6.3 Water quality in Queensland catchments and the cotton industry

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Key points

- In the Condamine Balonne Catchment, cotton contributes less than 5% of total nitrogen and phosphorus found in water.
- Total phosphorus levels in the Border Rivers catchment is generally low although it has been increasing over time in some tributaries.
- Total nitrogen levels have been generally below those likely to aid in algal bloom development. In the Condamine Balonne the levels increase with distance downstream from the headwaters – these have been attributed to the high nitrogen content of soils and run-off from upstream land use.
- Studies on cotton farms have shown that total phosphorus and total nitrogen levels increase in tailwater from irrigations.
- Cotton herbicides prometryn and metolachlor increased in detection frequency between 1993 and 2001.
- Atrazine (predominantly used on sorghum) was found in 80-90% of samples over 8 years.
- Since 1999 endosulfan has not been found in water samples in the QMDB.
- Storms and sediment are the two main factors affecting the movement of pesticides and nutrients off-site.
- Mean sediment concentration leaving cotton tail drains ranges from 3 to 9 g/L in storm and irrigation run-off.
- Typical annual soil loss leaving cotton tail drains ranges from 6 to 22 t/ha.
- Median EC values measured at all sites in the QMDB were below 700 µS/cm.
- The high-risk period for off farm movement of pollutants is pre- and post-plant when groundcover levels are below 30%.
- There are a number of practical management options available to farmers now that can dramatically reduce off farm movement of pollutants – for example, planting into stubble and the use of vegetative filters.

Introduction

The quality of surface and groundwater in the Queensland Murray-Darling Basin (QMDB) has significant social, economic and environmental implications for use. This includes its use as a water supply for human consumption, industry and irrigation, and as an ecosystem.

A healthy riverine system is defined as one having the ability to support and maintain a balanced, integrated adaptive community of organisms, and having a species composition diversity and functional organisation which is comparable to that of an undisturbed natural habitat of the region (ANZECC 1992). Catchments require a healthy water system to support human communities, agricultural production and the environment.

The cotton industry, like many industries, impacts on river health through off-site movement of soil, nutrients, insecticides and herbicides into waterways. The impacts of nutrient and pesticide contamination on the aquatic environment and human health have been well documented (Wardrop 1986, Sullivan et al. 1991, AIMS 2002, Chapman 1998). This has increased the level of scrutiny placed on the cotton industry to minimise off-site movement of these pollutants.

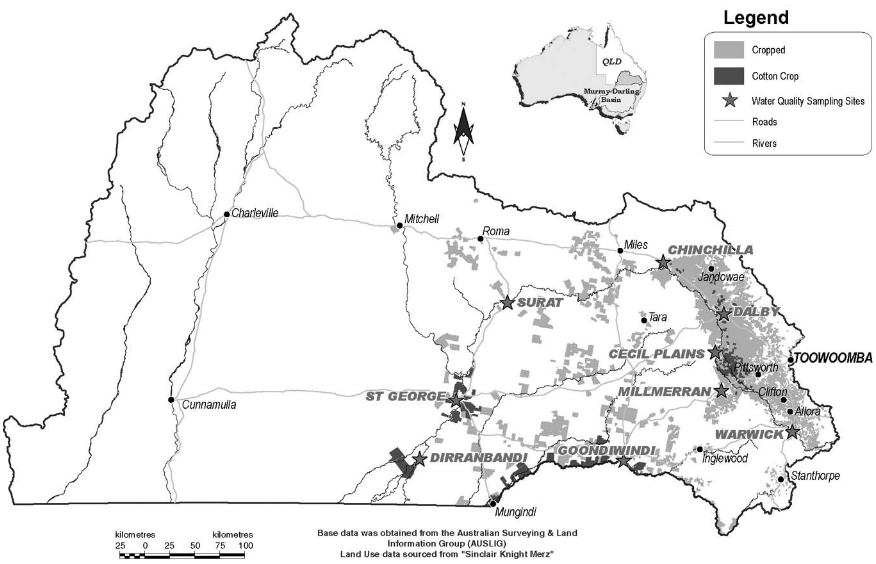
In terms of overall nutrient contribution in the Condamine Balonne Catchment, cotton contributes less than 5% of total nitrogen and phosphorus (CBWC 2001).

The following summary outlines water quality monitoring over the past decade in the QMDB and the key nutrient and pesticide findings over the period.

Water quality in the QMDB

Water quality monitoring in the QMDB has been conducted under two separate programs - one for the Border Rivers and the second for the Condamine Balonne river system (Figure 6.3.1).

Figure 6.3.1. Spatial extent of cotton and cropping areas and water sampling sites on the main river system in the Queensland Murray-Darling Basin



Water quality monitoring for the Border Rivers was conducted as part of the Central North West Region program (Gordon 2001). In 1999-2000 sampling, 29 sites from NSW and Queensland within the region were monitored for nitrogen, phosphorus and 34 agricultural chemicals.

For the Condamine Balonne river system the Condamine Balonne Water Committee Inc. (CBWC) in conjunction with the Qld Department of Natural Resources and Mines (NR&M) established a water quality monitoring program in 1993 which continued through a number of projects until 2002.The major focus of this monitoring was on pesticides.

The NR&M also has an ambient monitoring network looking at total nitrogen (TN) and total phosphorus (TP) for 20 sites dating back 10 years. Total suspended solids (TSS) has been recorded for a more extensive time (up to 30 years at some sites). Of the 20 sites monitored in the Condamine Balonne Catchment, nine are on the main river system.

Pesticides

In 1999-2000 sampling, 29 sites across the region of NSW and Queensland were monitored for 34 agricultural chemicals. Endosulfan, atrazine, diuron, fluometuron, metolachlor and prometryn were detected. Atrazine was the most frequently detected herbicide, with the second most frequently detected chemical being endosulfan.

The CBWC pesticide-monitoring program was conducted at the following town weirs - Millmerran, Cecil Plains, Dalby, Chinchilla, Surat, St George and Dirranbandi in the Condamine Balonne River system. This work was continued in the later years through funding provided by the chemical company Syngenta. Cotton is grown upstream of all sampling locations and would therefore have the potential to contribute to contamination of the water bodies sampled.

Water samples were analysed for 52 pesticides. These chemicals included the alpha and beta isomers of endosulfan, as well as endosulfan sulfate and the breakdown products of atrazine - desethyl atrazine and hydroxy atrazine. Eight chemicals were detected in all five weirs: metolachlor, dieldrin, simazine, atrazine, atrazine desethyl, atrazine desisopropyl, prometryn. A byproduct of DDT (p,p-DDE) was detected on one occasion.

General findings from the study were:

- Metolachlor and atrazine were found in all weirs sampled.
- Metolachlor was found in 60% to 90% of all samples.
- Atrazine was found in 80% to 90% of samples in Dalby, Chinchilla and Surat weirs.

A summary of data from 1993 to 1998 for the two sites with continuous data for the period, Loudoun and Chinchilla Weirs, is given in Table 6.3.1.

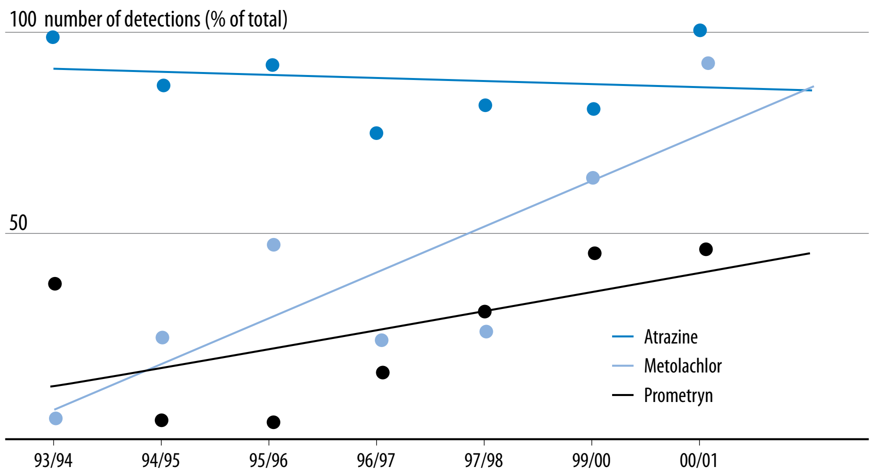
Table 6.3.1. Number of detections of simazine, atrazine, total endosulfan, prometryn & metolachlor for Loudoun & Chinchilla Weir across eight seasons

Chemical	Simazine	Atrazine	Total endosulfan	Prometryn	Metolachlor	Total no. samples analysed
93/94	0	18	12	7	1	18
94/95	0	20	4	1	6	23
95/96	0	21	7	1	11	23
96/97	0	18	6	4	6	24
97/98	0	18	2	7	6	22
98/99	NS	NS	NS	NS	NS	NS
99/00	0	9	0	5	7	11
00/01	5	13	0	6	12	13
01/--*	0	2	0	2	2	4

NS = Not samples *= Incomplete record

The herbicide atrazine, which is predominantly used on sorghum, was the most frequently detected, followed by metolachlor. Detections of atrazine remained constant across all seasons in 80-100% of samples (Figure 6.3.2).

Figure 6.3.2. Metolachlor and Prometryn detections have significantly increased from 1993-2001 with little change in the number of samples containing atrazine for the same period, remaining above 80% for Loudon and Chinchilla Weirs.



The reduction in use of endosulfan by the cotton industry from 1999 has had a dramatic effect on detections in stream. For the past three seasons endosulfan has not been detected in any of the watercourses on the Condamine Balonne river system.

As in northern NSW, herbicides such as prometryn and metolachlor have significantly increased in detection frequency between 1993 and 2001. Both are herbicides used in the cotton industry.

Bed load sediment sampling for pesticides

Sampling of bedload sediments in all town weirs from 1998–99 found traces of endosulfan sulfate (a breakdown product of endosulfan) in three of the forty sediment samples collected. No pesticides were detected in any of the samples collected in February and October 2000.

Endosulfan sulfate was not detected in the sediment on more than one occasion at any site. This finding suggests that the pesticide is leaching back into the water and breaking down and not accumulating in the bedload sediments.

Groundwater sampling for pesticides

Groundwater bores were sampled at Millmerran, Dalby, Chinchilla and St George every 6 months in 1998 and 1999 to determine if there was any leaching of pesticides into the groundwater system (CBWC 2001). No pesticides were detected in any of the monitored bores. An additional bore tested on two occasions in 2001 in a cropping area close to Dalby had traces of a number of chemicals including endosulfan, metolachlor, trifluralin, atrazine, chlorpyrifos and prometryn. This is the first agricultural bore sample in the Condamine Balonne Catchment to show a positive detection to date.

Suspended solids (TSS) and turbidity

In the upper reaches of the Border Rivers Catchment turbidity is generally low (below 20 nephelometric turbidity units - NTUs), however median turbidity values increase to 120 NTU at the lower end of the catchment (McGloin 2001). High turbidity also occurs in some tributaries (for example, 325 NTU in the Weir River). Monitoring over the last 10 to 15 years has shown that turbidity levels have been increasing over time in the lower half of the catchment and in several tributaries (such as the Severn River (Qld), the Macintyre Brook, the Weir River and Oakey Creek).

TSS and turbidity in the Condamine Balonne River System increase with distance downstream, with turbidity levels ranging from 10–100 NTU and TSS 0–0.16 g/L in the uplands to 100–500 NTU and TSS (0.5-1.5 g/L) from Chinchilla to St George (CBWC 1999).

Unlike pesticides, it is difficult to isolate the direct cause of an increase in sediment and turbidity. However, studies by Noble et al. (1997) in the Emerald Irrigation Area found median sediment concentrations measured upstream (0.03 g/L) of the irrigation channel network increased to 1.76 g/L leaving the cotton farm, and reduced to 0.154 g/L downstream of the irrigation channel network. They reported that concentrations found leaving the fields were above those for any river site studied although concentrations leaving the network were comparable to many mid to lower catchment river sites.

Waters et al. (2001) and Carroll et al. (1995) found mean sediment concentration leaving conventional cotton farms ranged from 2.6 to 8.4 g/L in storm and irrigation run-off. Total soil loss for the season ranged from 6 to 22 t/ha.

The highest risk period is early in the season when groundcover is low and high intensity rainfall event occur. Therefore, where storm run-off is not contained, as in some dryland cotton farming systems, management actions such as vegetative filters are highly desirable to minimise their early season risk of increased run-off and sediment loads moving off-farm.

Total phosphorus (TP)

Nutrient enrichment of waterways in run-off from cropping areas can result in the growth of large masses of plant material. ANZECC's 1992 TP guidelines for the prevention of nuisance algal growth use an indicative range of 0.01–0.1 mg/L (milligrams per litre) for freshwater rivers and streams.

In the Border Rivers Catchment TP concentrations are generally low (0.025–0.1 mg/L) (McGloin 2001). Despite this, TP levels have been shown to be increasing over the last 10 to 15 years in several areas including the Macintyre River at Boggabilla, the Dumaresq River at Bonshaw, the Beardy and Severn (Qld) rivers and Tenterfield Creek. The Weir River (a tributary of the Macintyre/Barwon River) has a high median value (0.17 mg/L) but TP levels do not appear to be increasing over time.

In the Condamine Balonne river system, TP levels generally increase with distance downstream (0.1–1.0 mg/L). In general, TP concentrations increase with flow, TSS and turbidity and decrease with electrical conductivity. The association of TP with flow, turbidity and TSS suggests that the major inputs of phosphorus are attached to sediments or organic matter.

Typical levels of TP measured by Waters et al. (2001) leaving cotton farms were 0.97 mg/L. Noble et al. (1996) found in the Emerald Irrigation area that TP loads increased from (0.04 mg/L) upstream of cotton farms to (0.148 mg/L) in irrigation run-off water downstream of the cotton irrigation channel network. Downstream figures were below those measured in adjacent rivers in the basin.

Total nitrogen (TN)

TN guideline values are only indicative with respect to algal bloom development and are only one of a number of other factors influencing algal growth. The recommended range for freshwater rivers and streams, for the prevention of nuisance algal growth is 0.1-0.75 mg/L (ANZECC 1992).

TN concentrations in the Border Rivers Catchment are generally below the upper range for the prevention of nuisance algal growth (0.5-0.75 mg/L) (McGloin 2001). The only site with a median TN value that exceeds guideline values is the Weir River (1.2 mg/L). Nitrogen concentrations have been increasing over the last decade in the Weir River, the upper reaches of the Macintyre River, the lower Dumaresq River, the Macintyre Brook, the Severn (Qld), and the Beardy Rivers.

For the Condamine Balonne, TN concentrations generally increase with distance downstream. TN ranged from 0.1 to 0.9 mg/L in the headwaters and in the lower end of the catchment, while the Maranoa and the Warrego rivers TN ranged from 1.1 to 2.9 mg/L. The high TN observed in the lower end of the catchment can be attributed to the high nitrogen content of the soils and run-off from upstream land use.

Typical levels of TN measured by Waters et al. (2001) leaving cotton farms were 12.38 mg/L and Noble et al. (1996) in the Emerald Irrigation area found that median TN loads measured upstream (0.556 mg/L) and downstream (5.78 mg/L) of a cotton irrigation channel network resulted in an increase in TN in run-off water. Downstream figures were extremely high and suggest that there is a significant contribution of nitrogen in irrigation run-off water.

Electrical conductivity (EC)

EC measures the ability of a solution to carry an electrical current and is dependent on the presence and concentration of inorganic salts including sodium chloride, calcium chloride and magnesium sulfate. Salinity is defined as the total concentration of these ions and electrical conductivity is often used as an alternative measure of salinity (CBWC, 1999).

Surface water throughout the QMDB is generally of low electrical conductivity (less than 300 µS/cm). However, it should be noted that this does not indicate that these waters will not have salinity problems in the future, as salinity problems can take over fifty years to become visible in the landscape.

A number of tributaries in the Border Rivers Catchment have elevated EC levels (300–660 µS/cm) in comparison to all other sites – these include the Macintyre Brook, Oakey and Pike Creek which had medium salinity levels but no significant upward trend. This may indicate that this is a natural state for these tributaries. The Weir River, Pike Creek upstream of Glenlyon Dam and the Severn River (NSW) upstream at Strathbogie, have low EC levels, however these have been increasing since the early 1990s in the Weir and Severn (NSW) rivers and since the late 1950s in Pike Creek.

Median EC values measured at all sites in the QMDC were below 700 µS/cm. Hence water quality at all monitoring locations could be regarded as suitable for irrigation purposes (ANZECC & ARMCANZ 2000).

Minimising off-site movement of pollutants

The cotton industry has invested significant R&D funds over the past decade to address the issue of off-site movement of pollutants. Key findings from the work identified the high-risk period as early season and highlighted the importance of storms and sediment in moving pesticides off-site and the importance of groundcover in reducing movement (Simpson et al. 1996; Silburn et al. 1998).

Waters et al. (2000) demonstrated that there are a number of practical management options available to farmers now that can dramatically reduce off-farm movement of pollutants. Containment of pollutants on farm requires a whole farm approach. Techniques such as sumps, silt traps and vegetative filters are effective in collecting sediment once it has left the paddock. Crop rotations and stubble retention offers the most effective means of reducing 'off-site' movement of sediment bound pollutants for both irrigation and storms at this point in time. Cereal crops have been shown to be the most effective in terms of achieving high cover levels and having minimal impact on soil-borne diseases. To control chemicals which are more water-soluble is a separate issue again.

One technique alone will not address all the problems. An integrated approach which looks at the whole farm design and management is highly effective in reducing the associated risks of off-site movement of pollutants.

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