

INVENTORY OF DAMS IN THE MARNE CATCHMENT, SOUTH AUSTRALIA

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ABSTRACT: The yield of water within the Marne catchment has been greatly affected by the number of farm dams that have been constructed within the catchment. Landholders in the lower Marne catchment now perceive that the lower catchment is not receiving enough water for agriculture, the environment and their own use.

Large and small dams have a significant effect on the water yields throughout the catchment. Collectively, dams smaller than 5ML (stock and domestic dams) represent 90% of the dams in the catchment, with a capacity to hold 30% of the total water stored in the catchment. Dams greater than 50ML only account for 2% of the dams in the catchment, also storing approximately 30% of the total stored water.

New dams are currently being constructed in the upper catchment which are in excess of 80ML (approximately 50 Olympic size swimming pools). The average runoff across the entire catchment is less than 50 mm (SCRN, 1998), therefore, the ability of these large dams to fill to capacity is small. This effectively prevents downstream flow, severely impacting on downstream users.

The combined effect of all 613 dams holding a total of 2.2GL has a significant affect on:-

- Total catchment yield
- Environmental flows
- Aquifer recharge and stream salinity

In response to this, we need to investigate the options available to manage water resources within the Marne catchment with regard to farm dams. Possible actions can be taken through the Water Resources Act 1997 and the dam approval process (under the Development Act) administered by Local Government and the Murray Catchment Water Management Board.

THE MAIN POINTS OF THIS PAPER

- Increasing numbers of dams with a tendency towards construction of larger dams.
- Runoff is reduced as a consequence of farm dam development.
- Small stock and domestic dams do have a significant impact within the catchment.

1. INTRODUCTION

Farm dams play an important role in water resource management. Dams influence the flow of water throughout a catchment as well as having an affect on catchment yield, water allocation, riparian rights, agricultural development and environmental flows.

As a consequence, we need to know basic facts about dams. Required knowledge includes; number of dams in a catchment or sub-catchment, their location within the catchment, capacity and effect on flow (including catchment and property scale). Without this information, water resource management, in particular decisions on water allocation, environmental flow

requirements, dam and groundwater licensing, is difficult and ad hoc.

2. BACKGROUND

In early 1998, the River Murray Catchment Water Management Board requested information on the extent of farm dam development within the Marne catchment from the then Water Resources Group of Department for Environment, Heritage and Aboriginal Affairs (DEHAA). This request was in response to community concerns regarding the level of farm dam development in the catchment and its impact on the environment of the Marne River, agricultural activities and optimal sharing of water resources.

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The Marne catchment is located on the eastern side of the Mount Lofty Ranges as illustrated in Figure 1. The Marne River flows intermittently through the catchment and discharges into the Murray River. Rainfall is highly variable, with annual rainfall ranging from 272mm in 1982 to 904 mm in 1974. Rainfall also decreases dramatically lower down in the catchment with run-off only being significant in the upper catchment. Approximately, 5% of rainfall will contribute to surface run-off.

Water users in the upper catchment are heavily reliant on capturing run-off, while those downstream are reliant on groundwater.



Figure 1: Location of Marne Catchment

The Marne catchment has close proximity to the Barossa wine region. As a result considerable farm dam development has occurred due to pressures from the viticultural industry.

3. METHOD

3.1 Previous Work

Two previous projects instigated by the Water Resources Group have attempted to collate water resource information for the Marne catchment (Good, 1992 and McMurray, 1996). The methods used in these previous studies varied considerably due to the nature and scope of each project. Good, 1992 manually identified and digitised dams in the Marne catchment utilising 1:16,000 aerial photos taken in 1991. McMurray, 1996 used infra-red aerial photos and a computer classification method to identify dams over most of the Mount Lofty Ranges.

Recent work by the South Central Regional Network (SCRN) Water Resources project team identified that the computer classification method used by McMurray, 1996 while providing a cost effective method over a large area, was not of sufficient accuracy for a specific catchment. As a result the McMurray, 1996 GIS data

was manually updated and the volumes of identified dams estimated.

3.2 Current Methodology

In an attempt to estimate dam development since the time of the 1996 aerial photography, information on development applications approved by the then Mount Pleasant Council was collated and compared to the updated 1996 information. This methodology is outlined as follows:-

The original 1996 GIS coverage was visually compared with the 1996 aerial photographs to identify omitted and falsely identified dams.

The dams missing from the original GIS coverage were either obtained from the 1991 coverage or digitised on screen from the registered 1996 aerial photos. Areas mis-classified as dams were deleted.

Field survey was carried out to determine the volume and surface area of 120 of the 613 farm dams. This enabled us to derive equations for dam volume based on area.

Development application data from the Barossa Council and the previous Mount Pleasant Council was collated and the additional dams built between 1996 and 1998 were identified. These figures were added to the 1996 data to give an estimate of the dams currently in the Marne catchment.

The results from the 1992 study, the amended 1996 information, and the estimated results for 1998 were then compared.

4. RESULTS

The relationship between dam volume and surface area was best estimated when two linear equations were utilised.

Surface area less than 3000 m²

$$\text{Volume (ML)} = 0.0016 \times \text{Surface Area (m}^2\text{)} - 0.1086$$

Surface area more than 3000 m²

$$\text{Volume (ML)} = 0.0035 \times \text{Surface Area (m}^2\text{)} - 5.7425$$

The number of dams and the estimated volume for each size class are listed below for 1991, 1996 and 1998. The total volume of water held in farm dams is also given in tables 1,2 & 3.

Table 1: 1991 Number and Volume of Dams in the Marne Catchment

SIZE CLASS	NUMBER OF DAMS	VOLUME (ML)
<0.5 ML	110	34.9
0.5 - 2 ML	247	293.6
2 - 5 ML	81	255.9
5 - 10 ML	13	87.6
10 - 20 ML	14	205.7
20 - 50 ML	11	347.8
> 50 ML	4	430.9
TOTAL	480	1656.3

Table 2: 1996 Number and Volume of Dams in the Marne Catchment (Amended Data)

SIZE CLASS	NUMBER OF DAMS	VOLUME (ML)
<0.5 ML	155	38.5
0.5 - 2 ML	323	312.7
2 - 5 ML	77	224.9
5 - 10 ML	18	129.8
10 - 20 ML	11	177.9
20 - 50 ML	12	357.2
> 50 ML	7	596.3
TOTAL	603	1837.4

Table 3: 1998 Number and Volume of Dams in the Marne Catchment

SIZE CLASS	NUMBER OF DAMS	VOLUME (ML)
<0.5 ML	155	38.5
0.5 - 2 ML	323	312.7
2 - 5 ML	78	227.9
5 - 10 ML	21	154.8
10 - 20 ML	12	192.9
20 - 50 ML	14	416.2
> 50 ML	10	816.3
TOTAL	613	2159.4

(1996 Data + Council data for dams requiring development approval. Note: Another 8 dams were identified in the Council records. The extra volume of these dams was not recorded. Volume was estimated to be 250 ML in total for all 8 dams.)

A comparison of the data collected is illustrated in Figures 2 to 4.

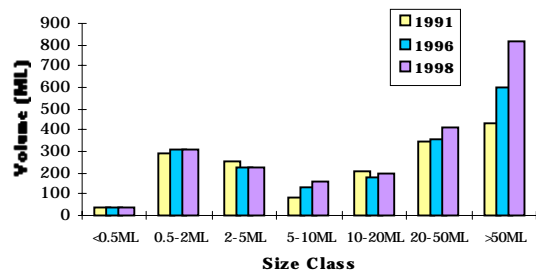


Figure 2: Comparison of dam volumes from each study by size class.

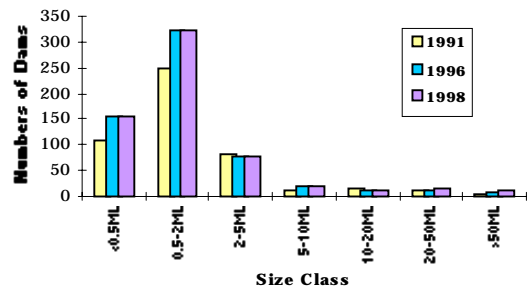


Figure 3: Comparison of dam numbers from each study by size class.

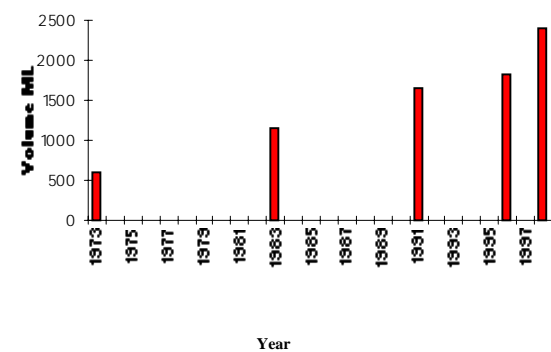


Figure 4: Total capacity of farm dams
(Note: Total capacities of dams for 1973 & 1983 were obtained from the study by Good (1992)).

5. DISCUSSION

Previous reports have suggested that stock and domestic size dams played an insignificant role in harvesting water from a catchment. The results from this study show that in 1996, 90% of the dams in the Marne catchment were stock and domestic dams (ie.<5ML) and held approximately 31% of the total dam storage capacity. However, the small number of large dams (>50ML size class) also accounts for approximately 30% of the total dam storage capacity in the Marne catchment.

The trend, in the Marne catchment has been a change from building small stock and domestic dams to constructing larger dams for irrigation. From 1991 to 1996, there were 123 dams constructed. The majority of these were <1.5ML with an overall average size of 2.6ML. Collectively, these dams contributed 181ML to the overall dam storage capacity in the Catchment. More recently, between 1996 and 1998, according to available records, only 10 dams were built. These dams had an average size of 33.7ML. As a result these ten dams have contributed 337ML to the overall dam storage capacity of the Marne catchment.

The council records for development applications omit many smaller size dams, and have not recorded the volumes of all the dams approved. (The information shown here is only for those applications which went before council.) It can be assumed that these figures underestimate the current dam storage capacity in the Marne catchment. For example, eight applications were obtained which did not contain the size of the approved dam. It is estimated that these eight dams would contribute a further 250ML to the overall dam storage capacity.

The position of dams within a catchment is very important. Most dams in the Marne are located high in the catchment. These dams only have small watersheds, compared with dams further downstream in the catchment. Dams in the upper part of the catchment do not fill very often, and therefore runoff from the area above the dam is no longer able to contribute to flow downstream.

Direct comparison between total dam storage capacity and the volume of water passing through the gauging station located in the lower catchment is of limited value, without considering the contributing run-off across the catchment. The comparison is poor because a given level of runoff must occur before any flow is recorded at the gauging station. The level of run-off is dependent on the extent of dam development.

The extremely variable seasonal and spatial rainfall patterns within the Marne catchment also increases the difficulty of understanding the run-off processes. As a result a hydrological model is required to fully understand the impacts of farm dam development. Such a model was beyond the scope of this study. Efforts have been made, however, to compare the current level of development with past studies which have derived such models.

Good (1992) completed a water balance model for the Marne catchment. From this model it was determined that the percentage of catchment yield trapped in the dams during the period 1973-1988 varied from:-

- minimum 5%
- average 19%
- maximum 34%

The overall effect was a reduction in flow by 10% at the gauging station.

Similarly, studies completed in the Barossa Catchment (Cresswell 1991) on the impacts of farm dams show that the percentage of catchment yield trapped in the dams during the period 1973-1988 varied from:-

- minimum 13%
- average 18%
- maximum 44%

The overall effect on flow was a mean reduction of 20%.

By considering the Good model and run-off data since 1988 it can be estimated that out of the 6 years to 1994, there were 5 years where at least 20% of the total flow was trapped by dams. Furthermore, this conclusion does not take into account the affect that farm dam development since 1991 has had on run-off. This development has seen the total capacity of water held in dams increase by 500ML from 1991 to 1998.

Groundwater recharge will also be affected by development of farm dams. Highland areas of the Marne catchment provide the recharge areas for the Murray Group limestone aquifer. This aquifer provides water for stock and irrigation along the lower Marne.

Recharge occurs via:-

- Infiltration of rainfall.
- Direct hydraulic connection to the Marne River.
- Recharge by infiltration of overbank flow.

It is also known that most recharge occurs during periods of high flow, and that the amount of water recharged decreases down the catchment (Good, 1992).

As a result of this information, landowner concerns about the decrease in water availability is supported. Water availability is expected to decrease further as farm dam densities in the headwaters of the catchment increase.

To move towards better water resource management and allocation within the catchment like the Marne the following strategies should be considered:-

- Investigate the options available to manage the development in the Marne catchment under the Water Resources Act 1997.
- Work with Local Government to refine the development approval process of dams.
- Education for landholders and local government in the sustainable use of surface water.

- Linkage required between Primary Industries & Resources SA and the Environment Protection Agency to value the expansion of agricultural industries.

The River Murray Water Catchment Management Board has commenced further studies in the Marne catchment. A significant part of this study is including the above dam information in a hydrologic model.

Other studies which could be investigated included;

- Investigate the cost effectiveness of remapping the Marne dams to obtain the most up-to-date information.
- Refine runoff mapping so that watersheds of existing and proposed dams can be estimated.
- Future development of agricultural industries with mains water requirements.

7. CONCLUSIONS

Both stock / domestic dams (<5 ML) and large dams (>50 ML) impact significantly on catchment yield and run-off throughout the Marne catchment.

With the expansion of the viticulture industry increased pressure has been placed on surface water resources. Many viticultural areas in South Australia, such as McLaren Vale and the Barossa Valley have had their surface waters proclaimed to ensure sustainable water allocations and resource protection.

Catchments such as the Marne, with close proximity to the Barossa Valley are now seeing increasing pressure on their surface water resources. This has seen a trend to develop larger farm dams for irrigation rather than the smaller stock and domestic dams. These large irrigation dams are concentrated in the upper Marne catchment.

That the likelihood of these large dams filling is small, impacting severely on downstream users and environments. This is due firstly to the relatively small watershed size of many dams in the catchment.

Secondly the extremely variable rainfall and thus run-off across the catchment can result in minimal run-off in dry years. Finally, that the number of dams now capturing run-off is increasing, minimising the potential yield of dams across the catchment.

The construction farm dams in the Marne Catchment will need to be controlled in the future in order to maintain the water resource for all users and the environment.

8. REFERENCES

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