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THE ECONOMICS OF COASTAL IRRIGATION SCHEMES: A CASE STUDY

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This paper examines the economic feasibility of Lostock Dam on the Paterson River, N.S.W. under a number of assumptions as to the resulting quantity and type of additional output. It is shown that the dam has a benefit-cost ratio greater than one only when the additional water is fully utilized and the discount rate is 5 per cent. However farmer estimates indicate that only a proportion of the extra water will be used, in which case the benefit-cost ratio is less than 0.1.

1 INTRODUCTION

1.1 GENERAL

Traditionally, large-scale irrigation dams in N.S.W. have been limited to areas of relatively low rainfall, on rivers with low levels of reliability. In recent years, however, the trend has been towards constructing irrigation dams on so called coastal streams.¹ Two dams are currently under construction on coastal streams,² and other sites are under investigation.

While the economics of irrigation schemes on inland rivers is relatively well documented, little information is available on the coastal schemes. This article examines the economics of Lostock Dam on the Paterson River to illustrate the type of return that can be expected from coastal dams. Lostock Dam is the first coastal irrigation dam to be constructed in N.S.W. As such, it will serve as a useful guide to the profitability of constructing dams on other coastal streams.

1.2 THE LOSTOCK DAM STUDY

During 1967 the N.S.W. State Government investigated the possibility of constructing a dam on the Paterson River. As part of the investigation the Water Conservation and Irrigation Commission of N.S.W. (W.C. & I.C.) commissioned an economic feasibility study of such a dam. After examining this report and other relevant data, the Government proposed legislation for the construction of a 16,000 acre-foot dam at Lostock. This legislation was passed in November, 1967. Construction has commenced and the dam should begin storing water during 1971.

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¹ Coastal streams in N.S.W. are taken to be those flowing to the sea east of the Great Dividing Range.

² Under construction: Lostock (Paterson River) and Toonumbar (Richmond River).

The construction of Lostock Dam on the Paterson River will alter the resource base in the Paterson Valley. With a regulated stream, farmers near the river will have to choose between utilizing or not utilizing water from the dam. However, during a farm survey of the Paterson Valley it became obvious to the author that farmers in the valley did not intend fully utilizing the water supply.³ This study was initiated to ascertain what effect less than full utilization would have on the economic feasibility of the project.

2 THE STUDY AREA

2.1 GEOGRAPHICAL CHARACTERISTICS

The Paterson Valley is a subcatchment of the Hunter Valley with an area of 425 square miles. The Paterson River is a south to south-easterly flowing tributary of the Hunter River, and has an estimated mean annual discharge at Lostock of 95,000 acre-feet per annum.

Rainfall in the Valley varies from as low as 30 inches per annum in the southern section, to over 60 inches per annum at the headwaters. Most of the study area is sub-humid in character, with no marked seasonality in the distribution of rainfall.

Landforms in the Paterson Valley are varied. In the southern section, there is an extensive area of river flats up to two miles wide, bounded by gently sloped hills. The valley then narrows considerably and large hills are found within two hundred yards of the river, although river flats up to half a mile wide do occur. In the northern section the valley floor narrows considerably and the hills become more rugged.

2.2 THE FARM SURVEY

For the economic feasibility study, information was required on the present farming pattern. As limited time and resources prevented a full farm survey, a sample of farms was visited to obtain the required information.

A number of alternative forms of land classification were examined to determine which would be most suitable for the selection of sample farms. The method selected was the Commonwealth Scientific Industrial Research Organization's Land Systems technique. A Land System is an area or group of areas exhibiting characteristic combinations of geology, soils, climate, and landforms. The Land Systems approach enables a systematic assessment of land potential of a region to be carried out.

Farms were allocated to the Land System or Systems that covered their surface. A 20 per cent random sample of the farms in each Land System was then carried out. Eighty farms were selected and visited, and farmer attitudes found to irrigation, pasture improvement, and innovations. Particular emphasis was placed on the importance of Lostock Dam to the individual farmer.

³ Richmond, R. N.: *The Economics of Lostock Dam: How Net Benefits can be Maximised* (University of New England, Armidale: Unpublished M.Ag.Ec. Thesis, 1971).

At the time of the survey there were 404 farms in the Paterson Valley. Of these, dairy farms constituted 160, beef cattle properties 195, commercial cropping⁴ farms 43, with a further 6 miscellaneous farms.

Dairying was found to be wide-spread throughout the study area. In the southern section it was the dominant industry, both in area and economic importance. Dairy farms constituted nearly 40 per cent of all farms in the valley, and varied in size from less than 50 acres to over 1,000 acres. Most dairy farmers had some frontage to the river, and on the larger dairy farms beef cattle grazing was often combined with dairying.

Beef cattle properties were found to be spread throughout the valley, although the main concentration was in the northern section. A majority of the properties were located away from the river on the poorer quality land. Beef cattle grazing was the sole activity of nearly half the farmers in the valley. Property size varied from 50 to over 5,000 acres, with most being in the vicinity of 500–800 acres. There were 51 properties of less than 200 acres, and most of these were operated on a part-time basis.

Commercial cropping farms were found to be restricted almost exclusively to the flood plain south of Paterson township. At the time of the farm survey they constituted less than one per cent of the total valley area, with 24 out of the total (43) being less than 50 acres. Over half of the commercial cropping farms were run on a part-time basis. This high proportion of part-time farmers in the most profitable agricultural enterprise could have considerable influence on the ultimate development of the valley.

2.3 RESULTS OF THE FARM SURVEY

At the time of the farm survey there were 79 farms in the valley operated by part-time farmers. These farms could be divided into two groups, those on and those off the flood plain. Total area of land owned by part-time farmers on the flood plain was found to be 1,281 acres. The total area of the flood plain has been estimated at 9,000 acres, so that over 14 per cent of all river flat land in the valley was owned by part-time farmers. However, on the more fertile expanse of river flats below Paterson township, the proportion owned by part-time farmers was 1,200 acres out of 5,000 acres, nearly 25 per cent. Thus 7 per cent of the farms in the valley were operated on a part-time basis, and occupied nearly 25 per cent of the most fertile land.

There were fifty-one part-time farmers owning land off the flood plain, or 13 per cent of all farms in the valley. The total acreage involved in those fifty-one farms was 8,072 acres, or nearly 4 per cent of all land owned by farmers off the flood plain. Therefore, part-time farmers off the flood plain owned a significant proportion of the number of farms, but a relatively insignificant proportion of the area.

⁴ Commercial cropping is used to devote the production of all types of vegetables, as well as cash crops such as lucerne and maize.

The importance of part-time farming to the present study is that farms operated on a part-time basis are unlikely to make as great a use of a regulated stream as farms operated on a full-time basis. Therefore the large proportion of top quality irrigable land held by part-time farmers will ultimately limit the net benefits from Lostock Dam.

Few farmers with properties adjacent to the tidal stretch of the Paterson River saw any real benefit from Lostock Dam. All claimed that lack of irrigation water was not a problem. They said the only possible benefit to them was from flood protection, but Lostock Dam is too small to be of benefit for this purpose. There appears to be some confusion regarding the problem of salinity. Farmers said that there is sufficient irrigation water, but that salinity was sometimes a problem. This would suggest that farmers may be irrigating when the salinity level is too high.

Farmers above the tidal influence showed a surprising lack of interest in the dam. A large majority of them thought the dam would be of great benefit to other farmers, but saw little benefit to themselves. Intended increases in the area already under irrigation were found to be marginal when compared with the area under irrigation. In particular, beef cattle producers saw little or no benefit from the dam, but expected that dairy farmers would benefit. Yet dairy farmers stated that they would not greatly alter the area under irrigation.

When farmers were asked the reasons currently preventing an increase in their net income, over a third gave lack of developmental capital. However, over a quarter claimed to be satisfied with their present position. If this is so, it is unlikely that any marked change in the type or amount of production will occur after completion of Lostock Dam.

Farmers were also asked the reason preventing an increase in the area under pasture improvement. Lack of sufficient capital was again a major problem, particularly on dairy farms. Two-thirds of beef cattle operators with land adjacent to the river were satisfied with their present position. Nearly 15 per cent of all farmers interviewed stated that they were satisfied with the area under pasture improvement, yet the typical property had less than 20 per cent of its area under any form of pasture improvement. Thirty per cent of farmers interviewed gave "lack of suitable land" as the reason for not increasing the area under irrigation. A further 13 per cent were satisfied with their present irrigated area.

Farmers were also asked would they change to another activity if it became profitable to do so. Only twenty-six of the farmers interviewed said that they would change to any other profitable activity. The remainder (54) said that they would remain with their existing form of production even if they knew other more profitable alternatives existed.

Results from the above questions indicate that farmers in the Paterson Valley will not be particularly receptive to change. In the light of this evidence it is doubtful if the farmers will greatly alter their existing scale or type of operation after completion of Lostock Dam. Nonetheless, a regulated stream will enable existing water users to place greater emphasis on irrigation in their farm planning.

2.4 ADDITIONAL AREA TO COME UNDER IRRIGATION

Farmers interviewed were asked what acreage they were irrigating, the maximum area that they could irrigate, and the area they intended irrigating after completion of the dam. The answers showed considerable differences between the three major types of production; dairying, beef cattle grazing, and commercial cropping (table 1). Dairy and commercial cropping farms averaged approximately thirty acres under irrigation at the time of the survey. On average, dairy farmers anticipated that they would place an additional twenty-one acres under irrigation after completion of the dam. Beef cattle operators (none of whom were irrigating at the time of the survey) anticipated that they would irrigate 9 acres per farm, while commercial cropping farmers stated that there would be no change.

Total area under irrigation at the time of the survey was found to be 3,881 acres (table 1). Farmers anticipated that this would increase by a further 2,200 acres to over 6,000 acres. However, a total irrigable area of 11,600 acres has been estimated by the W.C. & I.C. Thus, there is a difference of over 5,500 acres between what farmers intend irrigating after completion of Lostock Dam, and the total irrigable area.

TABLE 1
Farmers' Estimates of Irrigation Areas in the Paterson Valley

	Area under irrigation		Farmers' estimate of area to be irrigated after completion of Lostock Dam		Maximum irrigable area	
	(acres)		(acres)		(acres)	
	Average per farm	Total all farms	Average per farm	Total all farms	Average per farm	Total all farms
Dairy Farms ..	28	2,548	49	4,459	86	7,867
Beef Cattle Properties ..	0	0	9	261	49	1,408
Commercial Cropping Farms	31	1,333	31	1,333	54	2,325
	24	3,881	37	6,053	71	11,600

3 BENEFIT-COST ANALYSIS

3.1 SELECTION OF INVESTMENT CRITERIA

An economic feasibility study of Lostock Dam was commissioned by the N.S.W. Government during 1967.⁵ The report found a benefit-cost

⁵ A. Pattison *et al*, *Lostock Dam: An Economic Feasibility Study* (Hunter Valley Research Foundation: Maryville, 1967).

ratio of 1.32 based on the assumption that the total available area would be irrigated. So that comparisons between that report and this present study could be made, it was necessary to use similar criteria. Two feasibility criteria were used, the benefit-cost ratio and net present value, although only the former criterion is used in this article.⁶

Benefits from Lostock Dam were assumed to come entirely from increased production due to irrigation. Secondary benefits were noted but no monetary value was allocated to them. Cost figures used were those supplied by the W.C. & I.C. in 1967. Prices used throughout the analysis were those existing at the time of the field survey.

To determine the sensitivity of the analysis to changes in the discount rate, a range of rates from 2 to 10 per cent was used, with most emphasis being placed on the 6 per cent rate. A seventy-five year period of analysis was assumed.

3.2 ALTERNATIVE AVAILABLE TO THE FARMER

Any increase in production due to the dam can result from three main alternatives. Firstly, any increase in production attributable to Lostock Dam might occur only within the existing enterprises. Thus, dairy farmers would increase their milk production, beef cattle operators the production of beef, and commercial cropping farmers the production of vegetables. As shown in the farm survey results, farmers in the Paterson Valley do not appear to be particularly flexible in their management policies. Therefore any increase in production can be expected to occur mainly within the existing enterprises.

A second possibility might be that following completion of the dam, farmers increasing their area under irrigation would do so in the most profitable enterprise currently found in the Valley. Thus, farmers would change to the most profitable activity out of dairying, beef cattle grazing, and commercial cropping. However, the farm survey revealed that farmers are unlikely to change to a more profitable activity.

Thirdly, with a regulated water supply available to farmers adjacent to the river, any additional irrigated land might be used for some enterprise that is currently not found in the Paterson Valley. However, it is reasonable to assume that alternative enterprises requiring irrigation have already been tried elsewhere in the Hunter Valley. Possible exceptions to this would be an enterprise heavily relying on a regulated stream, or an enterprise with a developing market. Results from the farm survey indicate that no marked change from new enterprises is likely to occur.

For each of the three main alternatives described above a separate benefit-cost analysis was undertaken. Various combinations of these assumptions were also examined. In addition, sensitivity tests were carried out to determine the effect of altering the main assumptions. The more important results of the analysis are discussed below.

* See R. N. Richmond, *ibid*, Ch. 1 for a more detailed account.

3.3 INCREASED PRODUCTION ATTRIBUTABLE TO LOSTOCK DAM WITHIN THE THREE EXISTING ENTERPRISES

Farmers in the Paterson Valley anticipate that the area under irrigation will increase from almost 3,900 acres to just over 6,000 acres, following completion of the dam. Expected net benefits per acre resulting from the use of irrigation were calculated for dairying, beef cattle, and commercial cropping.⁷ If the farmers' estimates of the area to be irrigated and the authors' estimate of net benefits per acre are correct, the benefit-cost ratio is 0.10 at the five per cent level (table 2). The corresponding result at the six per cent discount level is 0.07. Based on these assumptions (the *expected* result), the dam is not economically justified at either discount rate.

TABLE 2

Benefit-Cost Analysis of Lostock Dam: Assuming Increased Production Occurs within the Existing Enterprises

Discount rate (per cent)	Farmers' estimates of area correct; Net benefit per acre estimates correct	Farmers' estimates of area correct; Higher net benefit per acre estimates	Maximum area irrigated; Net benefit per acre estimates correct	Maximum irrigable irrigated; Higher net benefit per acre estimates
5	0.10	0.23	0.69	1.09
6	0.07	0.18	0.53	0.84

Maximum irrigable area has been calculated by the W.C. & I.C. at 11,600 acres. The maximum possible net benefits per acre attributable to the dam were also calculated.⁸ If the maximum area is irrigated following completion of the dam, and the maximum net benefits per acre are achieved, then a benefit-cost ratio of 1.09 results at a 5 per cent discount rate (table 2). This ratio drops to 0.84 at the 6 per cent level.

Therefore, based on the *maximum* possible result, the dam is economically justifiable at the 5 per cent level. This maximum situation however, is unlikely to occur.

3.4 INCREASED PRODUCTION ATTRIBUTABLE TO LOSTOCK DAM OCCURS WITHIN MOST PROFITABLE ENTERPRISE IN THE PATERSON VALLEY

Of the three enterprises in the Valley, commercial cropping was found to be the most profitable, followed by dairying and beef cattle grazing. However when the expected increase in production is considered, beef cattle grazing becomes more profitable than dairying. This occurs

⁷ R. N. Richmond, *op cit*, Ch. 4, 5, and 6.

⁸ R. N. Richmond, *ibid*.

because any increase in milk production will be sold as surplus milk at 20 cents a gallon, whereas, currently, farmers average a return per gallon of approximately 35 cents.

Commercial cropping farmers stated that they would not place any additional area under irrigation after completion of the dam. Therefore, if the farmers' estimates of the additional area to be irrigated are correct, then the area under commercial cropping will remain the same. Consequently, any additional area irrigated would be used for the next most profitable enterprise, beef cattle.

If the farmers' estimates of the additional area to be irrigated and the authors' estimates of expected net benefits per acre are correct, then a benefit-cost ratio of 0.16 results using a 5 per cent discount level (table 3). At a discount rate of 6 per cent, the relevant ratio is 0.12. Consequently, the dam is not economically justifiable at either discount rate.

TABLE 3
Benefit-Cost Analysis of Lostock Dam: Assuming Increased Production Occurs within the Most Profitable Enterprise in the Paterson Valley

Benefit-Cost Ratios				
Discount rate (per cent)	Farmers' estimates of area correct; Net benefit per acre estimates correct	Farmers' estimates of area correct; Higher net benefit per acre estimates	Additional 2,000 acres irrigated on commercial cropping farms; Net benefit per acre estimates correct	Additional 2,000 acres irrigated on commercial cropping farms; Higher net benefit per acre estimates
5	0.16	0.49	0.98	1.18
5	0.12	0.25	0.75	0.90

What will be the effect on the result of increasing both the area to be irrigated and the net benefits per acre? An increase in the area irrigated to the maximum available would result in an increase in the area under commercial cropping. However it is unrealistic to assume that all of the available land would be placed under vegetables. Due to the state of the markets, and its heavy reliance on Sydney and Newcastle, any increase in the area planted to vegetables in the Paterson Valley must be limited. Therefore, after considering the market situation, a limit of additional 2,000 acres was placed on the area available for commercial cropping. Any increase in the area irrigated above this level was assumed to occur in the beef cattle enterprise. The effect of these new assumptions on the benefit-cost ratio was then examined. With the maximum area irrigated, and the maximum possible net benefits per acre, a benefit-cost ratio of 1.18 resulted at the 5 per cent discount rate (table 3). However, a ratio of 0.90

resulted at the 6 per cent discount level. Therefore, based on these assumptions, the dam is not economically justifiable using a 6 per cent discount rate.

3.5 ASSUME INCREASED PRODUCTION FROM LOSTOCK DAM OCCURS IN MOST PROFITABLE ALTERNATIVE: NOT NECESSARILY FOUND IN PATERSON VALLEY

Finally it was assumed that farmers expand their irrigable area by producing the most profitable alternative, which may not be currently found in the Paterson Valley. As there are large areas under irrigation in the Hunter Valley it is reasonable to assume that any enterprise suitable for the Paterson Valley can be expected to be currently under irrigation in the Hunter Valley. Major types of production in the Hunter Valley are dairying, beef cattle grazing, and commercial cropping. These are also the major types found in the Paterson Valley. The only other enterprise found to be more profitable than those already described was wine-grape production.

It was found that at the present prices for wine grapes, 500 acres of vineyards would be required to make Lostock Dam economically justifiable at the 5 per cent discount level. An additional 200 acres of vineyards would be necessary to obtain a benefit-cost ratio greater than one, at a 6 per cent discount rate. There are currently no vineyards in the Paterson Valley, and little likelihood that such a development will take place.

3.6 REQUIREMENTS FOR A BENEFIT-COST RATIO GREATER THAN UNITY

At the 5 per cent discount level there are three combinations of resources which result in a benefit-cost ratio greater than unity. These are:

- (i) Increased production occurs within existing enterprise:
Maximum area irrigated, maximum net benefit per acre estimates.
Benefit-cost ratio: 1.09—unlikely.
- (ii) Increased production occurs within most profitable enterprise in the Paterson Valley:
Additional 2,000 acres planted to commercial cropping, additional 5,700 acres for beef cattle; maximum net benefit per acre estimates.
Benefit-cost ratio: 1.18—unlikely.
- (iii) Increased production occurs in a more profitable enterprise, not currently found in the Paterson Valley:
500 acres planted to grapes, 7,200 acres for beef cattle.
Benefit-cost ratio: 1.55—unlikely.

At a 6 per cent discount rate the dam is economically justifiable under one combination of resources:

- (i) Increased production occurs in a more profitable enterprise, not currently found in the Paterson Valley.
700 acres planted to grapes, 7,000 acres for beef cattle.
Benefit-cost ratio: 1.00—unlikely.

5 SUMMARY AND CONCLUSIONS

5.1 LOSTOCK DAM

Farmers in the Paterson Valley anticipate that they will place an additional 2,200 acres under irrigation following completion of the dam. Based on this estimate, a benefit-cost ratio of 0.07 results using a 6 per cent discount rate. If the maximum available area is irrigated, then the ratio increases to 0.75 at the 6 per cent level.

Three different combinations of resources were found to provide a benefit-cost ratio of greater than unity, using a 5 per cent discount rate. At the 6 per cent level, only one combination of resources was found to have a ratio greater than one. However, all of these combinations were considered unlikely to occur.

5.2 OTHER COASTAL DAMS

Sites of proposed coastal dams are mainly in dairying areas, with considerably smaller proportions of their land devoted to commercial cropping and beef cattle grazing than is the case in the Paterson Valley. As dairying was found to be the least profitable venture of the three in the Paterson Valley, then future coastal dams are likely to be even less profitable than Lostock Dam. One can only agree with the comment by Davidson that "as long as irrigation on the coastal rivers of sub-tropical Australia is used to enlarge the dairying industry or to produce commodities which prevent the conversion of existing dairying regions to other more profitable types of farming, there appears to be little economic reason for expanding irrigation".⁹

There are two main reasons why coastal dams are unlikely to be economically justifiable. Firstly, the net benefits per acre attributable to the dam (particularly with the emphasis on dairying) are likely to be low. Secondly, the relative abundance of rainfall, and availability of irrigation water for land adjacent to coastal streams means that the farmer only has a requirement for supplementary irrigation. Consequently farmers will not greatly increase the area under irrigation after construction of a dam. Economic feasibility studies of proposed coastal dams should therefore place considerable importance on the farmers' estimates of the likely area to be irrigated following completion of the dam.

⁹ B. R. Davidson, *Australia Wet or Dry? The Physical and Economic Limits to the Expansion of Irrigation* (Melbourne University Press, Melbourne: 1969), p. 213.