

What happens when the rules change? Stakeholder reaction to the new water allocation arrangements in outback Australia

DRAFT. NOT FOR CITATION

Silva Larson¹

CSIRO Sustainable Ecosystems,
University Drive, Townsville QLD 4814, Australia
Phone: + 61 7 4753 8589; Fax: + 61 7 4753 8650
silva.larson@csiro.au

Abstract:

Several natural resources planning processes are currently underway in Australia, with the Water Reform Agreement 1994 providing a legislative umbrella for the catchment based water planning processes.

This paper presents the result of a case study conducted in the joint catchment of the Diamantina and Georgina rivers. This catchment is unique as it is a major tributary of the Lake Eyre Basin, the world's largest internally draining system covering an area of 1.2 million km². Surface water flows in the basin are characterised by extremely variable seasonal and multiannual hydrology. The resource therefore fluctuates from a state of extreme scarcity to a temporary abundance.

Historic withdrawals and allocation arrangements throughout the catchment have now been formalised through the Diamantina and Georgina Water Management Plan 2004 and the Resource Operational Plan 2005. The paper presents a brief overview of the collective-choice level formal rule creation process followed by a qualitative analyses of the stakeholders' reactions to the rule. Intrinsic valuation of interactions and outcomes and the likely future implementation by stakeholders are also discussed.

Keywords: water management policy, catchment management, Australia, IAD framework

1. Introduction

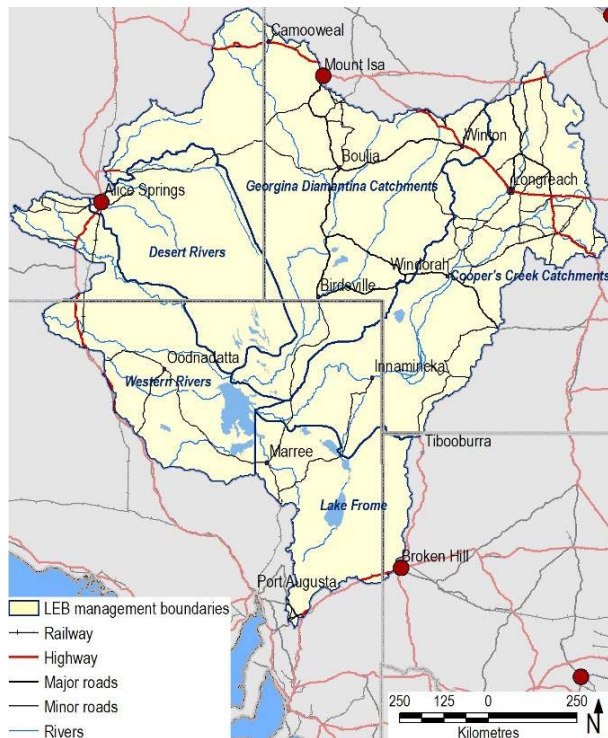
Australia's 'Outback' regions have become the focus of renewed development interests from industry and political spheres. There is mounting pressure for outback regions to explore options for diversifying the use of natural resources and the portfolio of products. Diversifying into growing service industries such as tourism, more intensive agricultural and irrigation developments (Holmes 1996), and potential new international markets for environmental services such as carbon sequestration and biodiversity credits, are seen as options for growth of outback regions (Williams et al. 2004, Faith et al. 2003). These regions also face increasing demands by society for tourism, recreation and biodiversity conservation (Greiner and Larson 2004, Greiner et al 2004, 2005, Smajgl et al 2006) and by Traditional Owners for additional use and access rights (Jackson 2004, Larson, 2006a).

¹ PhD student, James Cook University School of Business, Townsville, Australia

The research project described in this paper is part of a larger project set to investigate the impacts of institutional arrangements and property rights on water allocation and use in tropical savannas and desert regions of Australia. The project is also looking into the applicability of the Institutional Analysis and Development (IAD) framework (Ostrom, Gardner, & Walker, 1994); Ostrom 2005) in an Australian remote setting.

The interest in Georgina and Diamantina catchments as a location for the case study was based on the water management related institutional change underway in the region (Larson, 2006b). The Diamantina and Georgina catchment is unique as it is a major tributary of the Lake Eyre Basin (Figure 1a), the world’s largest internally draining system covering an area of 1.2 million kilometres square, or about 18 per cent of the land area of Australia (Figure 1b). The expectation of an inland freshwater lake drew many explorers into the Australian centre in early 19th century, and by 1870s pastoral leases were formed in the Georgina and Diamantina catchments (Nolan, 2003). However, the rivers of the Lake Eyre Basin have some of the most variable hydrological regimes in the world (Puckridge, 1998). The majority of the rivers in Australian Outback are “dryland” rivers. Dryland rivers typically occur where annual rainfall is less than 500 mm and the annual evaporation rate exceeds rainfall (Sheldon et al, 2003). Both large floods, which breach the banks and cover vast tracts of land, and extensive droughts, where the water in the channel dries back to a few permanent waterholes, are features of Australian dryland rivers. Therefore, from a human perspective, dryland rivers are often unreliable sources of water for development and water supply.

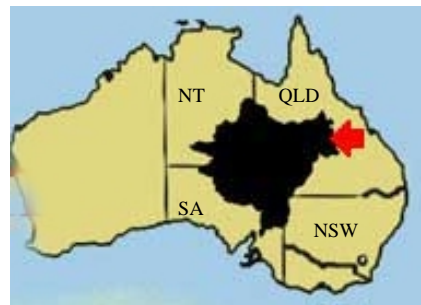
Figure 1. a. Catchments of the Lake Eyre Basin



Source : Herr, 2006

b. Extent of Lake Eyre Basin within Australia

NT = Northern Territory
 SA = South Australia
 QLD= Queensland
 NSW= New South Wales



Source: <http://www.lakeeyrebasin.org.au/>

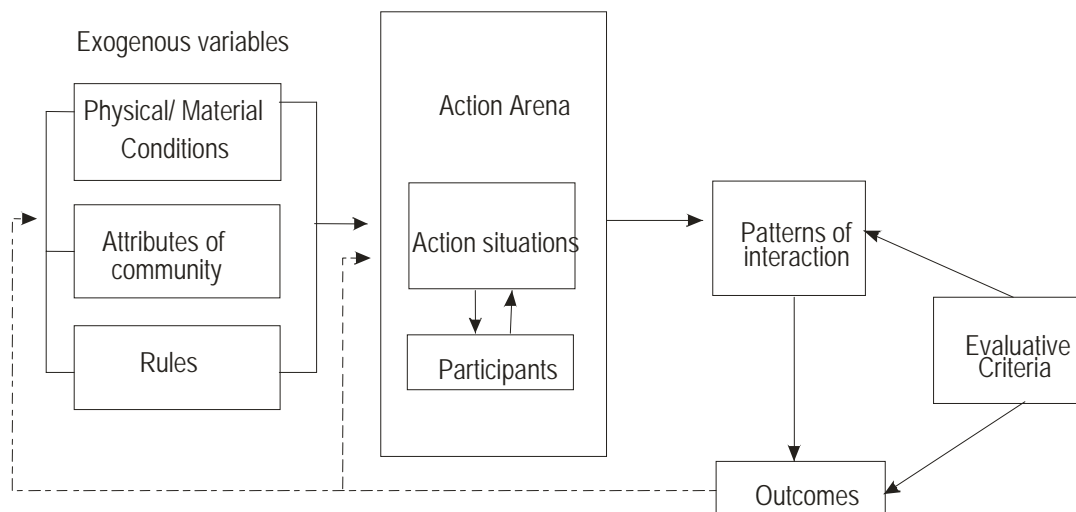
The Diamantina and Georgina rivers provide essential water for stock and domestic purposes in the region, while floods that inundate the floodplain provide essential grazing and nutrient movement for the pastoral industry.

This paper presents insights into collective-choice level Diamantina Georgina water planning processes and particularly concentrates on intrinsic valuations of interaction and outcomes by local community. Methodology used for data collection is summarised in the next section, followed by the description of the exogenous variables and action arena. Intrinsic valuations of interaction and outcomes are presented then, followed by the discussion on the stakeholders perception of the future and potential outcomes at the operational level.

2. Methodology and data collection

The Institutional Analysis and Development (IAD) framework (Ostrom et al, 1994; Ostrom 2005; Figure 2) was selected as an internationally widely applied method for the analysis of the common-pool resources, such as fisheries (Yandle, 2001; Yandle and Dewees, 2003), irrigation (Tang, 1994), forestry (Agrawal 1994; 2000) and groundwater (Blomquist, 1994). It was deemed an appropriate theoretical background for the analysis as water, biodiversity, environmental and cultural values all exhibit characteristics of the common-pool resources.

Figure 2. Institutional Analysis and Development (IAD) Framework



Source : Ostrom 2005, p15

The first part of the research consisted of a desktop study of the key documents related to the water planning processes in Georgina and Diamantina; that is, Water Resource (Georgina and Diamantina) Plan 2004 (State of Queensland, Office of the Queensland Parliamentary Counsel); Georgina Diamantina Water Resource Plan Consultation Report (Water Planning Group, 2004) and the Georgina and Diamantina Draft Resource Operations Plan (Water Planning Group, September 2005).

In addition to the above key documents, the desktop part of the study also included a review of the information and background reports used to support decision-making during the planning process; documentation related to the consultations processes; wider water and

natural resources legislative framework; and strategic planning documents of the regional natural resources management bodies and interface agencies.

The field research was designed to gain insights into the planning process underway. A total of 23 semi-structured interviews were conducted in 2005 with a variety of the water planning process participants; that is, representatives of government organisations, community groups and local stakeholders. Due to the large distance and sparse population of the area, the study concentrated on the investigation of the local stakeholders in the Diamantina Shire only.

The semi-structured interviews lasted around one hour and involved, firstly, the participant being introduced to the project by the researcher, followed by discussion on the institutional arrangements for natural resources management in general. The interviews continued with discussions on the Georgina and Diamantina Water Management Plan and Resource Operational planning processes. The reaction of the interviewee to the new rules proposed in draft resource operational plan and the likely future behaviour at the operating level were also discussed. Guiding questions for the semi-structured interviews are available in Larson (2006b).

3. Exogenous Variables

3.1. Biophysical conditions

The Georgina and Diamantina are transboundary rivers, with the total catchment area of 361,305 km² spreading through the Northern Territory, Queensland and South Australia (Figure 1). The major cross-border water flows are from Queensland into South Australia. The area of the catchments within Queensland state borders, of approximately 266,000 square kilometres or 14% of Queensland land area (Figure 3), is a subject of the current water planning changes discussed in this paper. Water resource planning in Queensland is responsibility of the Department of the Natural Resources, Mines and Water.

Rainfall in the arid interior of Australia is highly variable in timing, duration and intensity, even when compared with other arid regions of the world (Stafford Smith and Morton, 1990). Consequently, Australian rivers have greater variation in flow and flooding patterns than elsewhere on the globe (Williams 1981; Puckridge et al. 2000).

The Diamantina Georgina catchment falls within semi-arid to arid regions, with the annual rainfall variation between around 400 mm in the upper catchments to about 120 mm at the lower, Birdsville end of the catchments (Sheldon, Balcombe, Brunner, & Capon, 2003). Rainfall patterns are summer-dominant, with over 70% falling between October and March. However, the relevance of the annual mean rainfall figures for the arid areas is questionable. For example, *annual* decile one rainfall for the region, based on 106 years on record, is 54 mm, while maximum *daily* rainfall for the same period is 155 mm. Maximum daily temperatures vary from 21°C in winter months (July) to around 38°C during summer period of December to February (ABM, 2005).

The combination of high variability, incidence and total received rainfall results in river systems with extreme variation in discharge and flow duration. The river systems of the Lake Eyre Basin are typically ephemeral, subject to an alternating flood and dry cycle. However, misconceptions about the aridity of the area appear to be as old as the records. Archibald Meston wrote in 1895 in the “Geographic History of Queensland”: “The whole Western country is a network of rivers, creeks, waterholes and billabongs, all subject to tremendous floods, the main rivers spreading miles on both sides of their channels, and submerging the

adjoining country in a wide torrent of muddy water, sweeping all before it” (as reproduced in Nolan, 2003, p9). This certainly is true in the summer months of the “wet” years. However, for the majority of the time, the rivers do not flow.

Figure 3. Georgina and Diamantina water resource planning area



Source: http://www.nrm.qld.gov.au/wrp/pdf/georgina/gd_map.pdf

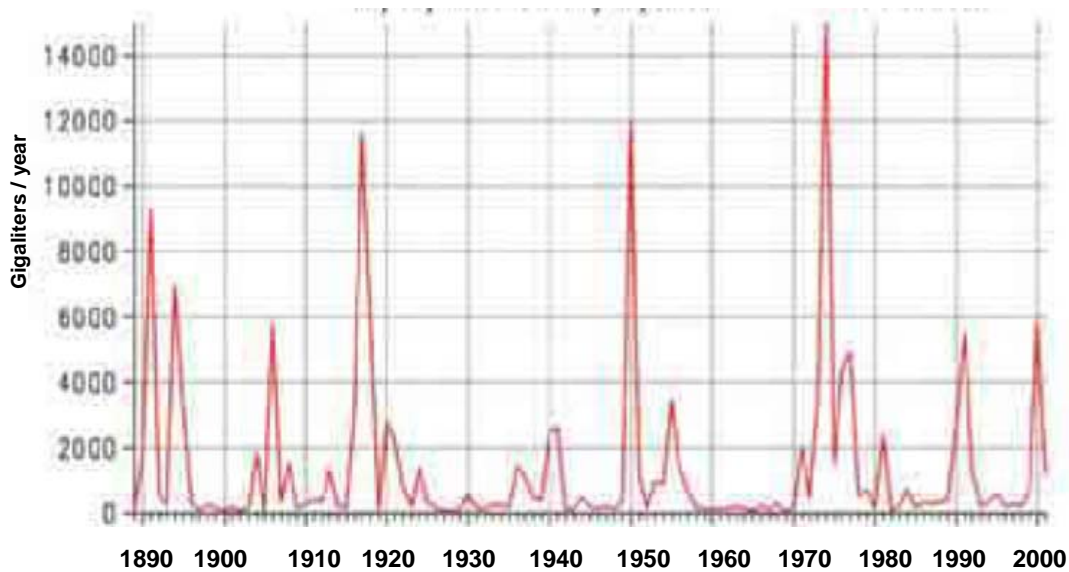
According to Sheldon et al (2003), there was no discharge recorded at the Georgina River gauge at Roxborough Downs for 60% of the time on record. Similarly, the flow duration curve for the Diamantina River at Birdsville gauge indicates that there was no discharge from the river for 50% of time. As an example of a high flow variability in the catchment, Figure 4 presents a hydrograph model of Diamantina River flows at Birdsville, for the period of 1889 to 2001 (from Sheldon et al, 2003, page 58). The cyclical nature of the flows, with flows recorded in the range between 0 and 15,000 gigitalitres (1974 floods), can be observed in the figure.

There are no major regulating structures or areas of extensive water extraction along the rivers and creeks of the Georgina Diamantina catchment. They are among the few remaining wild rivers of Australia (Sheldon et al, 2003).

The catchment contains a wide variety of ecosystems and biogeographic regions. These include sandy and stony deserts, Mitchell grass downs, channel country, floodplains, ephemeral lakes and wetlands. All of these ecosystems rely heavily on the variable drought and flood cycles of their arid and semi-arid environment. Native animals and plants

inhabiting the rivers appear to be well adapted to the flood-drought variability. The ecological integrity of many dryland rivers, particularly in lowland areas, depends upon the periodic lateral movements of water onto the floodplain (period of flooding) and the converse drying out of the channel environment (period of drought).

Figure 4. Hydrograph model of annual flows, Diamantina at Birdsville, for period 1889-2001



Source: Sheldon et al, 2003, p58

Channel country bioregion, which characterises most of the Georgina Diamantina catchment, is estimated to contain 56 ecosystems (Lake Eyre Basin Coordinating Group, 2000), with 8 riparian and floodplain bioregional ecosystems considered endangered or of concern (Sattler and Williams 1999). The region is of very high ecological and conservation value, hosting number of rare, threatened and endangered species of flora and fauna. There is also increasing evidence that the Lake Eyre Basin wetlands are one of the major foci for water bird activity on the continent (Roshier et al, 2001), and 21 wetland in the catchment have been classified as “of significant conservation value” (Sheldon et al, 2003).

Currently, the unique ecology of the Georgina Diamantina catchment is protected through 12 parks and reserves within or partly within the catchment, representing about 3.1% of the total catchment area. Some of these reserves are jointly managed as multi-use reserves; for example, the Simpson Desert Regional Reserve.

The scope of the Water Resource (Georgina Diamantina) Plan (2004) is limited to surface flow, overland flow and hydraulically connected groundwater. However, the most significant and the only reliable water resource in the region is the Great Artesian Basin, a deep sub-artesian resource regulated under separate institutional arrangements and subject to a separate water resource planning process. The Great Artesian Basin covers an area of 1.7 million square kilometres, with the estimate stored volume of 8,700 million megalitres of water. The Great Artesian Basin is currently discharging an estimated 570,000 megalitres of water per

year and is a main source of drinking water for stock, domestic use and industrial water (Great Artesian Basin Consultative Council, 1998).

3.2. Attributes of the community

In 2001, the estimated total resident population of the Plan area was 2,519 persons, representing a population density of 0.009 persons per kilometre square. The largest centre within the catchment is Winton, with an estimated population of 900. The indigenous population comprises 16% of the total population in the Plan area. The overall unemployment rate for the region is lower than that for Queensland (Water Planning Group, 2003, based on 1996 data).

The regional economy of the Plan area is based largely on agriculture and mining, with tourism and public sector employment being the other major contributors.

The pastoral industry is the dominant agricultural industry, with much of the available land used for beef cattle grazing and sheep for wool production. Tenure in the Georgina and Diamantina catchment is dominated by extremely large pastoral leases and mining operations (Water Planning Group, 2003). Approximately 54% of the working population are directly or indirectly employed in the agricultural industry, creating \$66 million of total gross annual value of production (Department of Natural Resources and Mines, 2003, based on 1998–99 financial year data).

Approximately half a million visitors pass through Queensland's "Channel Country" each year, contributing about \$82 million to the Queensland economy (Water Planning Group, 2003). Local estimates are that up to 40,000 tourists pass through Birdsville – population 100 - each year (Shire and local tourism operators estimates, personal communication).

Mining in the Diamantina Georgina catchment is a key contributor to the state economy, with significant regional reserves of gold, copper, silver, lead, zinc, gypsum and opals. Mining activity is estimated to contribute over \$1.1 billion to the Queensland economy each year (Water Planning Group, 2003).

It can be observed from the statistics above that pastoral industry, although being held as the main business activity in the region being the key employer in the region and covering most of the land in the region, is only third in terms of economic returns, after mining and tourism.

The major use of water for economic production is associated with the pastoral and mining industries. Other significant water uses in the catchment include small-scale irrigation for drought preparedness, industrial use, and town water supplies (Water Planning Group, 2003).

The main advantages of living in the Shire were perceived by participants in the study as beautiful landscapes and good lifestyle for families with small children. The main difficulties perceived were lack of high school facilities and other support facilities (recreation, health etc.), poor road conditions, and a high cost of travel, both within the region and to other parts of Australia.

3.3. Rules in use

The institutional history of water in Australia is closely linked to the colonisation and settlement policy of the country and Australia's economic needs (Craig, 2006).

With the establishment of the Australian Constitution and the Federal system of government in 1901, the constitutional division of power left water resources largely within the

jurisdiction of the states. Each state began to develop a narrow approach to water management, allocation and use, by considering the water resources of its territory as its own resources (McKay, 2005).

McKay (2005) compares the underlying paradigm governing water resources development in Australia from the start of the colonisation period in late 18th century to 1990s to the story of “magic pudding”, written by Norman Lindsay in 1918 (as cited in McKay 2005, p38): “...peculiar thing about the magic puddin’ was that, though they had all had a great many slices off him, there was no sign of the place whence the slices had been cut off. The custodians of the puddin’ . . . were always on guard in case it should run away or be stolen by puddin’ thieves”. In other words, growth in water demand was met over time by growth in water supply, through increased capture and development of water resources. The resource appeared endless.

However, by mid 1970s, concerns were voiced about rising scientific and anecdotal evidence of deterioration in the qualities and quantities of the waters in Australia. The concerns grew, and led to several key institutional developments in the early 1990s. The National Strategy for Ecologically Sustainable Development (1992) and the Council of Australian Governments Water Reform Framework (1994), among other institutional changes, have created a new era in approaches to water management. The new frameworks promote markets for water entitlements to improve efficiency but also promote allocation of water for environmental and social needs. Furthermore, since the Water Reform Agreement was signed in 1994, water institutions have evolved to include national and interstate concerns. The key components of the agreement are improving water quality and environment, refining water rights system and water allocation procedures, pricing water through independent review and promoting community participation (Department of Land and Water Conservation, 1998).

The Queensland Water Act (2000) was prepared as a result of the 1994 Water Reform Agreement. The Water Act requires that all catchments in Queensland develop Water Resource Plans. These Water Resource Plans then serve as a framework for the development of the Resource Operational Plans, the subordinate legislations of the Water Act (Larson, 2006b).

The Water Resource (Georgina and Diamantina) Plan was prepared as a statutory requirement under the Water Act 2000 and came into force on 6 August 2004. The objective of the plan is stated as “a framework for the allocation and sustainable management of surface, overland flow water and hydraulically linked groundwater in the plan area, and to meet future water requirements, including the protection of natural ecosystems and security of supply to water users”. Water Resource Plan led to the Georgina Diamantina Resource Operation planning process.

Several other key legislations were relevant to the water planning processes in Georgina Diamantina catchment, such as Lake Eyre Basin Agreement Act 2001; Integrated Planning Act 1997; Environmental Protection Act 1994; Native Title Act 1993; and Mineral Resources Act 1989.

The Queensland Government has also enacted new legislation, the Wild Rivers Act, in 2005. The Wild Rivers Act does not automatically declare or list any river as “wild”; rather, it outlines a process to declare a river “wild” and outlines how activities and future developments will be managed and regulated to preserve the natural values of declared catchment areas. Under the Act, the Minister for Natural Resources, Mines and Water can propose a river for declaration. However, the Act does allow for an extensive consultation process before a river is declared a “wild river”. Several rivers, creeks and waterholes in the

Diamantina Georgina catchment would qualify for nomination as a “wild river”; however, none have been nominated under the Act so far.

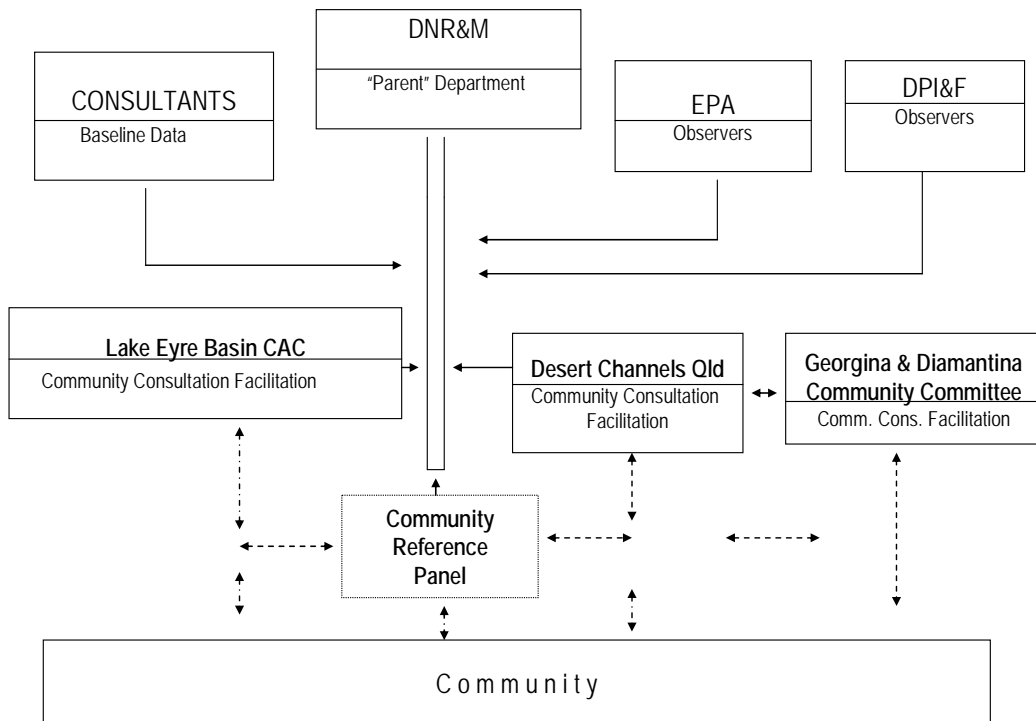
4. Action Arena

4.1. Participants

Water Planning in Queensland is the responsibility of the Department of Natural Resources, Mines and Water. Several other state government departments and agencies, in particular the Environmental Protection Agency and the Department of Primary Industries, have an interest in the planning process and act as observers and comment on the process (Figure 5) .

Natural resources management (NRM) and planning in Australia is facilitated by NRM bodies that act as interface agencies between government and public. Desert Channels Queensland Inc. is such an interface agency, covering the Queensland section of the Lake Eyre Basin. Desert Channels Queensland Inc. has three implementation groups covering the region, one of which is Georgina Diamantina Catchment Committee (Figure 5). In parallel, the Lake Eyre Basin Community Advisory Committee (CAC) covers the natural resources issues and stakeholder interests from the inter-state (Commonwealth) point of view.

Figure 5. Key stakeholders, water planning process



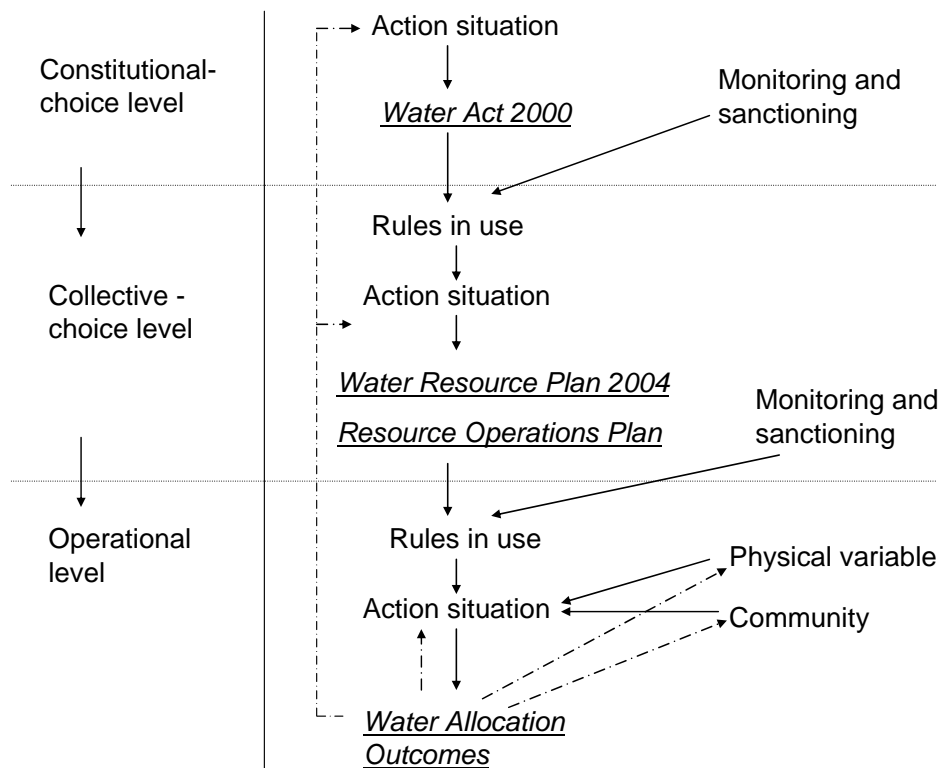
Local stakeholders were involved in the rule-creation process in several ways (Figure 5). The Community Reference Panel, a participative body formed as a statutory requirement of the Water Act 2000, included members from the catchment communities as well as representatives of State and Commonwealth governments. In addition, a Community

Awareness Program, comprising a series of workshops, information sessions and public meetings in population centres within the Draft Plan area was also organised in order to raise community awareness of the water planning process as well as to receive stakeholders' input on issues relevant to the planning process.

4.2. Action situation

The collective-choice level water planning process for the Georgina Diamantina catchment started with the production of the Water Resource Plan, followed by the Resource Operational Plan. Figure 6 presents levels of rule-creation (Ostrom et al, 1994), as they apply to this planning process.

Figure 6. Levels of rule creation, water resources planning process



4.3. Interactions

The consultative part of the planning process was the key formal mode of interaction between the participants in the action arena. The Community Reference Panel, Community Awareness Program and public meetings were used as methods of interaction between participants in the action situation.

Following the release of the draft Plan, public submissions were invited (Water Planning Group, 2004). Two key areas of concerns could be identified in the submissions. One area of concern included calls for the enhanced protection of instream habitats and waterholes, and in particular the importance of the maintenance of the flows that inter-connect waterholes. The other sub-set of submissions dealt with the need for further and more explicit recognition of interstate interests and for integrated monitoring programs across the Lake Eyre Basin. The specifics of the submissions made and consequently updated to the final Plan are summarised in the Georgina Diamantina Water Resource Plan – Consultation Report (Water Planning Group, 2004). Table 1 presents a summary of some of the key issues raised, such as concerns related to the transboundary water flows, levels of consultation during the planning process, lack of data, environment and monitoring.

Table 1. Summary of the issues raised in stakeholders’ submissions to the Water Resource Plan

Draft Plan topic	Number of submissions	Issues raised on the topic
Description of the Georgina and Diamantina Catchments	3	No appreciable change in flooding patterns should occur as the result of the Plan
Assessment of the ecological conditions	10	The Plan did not go far enough in its attempt to protect the natural environment of the catchments
Economic and social profile of the Plan area	12	The draft Plan would affect current levels of economic development by threatening grazing enterprises in Qld and SA, and the developing tourism industry The threat will be in the form of changing flow regimes, flooding cycles and increased periods of no flow Some submissions suggested that additional allocations should be used to enhance the development and lifestyle of those living in the communities
Cultural significance of the catchments	1	Cultural significance of the system should be elevated so that process takes into account concerns of the traditional owners
Community consultation process	10	Concerns that landholders in SA were uninformed about the process and that consultation process needed review
Lake Eyre Basin Intergovernmental Agreement	5	Need for the Plan and Minister to consult with Commonwealth and State governments when considering review of Plan or other changes, including “projects of state significance”
Water resource planning process	13	Concerns regarding the level of consultations Concerns regarding the level of data associated with the hydrological assessment

Draft Plan topic	Number of submissions	Issues raised on the topic
Resource operational planning process	11	Need for the additional water allocation of 12,000MI to be allocated in the fair and equitable manner across the catchments; There was no provision in the Draft Plan to stop a large percentage of total water allocation from being abstracted at a single location Extraction caps for sub-catchments were suggested
Total annual volume of water extractions	11	Additional restrictions need to be placed on the management of overland flows Uncertainly over the total volume of overland flows that could be taken under the Plan provision
Stock and domestic requirements	9	In favour of increased regulation Need for management of town water supply
Provision for mining or other project of state significance	8	Concern about the wording of the Plan section that gives substantial discretion and decision-making power to the Minister and “chief executive”
Provision for irrigation and other industrial use	8	Concern over the level of water proposed for extraction Concerns over DNRM’s ability to monitor and regulate water take
Minimum share of unallocated water	4	This approach might result in increased water take due to utilisation of the full share in fear to lose future water allocations
Future decisions	6	Impacts of the increase in allocations need to be continuously monitored and assessed
Maintenance of cultural and ecological flows	8	Potential impacts of the flow reduction on the significant wetlands and waterholes Need for monitoring
Monitoring of natural ecosystems	9	Data available within the catchments is limited More definite outline of the monitoring framework is needed, in particular monitoring for water quality and biological monitoring
Taking of overland flows	11	Need for monitoring
Metering of water extractions	5	Concerns about the ability of the DNRM to manage the system at a level which community would have a confidence in

DNRM = Department of Natural Resources and Mines, now Department of Natural Resources, Mines and Water

SA = South Australia

QLD = Queensland

4.4. Outcomes

The draft Georgina Diamantina Resource Operational Plan (the Plan), the result of the planning process described in this paper, is a collective-choice level set of rules that specifies rules to be applied at the operational level of the analysis, as presented in Figure 6. This section discusses the *types* of rules employed in the collective-choice level draft Plan. The water allocation outcomes at the operational level will depend on the interactions of the players at the operational-level action area. However, based on the existing body of research, we can hypothesise that a good combination of rules will provide a better chance for reaching the sustainable use of water objectives of the Plan (Ostrom, 2006).

The outcomes of the planning process, as well as the analysis of the Plan in relation to the Design Criteria (Ostrom 1992, Ostrom 2005), are described in detail in Larson (2006b) and summarised here:

- Boundary rules. The boundary rules proposed in the draft Plan appear to be rather specific and clear. The rules are based either on the appropriator's relation to the resource itself and other related resources (landholders and resource operational licence holders) or on the appropriator's attributes (local government or water authority). The entitlement to apply for the water allocation is specified in the Plan as that defined in the constitutional level rule-in-use, Water Act 2000 (see Figure 6).

- Position rules. There appear to be two general positions in the future water allocation action situations. One position is that of the "applicant". The actual rules of the applicant's position are specified for each relevant water category, and all applicants must first be compliant with the relevant boundary rule. The other position is that of the legislator or "chief executive", a decision-making position.

- Choice and scope rules. Choice rules specify actions, that is what a participant "must, must not or may do" (Ostrom and Crawford, 2005, p 200). Scope rules are similar to choice rules, as they also deal with "must, must not and may do" options; however, scope rules do not deal with action but rather specify outcomes. Part 4 of the draft Plan, dealing with the conditions of new water licences, is a combination of choice and scope rules.

Several Sections in Part 4 specify actions that "must", "may be" or "must not" be taken. The choice rules are supplemented with scope rules, such as those specifying the protection of key waterholes (Section 71- Conditions for the take of water from a waterhole).

- Payoff rules. Payoff rules directly impact upon costs and benefits of action or outcomes for actors in action situations (Ostrom and Crawford, 2005). Pricing of the water to be allocated under the Plan will be based on two separate well-defined mechanisms. An auction, with the bidding process determining the price, will be used to determine the price of large allocations under Category A water. A tendering process and fixed pricing will be used for smaller allocations specified as "Category B" water. Penalties, fines and sanctions for rule-breaking behaviour are specified on the constitutional level of the Water Act 2000.

- Information rules. There appear to be no rules regarding obligations, permissions or prohibitions to communicate between the participants holding the same position in potential future action situations. Rules regulating communication between the "applicant" position and the "chief executive" position however do appear in the Plan.

- Aggregation rules. The aggregation rule is one area of the draft Plan that has received repeated criticism from the stakeholders, both in written submissions (Table 1) and during the field work interviews. The stakeholders have expressed concerns about the lack of

aggregation rule in the Plan. This lack of rule is manifested, in their view, in expansive rights granted to “Chief Executive” position in decision-making.

5. Intrinsic valuation by local community

The outcomes of any action situation depend to a large extent on the evaluative criteria used by participants. Ostrom (2006) argues that outcomes are a function of physical outcomes, external valuation, and participants’ intrinsic valuation.

Data collected during the field-work part of the analysis provides insight into the intrinsic valuation applied by local stakeholders in relation to the consultative part of the process (interactions) and the rules created (outcomes). The interviews were conducted with stakeholders from Diamantina Shire only, and therefore represent opinions and interests of communities inhabiting lower reaches of Diamantina and Georgina rivers only.

5.1. Intrinsic valuation of Interactions

5.1.1. Intrinsic valuation of Interactions by community at large

Community Committees and the Community Reference Panel were viewed by the local stakeholders as the key vehicles for interaction during the planning process. The Committees are seen as representing a “*reasonable blend of people*”, providing for a mix of economic sectors and geographic locations (representation throughout the catchments from both towns and country).

The consultation process was perceived as dominated by two extreme points of view. One group favoured additional allocation to be as high as possible in the upper reaches of Diamantina and Georgina (Burke) rivers. This point of view was regarded as being “*based on economics*”, where the preferences of the landholders in the upper reaches were driven by security and the protection of the investment (“*to be sure they protect what they have*”) concerns.

The other group lobbied for the “*natural river*”. This point of view was mainly coming from representatives from the lower reaches of the Georgina and Diamantina. The key desired outcomes of this group have been summarised as “*the less interference the better*”; “*natural processes are good*”; and “*community wants more water to flow through; as much as possible*”.

Overall community perception of the Plan proponent, the Department of Natural Resources, Mines and Water, is that the Department is “*strongly pro-development*” while “*community wants more natural processes to rule*”. The additional allocations originally proposed by the Department were actually decreased as a result of the consultation process.

There was a concern about the fact that attendance at the meetings and overall participation in the process continued to drop throughout the process. The comments were made that “*people are spread too thin as there are too many meetings*” and that it is “*hard to decide which ones to attend.*”

5.1.2. Intrinsic valuation of Interactions by Aboriginal stakeholders

The concern that Aboriginal interests were potentially under-represented and that the Aboriginal people might not be satisfied with the process were voiced by several stakeholders and were therefore further investigated.

Some of the main criticisms voiced by Aboriginal stakeholders were:

- Feeling of being invited only to support other's point of view; "*so the minutes say 'indigenous population was represented'*"; feeling of being used;
- The points made by Aboriginal representatives "*never got into the minutes*"; "*Name in the minutes was the only input*";
- Feeling that their presence made no impact; "*What Aboriginal representatives had to say did not make any difference*";
- People dropped out as "*the attitude was that whatever happens must suit us too*".
- "*All white requests are reasonable; all Aboriginal requests unreasonable.*"

The criticism of the workshops organised by the Department mainly relates to the inappropriateness of the language and methods used. The workshops organised were not "*at the mob level*" and did not give a true opportunity for all Aboriginal people to participate. The interviewees were of opinion that there should be a special process for Aboriginal people where they will be comfortable to express their opinions, "*to say what they think*"; and then "*that can be taken into a big picture*". The overall comment on the workshops was that they were "*too high-tech*" for indigenous people; that "*people sat there like glazed apples*" as the content presented was "*hard to understand*"; and that the other participants in the process and the mediator were using "*words the size of America*". It appears that most of the families did not attend the workshops as they felt intimidated by the level of conversation at those meetings.

This gap is also apparent in the comments about submission process: "*Mob can hardly read the plans, where do we even get the plans from?*"; "*Company managers (mining and grazing companies) are directed to read and submit (comments on the draft Plan) and payed to do it. No one will finance or help Aboriginal people to prepare a submission.*".

One of the interviewees summarised the consultation process like this: "*Once it comes back as a rule, they say 'you had a chance to input', but in reality, we did not have any chance at all.*"

5.2. Intrinsic valuation of Outcomes

This part of the interview concentrated on the allocation process as a "new rule" or a final output of the planning process. The key point of discussion was on the perceived outcomes of the new rule creation, and the perceived potential future impacts on the region. Several distinct types of concerns were put forward and are discussed in sections below. All of them, however, are centred on one main theme: the importance of floods to the viability of the lower Diamantina and Georgina region.

5.2.1. Economic concerns

In general, the opinion of the pastoralists in the region was that "*What is good for the environment is good for us*". They stressed the heavy reliance of their production cycles on

natural floods of the Georgina and Diamantina rivers (*“Pastoralists depend on floods”; “Rivers feed us”; “Lower reaches of the rivers depend on nature; live with nature”*).

As discussed in the section on exogenous variables, the production system of the lower Diamantina and Georgina river depends on the floods as they revitalise the pastures by bringing both water and nutrients to the soils. Therefore, the economic interest of the pastoralists in the area is to maintain the waters in the river (maintain the floods), rather than to extract it. The flood years are viewed as *“good”* ones, the years that allow for maximisation of the profits. The floods are perceived as crucial for the continuation of the farming and for wealth creation.

A key determinant that kept on coming into the discussion was the size and economical viability of the farms. It was repeatedly pointed that farms in the lower reaches of the Georgina and Diamantina are large and economically viable and that therefore they can *“afford to be good”* (i.e. active in conservation programs, such as recent registration of the parts of the North Australian Pastoral Company (NAPCO) owned Marion Downs with the Land for Wildlife program (EPA, 2002)).

It was stressed on several occasions that Diamantina and Georgina catchments are different from coastal regions in that *“seasons dictate management and not the other way around where farm management dictates seasons and activities”* and that one *“cannot escape the weather or landscape”*. The region is viewed as *“too big and too raw”* to impose *“humans”* over it.

There was also a general consensus that most of the pastoralists in the region run their cattle numbers conservatively and that they are aware of environment. Communication technology, availability of transport and the fact that majority of the properties in the region are owned by large stock companies that can easily mobilise cattle to another property, are seen as key drivers allowing for better stocking rates (*“if they (earlier generations) had stock on and it went dry, stock had to stay on; now with phones and cars it is easier to send cattle out”*). The community is also proud of the effort many pastoralists in the region have put into sustainable management of the Great Artesian Basin water, through capping of the artesian bores, piping and dam rehabilitation (*“artesian levels are rising, some springs are starting to flow again”*).

The perception of the tourist operators in the region was similar: *“If we lose floods we will lose tourists”*. The perception is that what draws tourists into the region is the amazing dynamics of desert transformed by the floods and the ecosystems that develop around the floods, such as proliferation of the bird life and flowers. Just like pastoralists, the tourist operators *“did very well”* during the last flood (2000/01; see Figure 4, Hydrograph model of annual flows, Diamantina at Birdsville).

Mining sector was perceived by local stakeholders as needing to be *“controlled and monitored”* as *“they tend to have their own rules”*. The mining sector was perceived as the major water user in the region, and was held responsible for poor water management and decrease of the artesian water levels. Apprehension was expressed by most stakeholders about the impacts of the opening of new mines in the region – seen as the reason for reserving water allocation for the ‘project of the State significance’ in the current Plan.

5.2.2. Environmental concerns

The number, seriousness and variety of environmental concerns voiced by interviewees and related to the changes in water allocation rules were overwhelming. Similar concerns were

voiced by all sections of community: town residents, Aboriginal people, pastoralists, tourism operators and services providers.

The overall mood expressed might be summarised that it is *“nice to let the river run”* and *“the more the better”*. *“People want to leave country as it is”* and that *“we survived this long (without state interventions or “improvements” to the system), we must be doing something right”*.

The main concern of the interviewees was that the additional allocations of water in upper reaches of the rivers will have a negative effect on the ecosystem, in particular on the lower reaches. The link between ‘ecosystems’ and ‘removal of water’ was made by all interviewees and it was stressed by several that *“environmental values are important to people”* and that *“people are aware of the environment; they are very concerned about impacts; they understand and appreciate the country”*.

As the region has extremely low rainfall, it depends on flood waters to bring the seasonal changes in water flows and resulting change in ecosystems. The sentiment therefore was that: *“The way river runs now should not change”*; *“Lower Diamantina needs floods”*; *“Floods feed the country”*; *“We want water in the river, we want floods”*; that *“Floods are not too often but they should flow”*; and that there *“Should not be water taken out in the first place”*.

The floods are not perceived as important to the ecosystems only, but also important for the wellbeing of the regional population. *“Floods change everything and everyone, even people – everyone is happy”*; *“Birds are important to people, just seeing them come with floods”*.

It is also perceived that water management should be enhanced by *“better conservation practices upstream rather than taking away what we need here”*.

Another concern expressed was that of water quality. Water quality was perceived as *“perfect now”* and the community was very concerned about pesticide and herbicide pollution should any crop growing go ahead in upper reaches. *“Do we know the impacts?”*, *“Do these things cumulate?”* were some of the questions that will be further discussed in the precautionary principle discussion below.

5.2.3. Precautionary principle concerns

Another area of concern overwhelmingly expressed by stakeholders interviewed could be best grouped as ‘Precautionary principle concerns’. The ‘Precautionary Principle’ is one of the key principles of sustainability, stipulating that:

“in order to protect the environment, a precautionary approach should be widely applied, meaning that where there are threats of serious or irreversible damage to the environment, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”

(ETC/CDS General Environmental Multilingual Thesaurus, English definition, 2000)

“The precautionary principle permits a lower level of proof of harm to be used in policy-making whenever the consequences of waiting for higher levels of proof may be very costly and/or irreversible.”

(EEA - European Environmental Agency, 1999, p278)

Typical examples of precautionary principle concern expressed during the interviews – concerns about potential currently unforeseen impacts that water withdrawals might cause in the future - are presented here:

- *“People do not know the science behind all this. Does the government?”*
- *“We do not know how it works, but we feel that this is a right thing to do (maintain the natural system), we do not want to interfere with nature.”*
- *“Ecosystems here are very vulnerable, and very understudied.”*
- *“We do not know what is going to be affected.”*
- *“There are cycles - how long can certain species go on without water? Do we know?”*
(several species in the desert environment, such as burrowing frogs, burry themselves and hibernate between the floods, and can be observed almost immediately after water passes over their hiding places (Tyler, 1997; Nakamarra, 2005)).
- *“People are worried when someone wants to mess with the environment.”*
- *“Ecology of the area is understudied. Who should do something about it?”*
- *there is an “Awful lot we do not know and should not experiment with.”*
- *“Rare scientists come to the region, they do not know what is going on in this region; most of their ‘findings’ and conclusions are based on other parts of Australia and not on data collected in this region.”*
- *“This is a unique system and data translated (from the coastal regions data of Australia) has little meaning in local conditions.”*
- *“This is a fragile show, good soil but not enough water; too much pressure would break it.”*
- *“Country mainly looks after itself.”*
- *“This is a very fragile country, we have learned how to live with it.”*
- *“If we push it too hard it will break on us.”*
- *“You get one good season in 4-5 years, you can’t flog it.”*
- *“In 125 years (of the settlement of the region and the observance of the conditions) water has gone past Big Red five times – even one per cent increase in allocations might make a difference there!”* (Big Red is one of the Australian icons, a large red sand dune some 40 km west of the township of Birdsville)
- *“Committees are spending millions to bring the nature back to the way it was...why not keep it as it is in the first place?”*
- *“We do not know enough about environment as it is.”*

5.2.4. Equity issues

Strong sense of equity was also present in all sectors of the community. The two main axes of equity were perceived as upper versus lower reaches of the river; and rich and powerful versus poor:

- *“People down bottom end need the water; that is common sense.”*
- *“People up top should not be taking it all away.”*
- *“It is not fare to take the water out; people need it down there.”*
- *“People with most money end up with everything.”*
- *“They have power and influence; they buy more and more water”.*

Another concern repeatedly voiced was about the extent of the powers granted to the ‘chief executive’ position in the draft Plan. *“Chief executive has a lot of powers”*; *“Lots goes through him in the Plan”*; *“(the Plan) needs a Board or other more transparent, less biased system”* were some of the concerns about lack of transparency and concentration of the power perceived in the Draft.

5.2.5. Specific concerns of Aboriginal participants

One of the key concerns about the planning process outcomes of the Aboriginal population interviewed in the Diamantina Shire was that *“no one wants to take culture seriously”*. Aboriginal cultural value of the water is not restricted to the specific geographical locations of spiritual significance only, *“special places on the river”*, but also encompasses the very presence of the water (intrinsic value). There was a concern that the Aboriginal people appeared not to be recognised as using water; their stories, their culture, the important place water plays in those, do not receive sufficient acknowledgment (*“The water is blood line of the Aboriginal people and culture in this part, there is no recognition of that in the Plan”*). They argue that *“All water was created by serpents, spirits and ancestors of Aboriginal people, the water and landscape are here because they were created by Aboriginal ancestors”* and that *“Once water is gone from river Aboriginal people lose everything, food, culture, home – it is not just water!”*.

Although the historical original Aboriginal traditions are mainly gone and are not practised any more, the Aboriginal people in the area expressed the desire to preserve things that are still there. The example of the places they would be interested in preserving were the remains of the traditional camps on permanent waterholes of the region. The concern was that *“Cattle are tramping over the camps and historic sites when accessing water, would be good to see the sites fenced-off”*.

In conclusion, the Aboriginal people were disappointed with the planning process as *“Mob wanted to see something come out of it; and nothing came out of it”*. It appears that two main outcomes were hoped for. One desired outcome was a greater understanding of and respect for the culture values of water to Aboriginal people in the region (*“everyone to begin to understand aboriginal people and how they see the land; to understand how the land and people of Australia were created”*). The other desired outcome voiced was for Aboriginal people to have specific set allocations that could be used for business development purposes (*“Maybe there should be a clause (in the Plan) saying: ‘water available for aboriginal business opportunities’ or something like that”*).

5.2.6. Monitoring

Lack of robust monitoring arrangements and provisions is seen by stakeholders as one of the main design failures of the new Plans.

- *“How is this going to be regulated?”*
- *“Who will control ‘topping up’”? (of the water storage infrastructure on farms)*
- *“If there is only one major operator it will be controllable, but if system grows, it might become major issue; who will enforce a complex system out here?”*
- *“It will have to be based on trust at the end.”*
- *“They have opened a can of worms.”*

- *“How do we know which areas are to be affected by take? How big is allocation compared to total water? How do you assess the flows? Water here meander, there are pools of water – it does not necessarily flow...”*
- *“You want to be sure you are measuring it accurately.”*
- *“How are they going to monitor river flows and on farms uses?”*

Enforcement is particularly difficult due to the extremely large area of the catchments and the properties, and poor to no accessibility to most parts of the properties.

6. Perception of the future: potential outcomes at the operational level

This section presents potential outcomes of the application of the allocation rules at the operational level. The outcomes presented are short fictional narratives of potential occurrences in the future, and are based on field work data collected during the study. The reactions of the stakeholders to the rule, stated likely implementations of the rule and perceived potential ecological changes in the region are grouped into four potential outcomes. The key purpose of these narratives is to facilitate discussion and creation of the scenarios of the future with the key stakeholders.

The target year for the scenarios is 2015, the final year of the current 10-year Water Resources (Diamantina Georgina) Plan. The following narratives present potential situations at the operational level at that time:

- **Business prosperity:** All the additional allocations are used up and active water trading is under way in the region. The additional water is being used by landholders and business operators for diversification and supplementation of the existing income streams. The main uses of the water in the upper reaches of the rivers are small-scale irrigation developments, in particular in upper Diamantina, and the development of new industries such as farm forestry, aquaculture and eco-tourism ventures, in particular at Ham and Burke rivers and the upper Georgina. The tourism in the region is booming, and the water allocations from the lower reaches are being used mainly by local businesses for newly developed tourism infrastructure. An organic-meat abattoir and market gardens have also been established in the region to serve both growing local tourist industry demand and national/international demand. An extensive yabbie farm is being operated by Aboriginal people, and they are also increasingly employed in the booming tourism industry.

There appear to be no negative impacts on the environment and ecosystems so far, however, the monitoring programs established early in life-cycle of the Plan will continue.

- **Pushed too hard:** All the additional water was allocated within 6 months of the start of the Plan. Vigorous trading ensued, and the prices of water were reaching unforeseen heights within 2 years of the Plan coming into the force. Five years into the plan, due to extensive lobbying, state has decided to double the amounts of water for allocations. A large cotton farm has been created in the upper Diamantina and has resulted in building of a large dam and irrigation reservoir. The new mining operation that opened in the upper Georgina has managed to obtain increased allocation as a “project of state significance”. However, by the end of the Plan period, the communities in the lower reaches of the rivers are starting to feel the change. Farms are reporting lower productivity as the number of cattle land can sustain is decreasing. Several waterholes have dried out and the tourism industry is struggling to attract the visitors.

Ecological monitoring is showing a decrease in numbers of birds and mammals in the region. Rumours are circling about pesticide residues in Diamantina Lakes and high levels of heavy metals in fish taken in the upper Georgina.

- Security first: All the additional allocations have been purchased. However, most of the allocations were purchased as a security measure and the water in neither used nor traded. The new rules have created only costs in terms of paying for the water allocations, but no apparent economic benefit. In addition, metering and pricing on the existing water infrastructure and of the town water has enhanced the stress on the least viable farms and most vulnerable residents in the townships. Social relations have suffered as a result of the lack of trust precipitated by the rush to purchase additional water for safety purposes, as well as by increased vulnerability of some of the residents.

Most of the water pumped from the rivers is stored in the large dams, creating huge evaporation losses. Although some environmental benefits have been created in the immediate vicinity of the dams, there is anecdotal evidence that some of the waterholes have lost their connectivity and that floods are not travelling as far overland as they used to.

- Business as usual: Few water allocation licences were taken early into the life of the Plan in the upper reaches of Diamantina and Burke; however, the majority of the water is still unallocated. It appears that an informal agreement has been reached between the majority of the pastoral companies in the region not to purchase any water. As a result of the high social cohesion in the region, the agreement is holding and the status quo similar to the pre-Plan situation continues. The tourism boom continues, however water needs for new tourism development are met from the Great Artesian Basin via city infrastructure supply. The population is increasing, mainly as a result of the tourism boom, and the tourism is also increasingly employing the local Aboriginal population.

There appear to be no negative impacts on the environment and ecosystems so far, however, the monitoring programs established early in life-cycle of the Plan will continue.

Scenarios can be used as a systematic method for thinking about uncertain, complex futures. They reveal dynamic processes and casual chains leading to different outcomes of the futures (Alcamo, 2001). The United Kingdom Environmental Agency (2005) defines scenarios as “a method of forecasting possible states of the environment under a range of plausible future conditions”. Scenarios help in understanding key drivers, their potential interactions and effect in the future. Scenarios go beyond a single best estimate and encourage exploration of a number of different, logically-consistent pathways as a way of framing questions about the future (Larson, 2005). Future scenarios are based on an underlying set of trends present in the given society/area (Bertrand et al, 1999).

As mentioned, the key purpose of the above four narratives will be to elicit stakeholder responses. The narratives will also serve as the starting point in the creation of the scenarios of the future with the key stakeholders. In addition to the short narratives, the Millennium Assessment conceptual framework will be used as a starting point of discussion on key drivers (Millennium Ecosystem Assessment, 2003), while the game theory (Ostrom, 1990, Ostrom et al, 1994) will further the predictions of the potential reactions of the participants. Expert opinion will be sought on the likely ecological changes.

This part of the study is expected to be completed later in the year.

7. Conclusions

The Institutional Analysis and Development (IAD) framework (Ostrom et al, 1994; Ostrom 2005) was applied in an outback Australian setting in the case study of current water policy reform. As in many other countries (Saleth and Dinar 2004, 2005), this institutional change is more a result of purposive reform programs than a natural institutional evolution processes.

The exogenous variables are key determinants of any action arena. The formation of rules in the field setting depends to the great extent on the biophysical structure of the resource being regulated and the shared norms of the community they are going to apply on. Furthermore, rules in use determine the scope of the situations and actions that can be taken. As we could see from the development of the natural resource management in Australia (McKay, 2005), and as expected from the studies elsewhere (Ostrom, 2006), one of the first challenges is to accept that the resource is limited.

The Water Resource (Georgina and Diamantina) Plan 2004 and the Georgina and Diamantina Draft Resource Operations Plan have resulted in the creation of a new set of rules for water resource users. An analysis of the types of rules specified or referred to in the Plans indicates that most have been used in the planning process. Boundary, position, choice, scope, payoffs and information rules are either specified in the Plan or referred to the relevant sections of the Water Act 2000, constitutional level rule-in-use. Concerns were, however, expressed by the stakeholders on the apparent lack of the aggregation rules. This lack of rule is manifested, in their view, in expansive rights granted to the “Chief Executive” position in decision-making.

The outcomes of any action situation depend to the great extent on the evaluative criteria used by participants. Data on the intrinsic valuation of the interactions and outcomes were collected during the field study. The key concerns of stakeholders were in the area of economic benefits, environment, equity issues and monitoring. The stakeholders also appeared deeply concerned about the creation of a rule based on limited sets of baseline information available, particularly bearing in mind the fragility of the desert and semi-desert environments.

One difficulty in performing the state or nation-wide planning processes is that the resources tend to differ on key parameters from similar resources in the wider setting. In the case of expansive areas of Australian Outback, only limited sets of knowledge and data are available and considerable uncertainties remain. Therefore, application of the “precautionary principle” and greater integration of local knowledge into the overall knowledge systems appear to be prudent actions to take.

Data collected during the field study was also used to create four short narratives of potential situations in the planning region in 2015, the year of expiration of the current plans. The narratives will be used as a starting point for creation of potential scenarios for the plan outcomes at the operational level.

Acknowledgments

The author wishes to thank all the stakeholders consulted, in particular the local community of the Diamantina Shire, Desert Channels NRM Board, Diamantina Georgina Catchment Committee, Lake Eyre Basin Community Advisory Committee, and Queensland Environmental Protection Agency and Department of Natural Resources, Mines and Water.

Funding for this study was provided by Desert Knowledge Corporate Research Centre (DK-CRC, <http://www.desertknowledge.com.au/>) and the Commonwealth Scientific and Industrial

Research Organisation Division of Sustainable Ecosystems (CSIRO CSE, <http://www.cse.csiro.au/>).

References

- ABM (Australian Bureau of Meteorology) (2005). Available online at: http://www.bom.gov.au/climate/averages/tables/cw_038002.shtml.
- Agrawal, A. (1994). Rules, Rule Making, and Rule Breaking: Examining the Fit between Rule Systems and Resource Use. In Ostrom, E., Gardner, R., & Walker, J. (eds.), *Rules, Games, and Common-Pool Resources*. (pp. 267-82). Ann Arbor: University of Michigan Press.
- Agrawal, A. (2000). Small Is Beautiful, but Is Larger Better? Forest-Management Institutions in the Kumaon Himalaya, India. In Gibson, C., McKean, M., & Ostrom, E. (eds.), *People and Forests: Communities, Institutions, and Governance*. (pp. 57-85). Cambridge, MA: MIT Press.
- Alcamo, J. (2001): Scenarios as tools for international assessments. Prospects and Scenarios No 5, Environmental protection Agency, Copenhagen,
- Bertrand, G., Michalski, A. and Pensch, L.R. (1999): Scenarios Europe 2010: Five possible futures for Europe. Forward Studies Unit, European Commission, Working Paper
- Blomquist, W. (1994). Changing rules, changing games: Evidence from ground-water systems on Southern California. In Ostrom, E., Gardner, R., & Walker, J. (eds.) *Rules, Games, and Common-Pool Resources*. (pp. 283-300). Ann Arbor: University of Michigan Press.
- Craig, D. (2006). Indigenous Property Rights to Water: Environmental Flows, Cultural Values and Tradeable Property Rights In *Adapting Rules for Sustainable Resource Use*, Smajgl and Larson (ed.), CSIRO Publishing, forthcoming
- Department of Land and Water Conservation (1998). Submission to IPART on rural bulk water pricing. Government of New South Wales, Sydney
- EEA (European Environment Agency) 1999. Environment in the European Union at the turn of the century. Environmental assessment report No 2
- EPA (Environmental Protection Agency) (2002): Marion Downs joins Land for Wildlife network. Online at: <http://www.epa.qld.gov.au/projects/media/index.cgi?offset=16>
- ETC/CDS. General Environmental Multilingual Thesaurus (GEMET 2000), as adopted by UN Conference on the Environment and Development (1992)
- Faith, D. P.; Carter, G.; Cassis, G.; Ferrier, S. & Wilkie, L. (2003). Complementarity, biodiversity viability analysis, and policy-based algorithms for conservation. *Environmental Science and Policy* 6, 311-328.
- Great Artesian Basin Consultative Council (1998). The Great Artesian Basin. Conservation and utilisation of a valuable groundwater resource.
- Greiner, R. & Larson, S. (2004). The relationship between landholders and tour operators: An investigation of the areas adjoining the Gibb River Road in the North Kimberley CSIRO Sustainable Ecosystems Townsville and Tropical Savannas CRC Darwin.
- Greiner, R., Larson, S., Herr, A., & Pinger, P. (2005). Independent travellers in the North Kimberley: Benefits, impacts and management challenges CSIRO Sustainable Ecosystems Townsville and Tropical Savannas CRC Darwin.
- Greiner, R., Mayocchi, C., Larson, S., Stoeckel, N., & Schweigert, R. (2004). Benefits and costs of tourism for remote communities - case study of the Carpentaria Shire in north-western Queensland CSIRO Sustainable Ecosystems Townsville and Tropical Savannas CRC Darwin.
- Herr, A. (2006). People, communities and institutions in sustainable natural resource management of Lake Eyre Basin. Draft document, personal communication, April 2006

- Holmes, J. (1996). Changing Resource Values in Australia's Tropical Savannas: Priorities in Institutional Reform. In Ash, A. (Ed.). *The Future of Tropical Savannas*. (pp. 28-43). Collingwood: CSIRO Publishing.
- Jackson, S. (2004). Preliminary Report on Aboriginal Perspectives on Land-Use and Water Management in the Daly River Region, Northern Territory. (pp.24). A report by CSIRO for the Northern Land Council.
- Lake Eyre Basin Coordinating Group (2000). *Georgina Diamantina Catchment Strategic Plan*.
- Larson, S. (2005). Can a wellbeing function assist in the assessment of policy impacts on regions? James Cook University School of Business, December 2005
- Larson, S. (2006a). Human wellbeing and natural environments: An Indigenous perspective. In *The 2nd International Conference of Sustainable Heritage Development*. January 8-13,2006, Hanoi, Vietnam.
- Larson, S. (2006b). *Water Planning in Diamantina and Georgina: Institutions and Concerns CSIRO Sustainable Ecosystems Townsville and Desert Knowledge CRC Alice Springs*.
- McKay, J. (2005). Water institutional reforms in Australia. *Water Policy*, 7, 35-52.
- Meston, A. (1895). *Geographic History of Queensland*, Government printer, Brisbane, 1895, p150
- Millennium Ecosystem Assessment (2003). *Ecosystems and human well-being: a framework for assessment*. (ed Alcamo, J. et al.), Island Press: Washington DC.
- Nakamarra, J. L. (2005). The Frog Icon. Accessed on-line at: <http://www.jintaart.com.au/iconography/frogicon.htm>, December 2005
- Nolan, C. (2003). *Sand Hills and Channel Country*. Bedourie: Diamantina Shire Council.
- Ostrom, E. (2006): Multiple Institutions for Multiple Outcomes. In *Adapting Rules for Sustainable Resource Use*, Smajgl and Larson (ed.), CSIRO Publishing, forthcoming
- Ostrom, E. (2005). *Understanding institutional diversity*. Princeton: Princeton University Press
- Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.
- Ostrom, E. and Crawford, S. (2005): *Classifying Rules*. In Ostrom, E. (ed). *Understanding institutional diversity*. Princeton: Princeton University Press
- Ostrom, E., Gardner, R., & Walker, J. (1994). *Rules, games and common-pool resources*. Ann Arbor: The University of Michigan Press.
- Puckridge, J.T. (1998). Wetland management in arid Australia. The Lake Eyre Basin as an example. In: *Wetlands in a Dry Land: Understanding for Management* (ed. W. D. Williams) pp. 87-96. Environment Australia, Canberra.
- Puckridge, J. T., Walker, K. F., & Costello, J. F. (2000). Hydrological persistence and the ecology of dryland rivers. *Regulated Rivers: Research and Management*, 16, 385-402.
- Roshier, D.A., Whetton, P.H., Allan, R.J. and Robertson A.I. (2001). Distribution and persistence of temporary wetland habitats in arid Australia in relation to climate. *Austral Ecology*, 26 (4): 371-382
- Saleth, R.M. and Dianr, A. (2004). *The institutional economics of water. A cross-country analysis of institutions and performances*. Edward Elgar Publishing, Cheltenham, UK, a copublication with the World Bank
- Saleth, R. M. & Dinar, A. (2005). Water institutional reforms: theory and practice. *Water Policy*, 7, 1-19.
- Sattler, P. and Williams, R. (1999). *The Conservation Status of Queensland's Bioregional Ecosystem*. Queensland Environmental Protection Agency, Brisbane
- Sheldon, F., Balcombe, S., Brunner, P., & Capon, S. (2003). *Ecological and Geomorphological Assessment for the Georgina-Diamantina River Catchment Centre for Riverine Landscapes*, Griffith University, Queensland.

- Smajgl, A., Nursey-Bray, M., Vella, K. and Herr, A. (2006). Building Institutional Incentives in Dying Communities. In *Adapting Rules for Sustainable Resource Use*, Smajgl and Larson (ed.), CSIRO Publishing, forthcoming
- Stafford Smith, D. M. and Morton, S. R. (1990). A framework for the ecology of arid Australia. *Journal of Arid Environments* 18, 255–78
- State of Queensland, Office of the Queensland Parliamentary Counsel (2004). Water Resource (Georgina and Diamantina) Plan 2004. Reprint No. 1, as in force on 6 August 2004.
- Tang, S. Y. (1994). Institutions and Performance in Irrigation Systems. In Ostrom, E., Gardner, R., & Walker, J. (eds.) *Rules, Games, and Common-Pool Resources*. (pp. 225-245). Ann Arbor: University of Michigan Press.
- Tyler, M. J. (1997). *The Action Plan for Australian Frogs*. Wildlife Australia, Canberra
- United Kingdom Environmental Agency (2005). URL: http://www.environment-agency.gov.uk/aboutus/512398/830672/831980/832317/?version=1&lang=_e. Accessed August 2005
- Yandle, T. (2001). *Market-Based Natural Resource Management: An Institutional Analysis of Individual Tradable Quotas in New Zealand's Commercial Fisheries*. Ph.D. diss., Indiana University.
- Yandle, T., & Dewees, C. (2003). Privatizing the Commons...Twelve Years Later: Fishers' Experiences with New Zealand's Market-Based Fisheries Management. In Dolšak, N. & Ostrom, E. (eds.) *The Commons in the New Millennium: Challenges and Adaptations*. (pp. 101-27). Cambridge, MA: MIT Press.
- Water Act 2000. Reprint No. 4B, as in force on 1 March 2006. State of Queensland, Office of the Queensland Parliamentary Counsel
- Water Planning Group (2003). *Social and Economic Report of the Draft Georgina and Diamantina Water Resource Plan*. Department of Natural resources and Mines, 2003
- Water Planning Group (2004). *Georgina Diamantina Water Resource Plan Consultation Report*. Department of Natural resources and Mines, August 2004.
- Water Planning Group (2005). *Georgina and Diamantina Draft Resource Operations Plan*. Queensland Department of Natural Resources and Mines, September 2005
- Williams, W.D. (1981). Inland aquatic systems: An overview. In: *Ecological Biogeography of Australia* (ed. A. Keast) pp. 1079–99. Dr W. Junk, The Hague.
- Williams, R. J.; Hutley, L. B.; Cook, G. D.; Russel-Smith, J. & Edwards, A. (2004). Viewpoint: Assessing the carbon sequestration potential of mesmic savannas in the Northern Territory, Australia: approaches, uncertainties and potential impacts of fire. *Functional Plant Biology*, 31, 415-422.