



RIVER BASIN MANAGEMENT AND ESTUARINE NEEDS: THE GREAT BRAK CASE STUDY

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ABSTRACT

The study of the effect of the Wolwedans Dam on the Great Brak Estuary and the development of the management plan to maintain a healthy environment yielded many interesting results. The general conclusion is that developments in a catchment, especially those affecting the runoff, can have serious effects downstream. The study also proves that detailed investigations can result in an effective management plan to maintain a healthy environment.

KEYWORDS

Estuary mouth management; Great Brak Estuary; public involvement; runoff; Wolwedans Dam.

INTRODUCTION

A study was recently undertaken on the effects of the Wolwedans Dam on the Great Brak Estuary (Figure 1) and on the effectiveness of the management plan designed to maintain a healthy environment in the estuary.

This dam was designed to supply water to the Mossgas refinery at Mossel Bay on the south coast of South Africa and to meet the future domestic and industrial demands of the region. It was commissioned in 1990. The construction commenced at short notice and the CSIR was requested to investigate the impact of the dam on the estuary and to develop a management plan to maintain a healthy environment after the construction had begun.

A management plan was developed and a monitoring programme undertaken to assess its effectiveness and to modify it when necessary.

The results achieved are not only important for the Great Brak Estuary, but experiences and methods developed can also be applied to similar problems in other catchments and estuaries and can contribute considerably to river basin management for sustainable development.

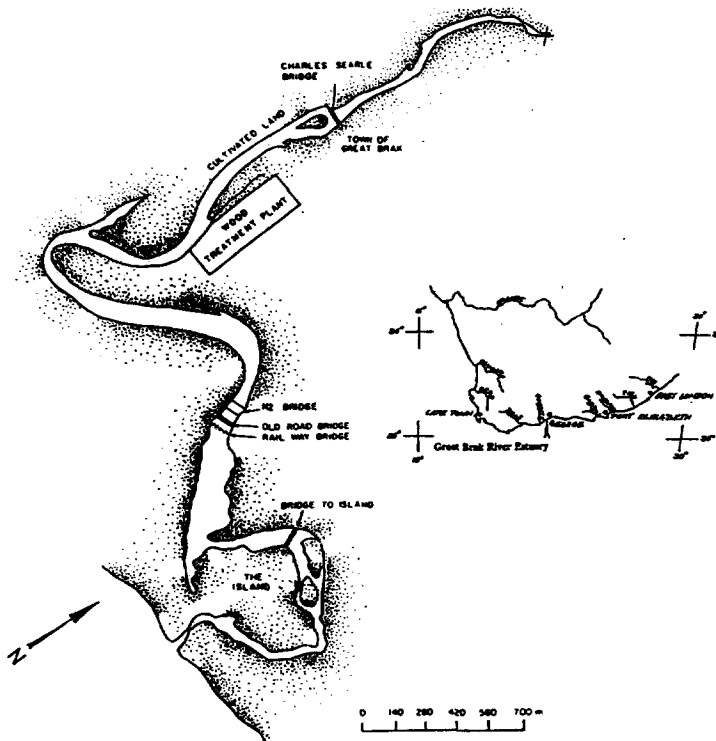


Figure 1. Map and location of the Great Brak Estuary.

THE GREAT BRAK STUDY

General

The Wolwedans Dam is located approximately two kilometres upstream of the Great Brak Estuary. Simulated runoff data indicated that the mean annual runoff (MAR) had already been reduced from an annual natural runoff of $38 \times 10^6 \text{ m}^3$ to $24 \times 10^6 \text{ m}^3$ before the commissioning of the dam. It also predicted a further reduction to $12 \times 10^6 \text{ m}^3$ when the dam meets its full demands by the year 2010.

The danger of the dam having negative environmental effects had been recognised at an early stage and, in addition to the overflow, an amount of $1 \times 10^6 \text{ m}^3$ water per year had therefore been allocated to the estuary. Based on the study results and to test the effectiveness of the management plan this allocation has been increased to $2 \times 10^6 \text{ m}^3$ till the year 2000, when a re-assessment will be undertaken.

The study included assessments of the primary effects of the dam on the physical aspects of the estuary and of the secondary effects on the environment, including the ecosystem, water quality and socio-economy.

Study approach

A major feature of the study was the involvement of the local community from the outset, who were represented on the Great Brak Environmental Committee (GEC) and who were also directly informed on the progress during public meetings. Also represented on the GEC were the Department of Water Affairs and Forestry, Mossgas, the Municipality, the Nature Conservation Department of the Cape Provincial Administration and the CSIR as consultant.

Investigations were undertaken to improve the understanding of the dynamics of the estuary. Unfortunately little reliable information was available and field surveys on the various aspects of the estuary were therefore included and a monitoring programme initiated.

Based on the results from the investigations, predictions were made on the future condition of the estuary when the dam will need to meet its full demands. This included the exploration of optimal ways of using the water available to the estuary and other management activities that could be applied such as improved mouth breaching techniques.

Available information

The main information used in the assessment of the impact of the dam was obtained from simulated runoff data. These data, provided by the Department of Water Affairs and Forestry, were for the natural, the pre-dam and the post dam situation.

It was identified that the major impact of a reduction in runoff on the Great Brak Estuary would probably be on the condition of the mouth. The environment of the Great Brak Estuary is strongly dependent on open mouth conditions. Reliable information on the condition of the mouth did not exist, however, and monitoring only commenced after a water-level recorder was installed during 1988.

During 1988, before the commissioning of the dam, a runoff of approximately $10 \times 10^6 \text{ m}^3$ occurred into the Great Brak Estuary and the mouth was open for approximately 50 percent of the time. According to the simulated runoff data this runoff was equivalent to that of an approximately 12.5 percent low runoff year for the pre-dam situation. The simulated runoff data showed that this amount of runoff can in the future be expected to occur for approximately 50 percent of the time. This gave a first indication that considerable periods of open mouth conditions will still occur in the future.

Water available for releases to the estuary

In addition to the overflow of the dam a quantity of $1 \times 10^6 \text{ m}^3$ per year has been reserved for the estuary and because the dam is expected to have to meet its full demands only by the year 2010 an additional $1 \times 10^6 \text{ m}^3$ has been allocated (if available) until the year 2000 to test the effectiveness of the water release management plan and to determine more accurately the quantity of water that is required.

A key aspect was to determine an optimum water release and mouth management policy. The general logic applied was to replace the reduction in runoff and (semi-) natural mouth breachings by:

- an optimal way of releasing water; and
- a greater mechanical effort during mouth breachings.

Monitoring programme

The dam was commissioned in 1990 and the results from the monitoring programme indicate that considerable success has been achieved so far in maintaining a healthy environment in the estuary. The periods of open mouth conditions in 1993 (when the dam was full and overflowing occurred regularly) are shown in Figure 2. The ecology of the estuary is also being monitored and recent information indicates that while some problems did occur during 1991 and 1992 the estuary is at present in a healthy condition.

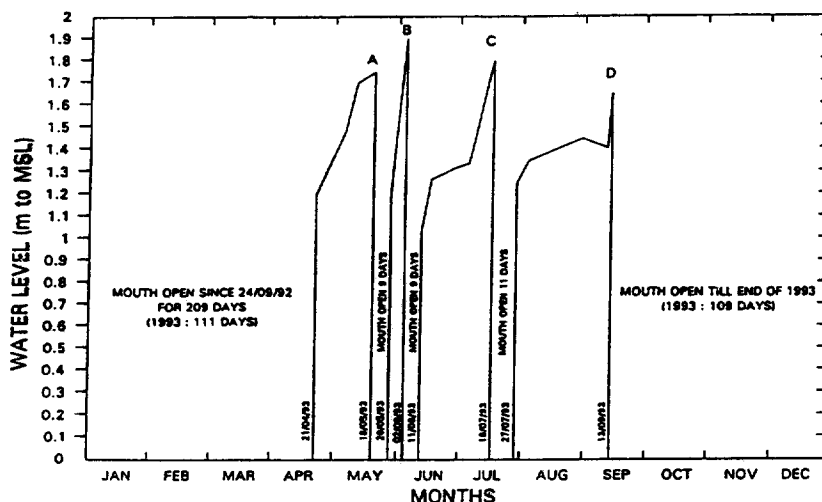


Figure 2. Summary of water levels and mouth conditions in the Great Brak Estuary during 1993.

Refinements in mouth management and water release techniques

Some interesting and simple methods were developed to improve the mouth management techniques. It was known that an open mouth condition was often maintained by river flow. Analysis of water-level recordings and mouth observations showed that at springtide an open mouth was often maintained by tidal flows alone, but that the critical conditions, when the mouth tended to close, occurred during neap tides. A minor baseflow of approximately $0.5 \text{ m}^3 \cdot \text{s}^{-1}$ during neap tides, achieved by low flow releases from the dam, is often effective in keeping the mouth open at these times. In this way water can be used sparingly and optimally to maintain open mouth conditions.

Pumping of seawater

It may be worthwhile to consider alternative sources of water because only a relatively small volume may be required to achieve major benefits for the estuary. One such alternative could be to pump seawater into the estuary. It seems that construction and maintenance costs of such a "solution" might make it an attractive alternative. However, the environmental consequences should be investigated in detail before such a seawater pumping scheme could be implemented.

Selection of season for open mouth conditions

The field data also proved that high wave conditions, normally occurring along this coast in winter, were a major closing factor for the Great Brak Estuary mouth. It is therefore much easier to maintain an open mouth during the summer months when the waves are lower.

The summer period is also the time when juvenile fish migrate into the estuary, which serves as a nursery, and it is therefore desirable to further open mouth conditions during this period.

Tidal flushing at open mouth conditions is also important to maintain good water quality in the estuary during the summer holiday season when loading of septic tanks is at a maximum.

Finally, open mouth conditions during the holiday season are desired for recreational purposes.

The emphasis of the water release management plan for the Great Brak Estuary is therefore on furthering open mouth conditions during the summer months.

Results

As mentioned, the main issue identified was the condition of the estuary mouth. Prolonged periods (months, up to a year) of open mouth conditions existed before the construction of the dam and for ecological (e.g. fish migration), water-quality and socio-economic (e.g. aesthetics) reasons it was considered essential that such conditions should continue to exist after the commissioning of the dam.

Urban developments necessitated artificial breaching of the mouth since the beginning of the nineteenth century. Reliable data on the effects of these breaching are not available, but they probably affected the dynamics (especially the sedimentation) in the estuary mouth considerably.

In the initial investigations it was concluded that a management policy should be implemented involving optimal utilisation of the water available for the estuary and considerably increased effort during mechanical breaching. However, further information was required to confirm the effectiveness of these activities and a programme was undertaken to monitor the results of the management activities and in particular to evaluate the results of the water releases and mouth breaching techniques.

The dam was commissioned early in 1990, but well below average runoff during 1990, 1991 and the first half of 1992 delayed the filling of the dam and little water was available for the estuary during this period. This was unfortunate and resulted in prolonged mouth closure with severe algal growth and deterioration of aesthetic qualities during 1992. However, it provided valuable information on the effectiveness of the management plan. Problems were identified and considerable expertise was gained which allowed modification and updating of the management plan. The dam filled up completely in October 1992 and a moderate flood occurred in the estuary, substantially improving its condition. Further overflowing of the dam and improved water release and mouth management techniques resulted in open mouth conditions for more than two-thirds of 1993, which was even better than the conditions experienced in 1988 and 1989, shortly before the completion of the dam.

SIGNIFICANCE FOR OTHER RIVERS AND CATCHMENTS

The following important lessons learned from the Great Brak study are relevant to other rivers and catchments.

The trade-off between developments in the catchment and the effects on the estuary

Developments in a catchment to meet water demands can have major negative effects on the river and estuary downstream. The problem to be solved is to determine the right trade-off between these demands and the consequences for the environment.

Required information related to river flow

Essential information to assess the effects of river flow on an estuary is often lacking as was originally the case in the Great Brak study. To address this the following field data should be collected:

- Water level recordings in the estuary
- River flow data
- Survey data on sedimentation and erosion
- Survey data on the ecology
- Survey data on the water quality.

Optimal usage of water for an estuary and substitutes to freshwater runoff

Investigations are required to assess the role of river inflow on an estuary and the key issues such as effects on mouth conditions and sedimentation need to be assessed. Based on this the river flow required to maintain a healthy functioning of the estuary can be estimated and a management plan can be designed to ensure optimal usage of water available for an estuary.

Even seemingly far-fetched ways of substitution of freshwater such as pumping of seawater, could be considered if this would result in the desirable effects on the environment of the estuary.

Other aspects such as siltation and water quality

Siltation caused by erosion in the catchment was not significant in the Great Brak Estuary, but in other estuaries such as Verlorenvlei on the west coast of South Africa or the Kleinriviervlei at Hermanus on the south coast and especially in Natal estuaries this is a major matter of concern. Measures to reduce erosion in the catchment should therefore be included in a catchment management plan for such systems.

Similarly pollution and deterioration of water quality are often major concerns and when appropriate these should be investigated and be addressed in the catchment management plan.

Implementation of the management plan and public involvement

A major lesson learned from the Great Brak study was the need to involve the local authorities and the community. This was relatively easy in the case of the Great Brak study because the Wolwedans Dam was a major impoundment with clearly identifiable effects.

More complicated and difficult problems are foreseen in other catchments where ongoing incremental developments can eventually cause similar or even far more serious problems. Irrigation activities, for example, can considerably reduce the baseflow in a river, which is often essential for maintaining open mouth conditions and salinity variations in an estuary. An effective management plan can then only be designed and implemented in close co-operation with all the interested and affected parties (I and APs). However, considering the deteriorated status of many of our estuaries it is essential that major efforts be undertaken.

First estimates of freshwater requirements of estuaries

In recent years a new way has been developed to determine first estimates of the freshwater requirements of rivers and estuaries. This is often done through workshops attended by scientists and interested parties. A major handicap is normally the almost total lack of essential information on the estuary. The first estimate reached is, however, often used for far-reaching planning purposes, while the recommendations to address uncertainties and to confirm assumptions are often ignored.

It is appreciated that this approach is used mainly because of lack of funding for proper studies. However, considering the enormous quantities of water required and the serious potential impacts of reduction in river flow, it is considered that efforts should be made to finance the recommended follow-up investigations. If the water supply to major cities such as Cape Town or Port Elizabeth is involved, ways of finding appropriate funding should be possible.

An option could be to have such investigations undertaken through and funded by the Water Research Commission (WRC). However, according to its policy, the WRC does not fund site-specific investigations. Their way of funding research projects through levies on water supply would, however, also be ideally suitable to raise funds for site (catchment) specific investigations.

CONCLUSIONS

The main conclusion of this study is that while originally only minor attention was given to the effects of the Wolwedans Dam on the Great Brak Estuary, the potential danger was then recognised as a very important aspect. This lesson is also applicable to other catchments and estuaries.

A major concern evolving from the Great Brak study is that while it is readily appreciated that a large dam has a major impact on an estuary, the accumulative effects of smaller developments in the catchment, such as those for irrigation activities, can have a similar or even more serious effect on an estuary. This is in particular the case where baseflow is being reduced sometimes to no flow at all. As has been explained for the Great Brak Estuary, the baseflow often plays a crucial role in an estuary, for example in maintaining open mouth conditions and salinity gradients.

Other conclusions

Involvement of interested and affected parties is essential in studies similar to that undertaken for the Great Brak.

The main problem to be solved is finding the right balance between the demands of water in the catchment and the effects of reduction in flow on the environment.

As was the case for the Great Brak, major efforts should be made to find ways of mitigating the effects of impoundments on an estuary.

Estuaries are a major asset as a tourism attraction for environmental and recreational reasons and also fulfil a key function in a much wider ecological sense.

Important lessons learned and various principles developed during the Great Brak study are also applicable to other estuaries.

The study provides an excellent example of river basin management to the benefit of the environment at the lower end of the catchment, i.e. the estuary.