Discussion Paper – Living Laboratories
"A Decision Support System for real-time River Murray water management in SA"
16 October 2008

1. Introduction

This discussion paper has been prepared to identify broad directions and priorities for a decision support system for management of River Murray water in South Australia, on an annual, monthly and daily basis from the Border to the Coorong. Increasing, competing demands on the use of River Murray water in SA combined with the ongoing drought and likelihood of reduced flows to South Australia in the future make the development of such a system important to ensure that water allocation, delivery and usage can be optimised across all sectors.

This paper will provide background and input for a Living Laboratories session scheduled 30 October 2008 titled "Science to develop an adaptive management system for the River Murray" at which it is intended to:

- explore what we would need to do to create a real-time management system for the River Murray, to deliver water to key assets and users, and to manage water quality; and
- identify what research would be required to develop such a system.

2. Background

The River Murray System

The 'River Murray system' is:

- the main course of the River Murray and all its effluents and anabranches;
- tributaries entering the River Murray upstream of Albury;
- the Darling River downstream of the Menindee Lakes storage;
- Murray-Darling Basin Commission works - Dartmouth Dam, Hume Dam, Yarrawonga Weir. Lake Victoria storage, weirs and locks along the River Murray, and the barrages near the mouth of the River Murray; and
- the Menindee Lakes storage, which the NSW Government has leased to the Commission in perpetuity.

In its natural state the River Murray was quite different from the regulated river we have today. During severe droughts it was sometimes reduced to a chain of saline waterholes. In South Australia, seawater infiltrated into the Lower Lakes during these periods of very low river flow.

In most years, Adelaide draws more than 40% of its water from the River Murray. During droughts such as that experienced in recent years, this dependence increases to more than 90%, and although there are measures being put in place to reduce this (eg desalination plants), South Australia will remain fairly reliant on the River Murray. Without our present system of river regulation, the population of Adelaide and many other South Australian cities and towns would have needed to seek alternate water supplies.

Since the completion of Hume Dam in 1936, a continuous flow has been maintained along the length of the River Murray at least to Wellington although there have been significant periods when there has been no river flow at the Murray Mouth. Without storages and regulation, the River Murray would almost certainly have ceased to run further upstream during the droughts of 1938-39, 1944-45, 1967-68, 1982-83 and 1997-98. The drought conditions experienced in the last few years have shown that even with storages and regulation, extended dry climatic conditions could lead to situations where it is difficult to maintain a flow to South Australia sufficient to ensure Critical Human Needs can be met both in terms of quantity and quality.

River Murray System management

The water sharing and management arrangements for the River Murray system are set out in the Murray-Darling Basin Agreement. In summary, South Australia is entitled to receive a minimum of 1850 GL/year, equally supplied by Victoria and New South Wales, unless there are extreme circumstances when the available resources are shared equally between NSW, Victoria and South Australia. The rules and operating strategies have been developed over a period of more than 90 years and reflect the progressive development of knowledge and understanding of how the river can be operated to meet the agreed water sharing requirements and how the operation of the river can accommodate a wide variety of inflows and climatic conditions.

River Murray Water has been established by the Murray-Darling Basin Ministerial Council as an internal business division of the Murray-Darling Basin Commission for the specific purpose of operating and managing the River Murray system and maintaining associated assets in accordance with the provisions of the Murray-Darling Basin Agreement.

Each day, more than 350 items of data are received from points along the River Murray and tributaries to facilitate operation of the River Murray system. This data comes from agencies in New South Wales, Victoria and South Australia.

River Murray Water uses MSM-Bigmod, two computer based models that operate as a package. Output from MSM (Monthly Simulation Model) feeds into Bigmod (a daily simulation model). MSM models monthly volumes of water in the river system based on inflows (from rainfall and tributaries), storage volumes and outflows (including diversions and losses). It models the River Murray system from Dartmouth Dam to the South Australian border, including the Lower Darling River. It is used for:

- planning seasonal allocations;
- planning releases from storages; and
- water accounting.

The monthly volumes from MSM can then be entered into Bigmod which models daily flow volumes and salinity. Bigmod models from Dartmouth Dam to the Murray Mouth, including the Lower Darling River. Bigmod can be used for:

- daily operation of storages and weir pools;
- routing of flows and salinity;
- salinity mitigation scheme operation; and
- flow and salinity forecasting.

Using 117 years of climate data (from 1891 to 2007), MSM-Bigmod can simulate the operation of the River Murray system to investigate what would happen under any given set of conditions. The daily flow and salinity information from MSM-Bigmod can be used as input into other models.

The focus of River Murray system management has been security of water supply, compliance with water sharing arrangements set out in the Murray-Darling Basin Agreement, salinity management and responding to real time issues such as blue-green algae outbreaks. A River Murray Operations system review has been initiated. This recognises the need to adapt river operations in light of the current drought, climate change, environmental water allocations, interstate trade and the new water sharing arrangements negotiated since the recent drought.

The impacts of more recent changes (eg the extreme drought, recognition of the over-allocation of some resources and the growing recognition of the need to maintain the connection between the floodplain and the river) have not been reflected in these rules to date. It is clear that better use can be made of existing resources through revised management. For example, historically the volume of above entitlement flow (or unregulated flow) to South Australia has not often been actively managed. It is now recognised that these flows could be more actively managed to achieve other targets, including environmental outcomes.

Until 2003-2004, South Australia had always received its annual entitlement flow, but since that time, the drought experienced in the Murray-Darling Basin, combined with high levels of water use, has resulted in reduction in flows below entitlement to South Australia and restrictions on water users throughout the Murray-Darling Basin. In the extreme case it is now evident that supplies for Critical Human Needs cannot be guaranteed at all times without changes to the current water sharing rules.

South Australia has negotiated both temporary and on-going changes to the water sharing rules to mitigate against this situation including securing access to storage in Hume and Dartmouth Dams for critical human water needs and private carry–over. These changes also cover the need to separately provide for conveyance water, again to ensure access for critical human needs. These agreed changes will need to be reflected in new river system management arrangements under the new Commonwealth legislation.

In addition, the existing water sharing arrangements and management systems were developed before the intergovernmental agreement on The Living Murray was signed and before the Commonwealth embarked on a significant water buy back and water savings program for the environment. The Living Murray provides for a structured approach to recovery and delivery of environmental water across six sites (referred to as icon sites), three of which are completely or partly within South Australia (Chowilla; Coorong, Lower Lakes and Murray Mouth; and the River Murray channel). There is a robust prioritisation process that results in an annual environmental watering plan.

Stages 1 and 2(a) of an optimisation modelling project have been undertaken by the Murray-Darling Basin Commission to identify the extent to which the Ministerial environmental objectives can be achieved at Icon Sites assuming a 500 gigalitre water recovery combined with the preferred works and measures at each site. The Stage 2 modelling includes the medium climate change scenario to assess the operational capability of structures under minimum operating levels. Stages 2(b) and 3 will incorporate more refinements including scheduling of environmental water delivery using the preferred delivery and inundation requirements at each site.

The South Australian Murray-Darling Basin Natural Resources Management Board has completed a Floodplain Prioritisation Framework, which identifies priority landscape-scale floodplain environmental assets. At a local scale, the wetland prioritisation project identifies priority wetland assets. In combination with the river channel prioritisation project, ecological assets are being prioritised for investment.

The Board is also developing a Management Action Database, which will assist real-time decision making in relation to delivery and application of environmental water, based on a number of key parameters. This will provide input to a Decision Support System for flow delivery and management.

3. Directions for a decision support system for real time management

The long-term management arrangements for the River Murray in South Australia are addressed in the Water Allocation Plan for the River Murray Prescribed Watercourse and the Strategic Environmental Watering Plan being developed by the River Murray Environmental Manager. SA Water also has arrangements in place to operate the River in accordance with operating rules laid out in the Murray-Darling Basin Agreement. Long-term management arrangements for salinity outcomes are addressed under the Murray-Darling Basin Commission's Basin Salinity Management Strategy and South Australia's River Murray Salinity Strategy. There are also long term targets for salinity and water management under the State Strategic Plan. However, real time management on an annual, monthly or even daily basis needs further exploration. While there are components of work that have been explored (as outlined further in what follows), some with related Decision Support Systems, there is no single framework that brings them together.

Within South Australia, decisions need to be made about the management of River Murray system to achieve multiple purposes:

- water supply for regional towns and Adelaide;
- water quality (maintain acceptable salinity, avoid algal blooms, other quality measures);
- conveyance water;
- water for environmental purposes (icon sites and other floodplains and wetlands);
- water for irrigation;
- water for recreation;
- water for industry;
- water for infrastructure (jetties, marinas, ferries);
- water for cultural needs; and
- water to prevent lower lakes acidification.

The Drought Response work has resulted in a River Murray drought allocation decision framework. This framework sets out an adaptive decision-making process for each month, following receipt of the Murray-Darling Basin Commission's water resources assessment of the water available for sharing between New South Wales, Victoria and South Australia. Through a decision hierarchy under this approach, the preferred application or use of any water available to South Australia beyond critical human needs can be determined in a consistent, transparent and justifiable manner. Each decision point narrows down the preferred alternative use or uses to which the water could be allocated. Through the Water Security Taskforce, the South Australian response to the drought has also resulted in improved understanding of system losses and response of the River Murray system in low flow conditions, including the geochemical responses in the Lower Lakes due to acid sulphate soils as well as the movement of salt along the river and through the lakes. A great deal of work has been undertaken to determine key triggers such as water levels required to prevent acidification of the Lower Lakes, operating ferries, pumping stations and fish passages. MSM-Bigmod is generally used for these purposes within SA, but decision points and triggers are not incorporated in this model; hence further work is being undertaken to develop the model in this direction.

Meanwhile, work has commenced to plan for flood conditions, particular in terms of managing the salt loads that could arise post flood. It has been identified, both within South Australia and more broadly (eg under the Mid-Term Review of the Basin Salinity Management Strategy) that there is a need to develop better understanding of the process of salt accumulation within the floodplain, in terms of its potential impact on river water quality if/when mobilised and the development of suitable remediation and mitigation actions. Some work is already being undertaken within the Basin in this direction. For example, Lower Murray Darling Catchment Management Authority has initiated a project with Murray-Darling Basin Commission to investigate floodplain salt and water interactions and ongoing salt modelling development in the Lake Victoria and Mallee region. The intention is to fill major data gaps and inform environmental flow management for this region.

It is noted that CSIRO have also undertaken some work in the area of floodplain salinity management, including work at Chowilla.

Given the potential risk of post flood salt to the river and the Basin Salinity Target, South Australia is interested in progressing a floodplain salinity data and modelling investigations project to establish:
- an improved understanding of the implications of the processes of floodplain salt accumulation and salt mobilisation on salt load to river;
- an improved understanding of how these processes can be influenced and/or controlled by other actions (eg dilution flows, weir pool level manipulation); and
- a model with the ability to predict impacts of salinity in terms of in-river salt load, to enable regional scale salt accounting in the riverine corridor.

A project brief has been prepared for an investigation in this direction for South Australia, although this project is yet to be funded. The project would help inform a policy position on how to manage salt impacts from flood events, both in terms of real time river management and the long-term accountability requirements under the Basin Salinity Management Strategy.

Under the Murray-Darling Basin Commission Risks to Shared Resources program, development and implementation of methods to consistently assess risks to shared water resources in the Murray-Darling Basin are being investigated. Early (draft) findings from this work suggest that ideally, in order to rigorously establish a baseline and comprehensively evaluate the consequence attributable directly to individual scenarios on environmental assets and water entitlement systems, a water resources model of the entire Murray-Darling Basin needs to be setup (i.e. broader than MSM-Bigmod) and that this model would need to operate in real time.

In terms of River operations, SA Water operate the river and Lake Victoria in accordance with operating rules laid out in the Murray-Darling Basin Agreement and direction from River Murray Water to ensure annual and monthly entitlement flow obligations are met, and ultimately, to provide water for all consumptive uses as defined under the Agreement. In terms of real-time operations, infrastructure is varied on a daily basis to ensure the longer-term obligations are met. There are provisions to ensure that management actions can be taken for particular events in real time. For example, there is an intensive monitoring network from the border to Lake Alexandrina so that changes to river water quality can be detected. If, for example, an algal bloom is detected, water can be released out of Lake Victoria to provide additional flow to help eradicate the bloom. Similarly, if water is needed to raise weir pools, fill Lake Bonney or the Chowilla regulator, this can be accommodated (providing there is sufficient water in the system).

There is a real-time component to the operation of floodplain disposal basins (Berri, Disher's Creek and Katarapko) and salt interception schemes. There are rules about releases from disposal basins during high flow and low salinity events and it is possible to reduce salt interception scheme pumping during certain high flow events that need to be further explored in terms of how these rules can be integrated to optimise river water quality outcomes.

However, in summary and notwithstanding these individual systems and processes, there is currently only a limited integrated approach to real-time management of the River Murray System, that incorporates the purposes, priorities, triggers, targets and models that ensures that we optimise management of water for best outcomes across-the-board. We are not after a rule-book: there needs to be options and flexibility in decision-making, but the Decision Support System needs to give direction and ensure transparency and consistency.

4. Key areas for further work

In preparing this paper, a number of key areas for further work have been identified:

- review and document all existing models and Decision Support Systems (not limited to the models currently in use);
- review and document all the known triggers;
- review and document real-time targets;
- review and further develop prioritisation of water use; and
- develop an integrated Decision Support System for multiple benefit outcomes building on the findings of the review work identified above.

The session on 30 October 2008 should assist in verifying these as the key areas for further work.