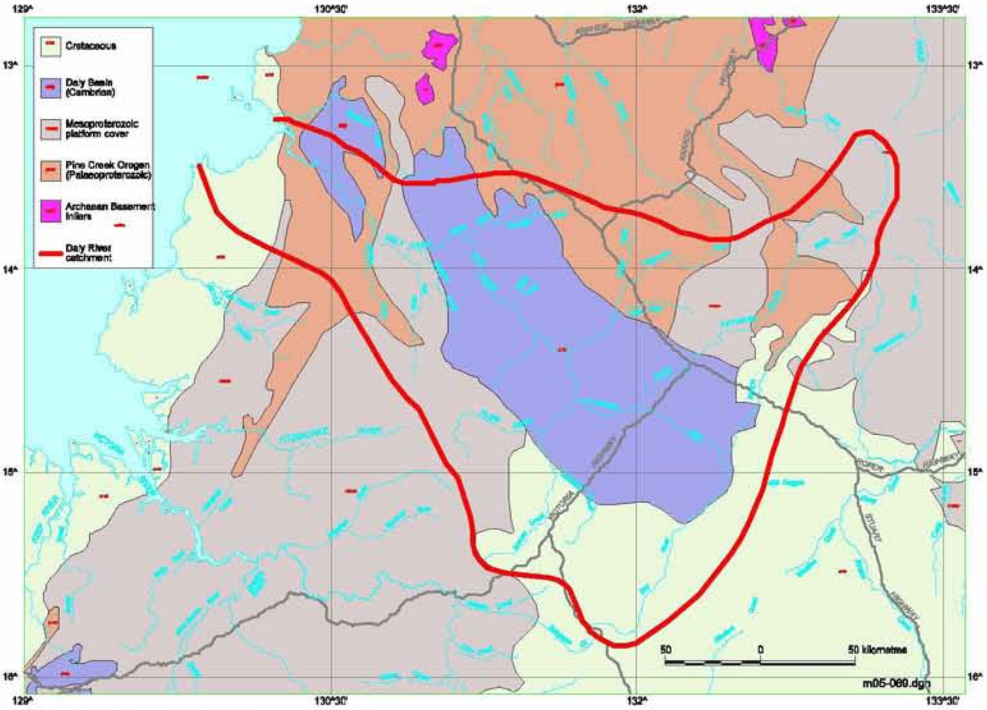


Figure 3. Simplified geology of the Daly River catchment.

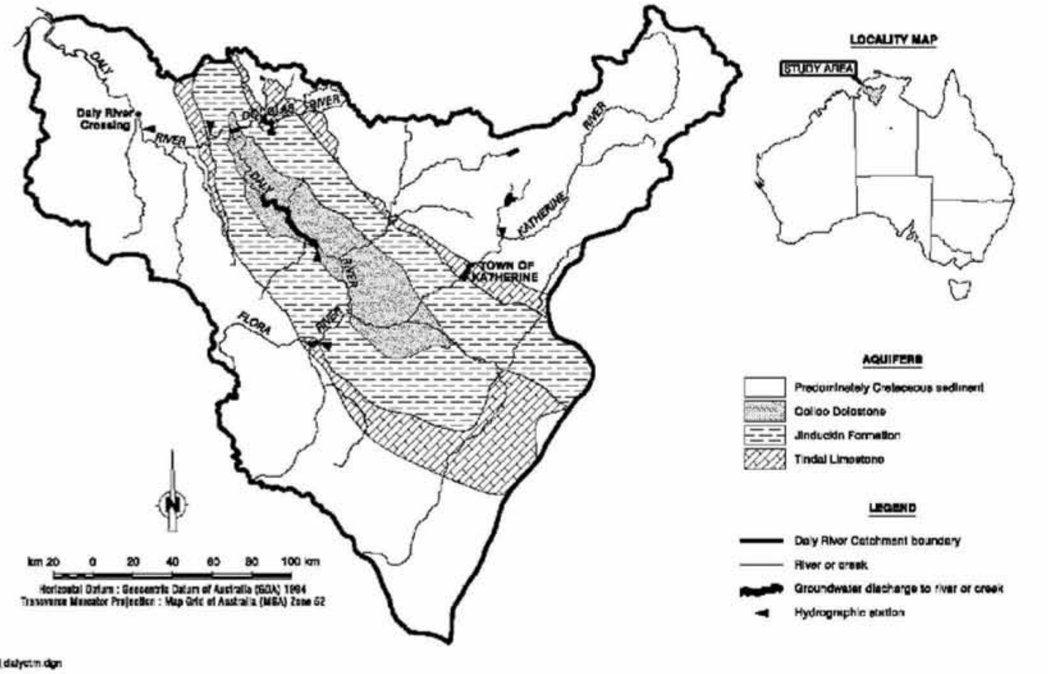
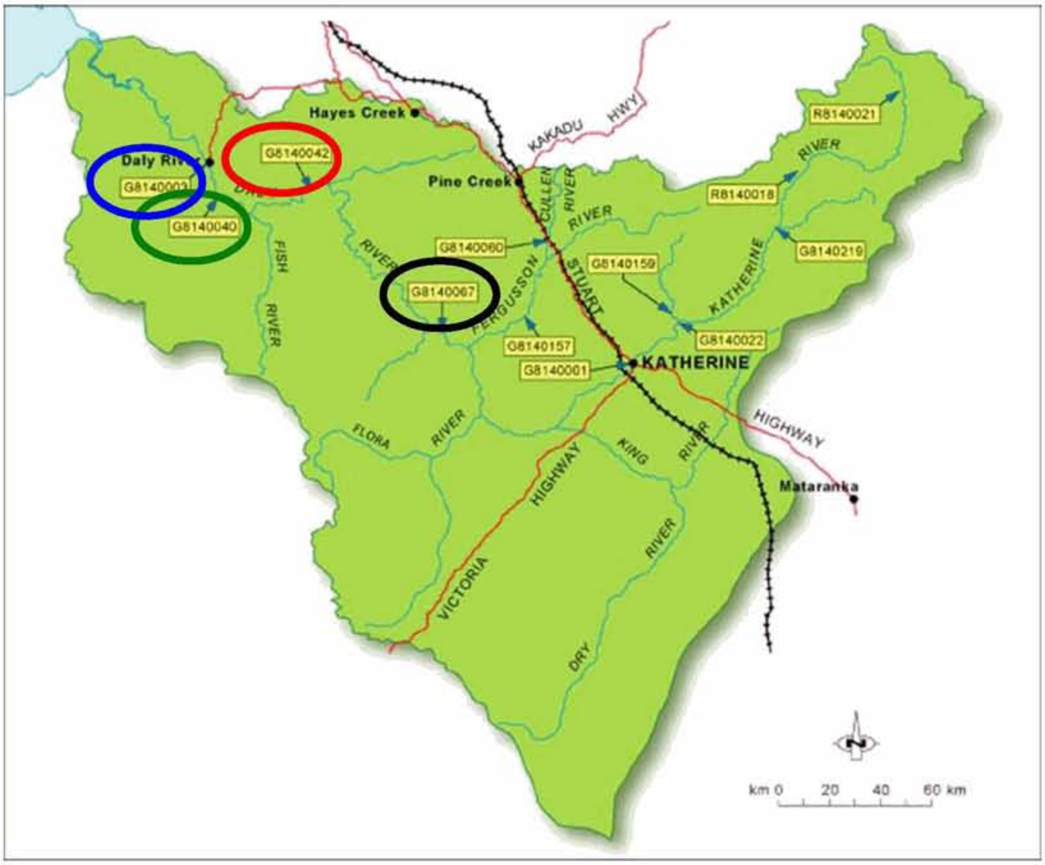


Figure 3. Aquifers of the Daly Basin (curtesy of the NT Department of Naturel Resources, Environment and the Arts).



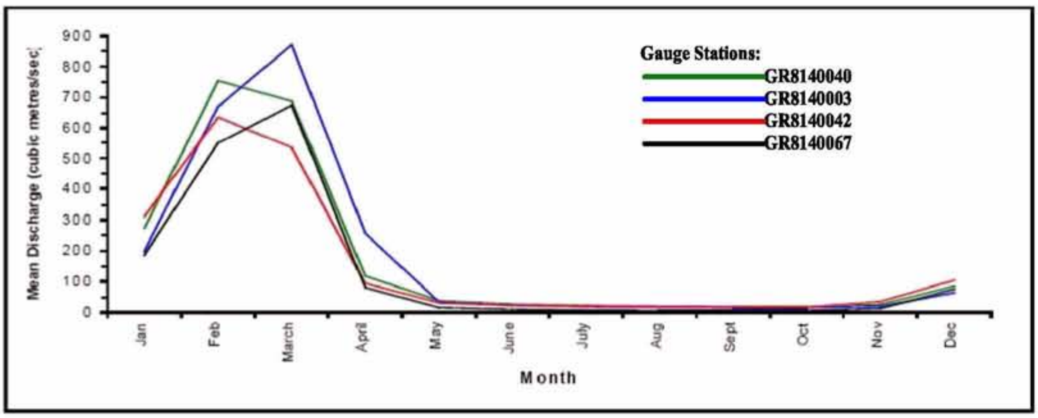


FIGURE 4. Mean monthly discharge from the Daly River recorded at four gauge stations (after Faulks, 1998).