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Cost Benefit Analysis and Land Reclamation: A Case Study

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COST-BENEFIT ANALYSIS AND LAND RECLAMATION: A CASE STUDY

by

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Abstract

This paper examines the costs and benefits of land reclamation in the United Kingdom, using as a case study one of the largest reclamation schemes ever undertaken, at Higher Folds in Lancashire, N.W. England. The approach adopted was based on the contingent valuation method (CVM) which solicits measures of willingness to pay for environmental improvement by a questionnaire directed at likely users of the reclaimed site, and at non-users who may exhibit preferences for the environmental benefit. In this case, CVM answers were elicited from potential users only. Measures of benefit based on CVM were significantly less than the costs of reclamation, suggesting that, on economic efficiency grounds, the reclamation was not justified. Observation of post-reclamation land values revealed land valuations that were significantly less than the costs of acquiring the land. Such a result is consistent either with the land having been purchased at an excessive price or with negative environmental benefits from the reclamation. While both the CVM and land value approach suggest that reclamation is not justified on efficiency criteria, other social objectives might be served by the reclamation, given that the site is in the North of England with higher than average unemployment. No shadow pricing exercise has been carried out to test this view.

1. INTRODUCTION

Monetary benefit measurement is increasingly being used in the United Kingdom to assist decision-making with respect to environmental improvement (Markandya and Pearce [1989], Turner [1988]). The contingent valuation method (CVM) is widely regarded as the most applicable technique because of its reliance on controllable interviews. Other valuation techniques, such as hedonic pricing from the use of surrogate markets, require fairly extensive data gathering and may involve unrealistic assumptions about the efficient workings of markets (Pearce and Markandya [1989]). CVM relies on a direct questionnaire approach, asking individuals what they are willing to pay for environmental improvement. Biases within the approach can be tested. Evidence to date suggests that 'hypothetical bias' - biased responses due to the interviewee being placed in a hypothetical situation rather than one involving real monetary exchange - is a problem. The direction of the bias tends to be known, and it may be quantifiable through 'mixed' CVMs in which some respondents engage in actual money payments (Cummings et al [1986]).

Although the contingent valuation technique is now a well established method of benefit measurement (Randall et al [1974], Brookshire et al [1976], Brookshire et al [1980], Rowe et al [1980], Thayer [1981] and Schulze et al [1983]), it has been little applied in relation to a major form of environmental improvement, namely land reclamation schemes. These seek to alleviate the effects of environmental dereliction through operations such as the regrading of spoil heaps, cultivation, seeding and tree planting. The most detailed study of the costs and benefits of reclaiming surface coal

mines was that of Randall et al (1978). Randall and his co-workers found, that, for the Central Appalachian region as a whole, the social benefits of reclamation exceeded its private costs. Policy makers are concerned with individual reclamation schemes as well as with regional considerations, and so this study focuses on a case study deep mine site in North West England.

2. EMPIRICAL STUDY

In order to assess the benefits of land reclamation, a contingent valuation survey was carried out at Higher Folds, located between the towns of Leigh and Tyldesley in Lancashire. Prior to reclamation, which began in 1977, this 191 hectare site included a prominent plateau of colliery spoil heaps up to 25 metres high, some of which loomed over houses on the Higher Folds housing estate and collapsed into back gardens. The spoil heaps frequently caught fire, causing problems of nuisance from smoke and unpleasant sulphurous smells, and dust blew off the site in dry weather. The site also contained 14 mine shafts, dangerous subsidence flashes and lagoons, derelict buildings, disused railway lines, a station and sidings and a former sewage works. Owing to the high acidity of the colliery spoil, vegetation was slow to colonise the site.

The complete removal of the enormous spoil heaps couldn't be justified on economic grounds, and so they were regraded to form gentle slopes for 122 hectares of agriculture, 67 hectares of tree planting and 2 hectares of football pitches. Over 330,000 trees were planted in what was Britain's biggest land reclamation scheme at the time. The reclamation works consisted of advance drainage provision, site clearance and demolition, earthmoving including the filling of drainage ponds and flashes, the stripping and

re-spreading of what topsoil was available on the site over some 40 hectares, and the extraction of subsoil to provide a layer of protective material to prevent acidity rising due to the weathering of iron sulphide in the spoil beneath. This was followed by the construction of 22 km of drainage ditches and 25 km of fences, the treatment of mineshafts, the importation of 23,000 tonnes of lime waste to neutralise spoil acidity and cultivation works to establish grass and clover. Finally, tree planting was undertaken and 6 km of footpaths and 9 km of bridleways laid down. The initial reclamation works lasted about two years, with further cultivation and landscaping taking place over the following five years.

The Higher Folds reclamation scheme was designed to produce aesthetic, environmental, health and safety benefits. It was a "soft" after-use scheme, primarily undertaken to improve the environment rather than a "hard" after-use scheme, designed to provide land for development. In Britain, "hard" reclamation schemes are currently given far greater priority by central government than "soft" ones (Department of the Environment [1987]).

3. SURVEY CHARACTERISTICS

An iterative bidding technique was used to value the benefits of the Higher Folds reclamation scheme. The questionnaire that was used consisted of three different sets of questions. In the first set of questions, respondents were asked how long they had been living near to the site, whether they remembered the site prior to reclamation, about their level of use of the site before and after reclamation, and their household incomes. Respondents were asked to place their income within specified ranges, and this was the final question in the survey because of possible objections to it.

Secondly, respondents were questioned about their willingness to pay to use the site and for reclamation. At the beginning of the questionnaire, each interviewee was shown a map to clarify the location and extent of the site. They were then shown sets of photographs of the site before and after reclamation.

Three measurement procedures were used, and this part of the questionnaire was broadly based on the design of Brookshire et al. [1976]. Firstly, respondents were asked if they would be willing to pay a £1 family entrance charge to visit the site. The amount was increased by 50 pence a day until a negative response was obtained and then decreased in steps of 10 pence at a time until a positive response was obtained.

Two alternative payment vehicles were employed to measure willingness to pay for reclamation, making it possible to test for vehicle bias. Respondents were first asked, supposing that the site was still unreclaimed, how large a single, once and for all payment in rent or rates they would be willing to make towards reclaiming and maintaining the site to its present state. It was stressed that no rebates would be available from the local council and that this form of payment would be the only way of financing reclamation at the site. The starting point bid was £10 and the bidding steps used were the same as those for the entrance charge question.

The final payment vehicle was willingness to pay for reclamation via electricity bills. The use of this alternative vehicle was justified by explaining that if the Coal Board did the reclamation work, it could increase the price of coal used to generate electricity, and therefore consumers' electricity bills. Respondents were asked, supposing that the site was still unreclaimed, how large an increase in their quarterly electricity

bill they would be willing to make as a single, one-off payment towards reclaiming and maintaining the site to its present condition. It was again emphasized that no rebates would be available for this payment from the local council and the starting point bid and steps used in the bidding process were the same as those for the rent or rates vehicle.

Finally, respondents were asked a number of other questions. They were asked to name and rank those benefits of reclamation that they were willing to pay for, to specify the advantages and disadvantages of reclamation to their households and whether they preferred the site in an unreclaimed or reclaimed condition. In addition, they were questioned as to what uses of the land and facilities they wanted to see on the site, to comment on the design of the reclamation scheme and whether they had any preferences about the way in which similar sites should be reclaimed in the future.

Interviews were conducted in May and June 1988 among a random sample of 100 residents living in the immediate vicinity of the reclamation scheme. The houses that were visited were all council houses, a small proportion of which were owned by housing associations.

4. SURVEY RESULTS

Household characteristics are summarised in Table 1. Standard errors are in parentheses. Residents in the immediate vicinity of the reclamation scheme are relatively immobile and have low annual incomes. Over three-quarters of them remember what the site was like prior to reclamation. 85% of respondents preferred the site after reclamation, but the fact that 8% preferred what was there

before indicates some dissatisfaction with the policy of reclamation.

The results of the bidding games are presented in Table 2. The mean bids for the rent or rates and electricity bill vehicles are not significantly different even at the 10% significance level, indicating the presence of negligible vehicle bias, i.e. bias due to the choice of hypothetical payment mechanism.

The contingent valuations in the range £8.3-9.0 can be used to estimate an aggregate bid for reclamation on a one-off basis. From estimates of the effect of reclaimed and unreclaimed land on house prices obtained from a survey of professional valuers working in local estate agencies, we assume that residents living within 250 metres of the site are likely to be affected by its state. In this survey valuers were asked to provide valuations for a house with a built-up area on one side and greenbelt farmland stretching away from it on the other. They were told that this greenbelt land may or may not, however, include an unreclaimed or a reclaimed colliery spoil site at different distances from the house being valued. Valuers were shown photographs of coal mine sites, including Higher Folds, before and after reclamation and asked to assess the extent to which houses, worth £20,000, £30,000 and £40,000 when the neighbouring land has never had a coal mine on it, would be affected by their proximity to reclaimed and unreclaimed deep-mined colliery spoil sites. In the case of the Higher Folds reclamation scheme, for a £20,000 house, which is the most appropriate in this area, 250 metres was the greatest distance at which a statistically significant difference between house prices associated with reclaimed and unreclaimed sites was obtained at the 5% level.

From 1981 population census returns at the enumeration district

level the number of households within 250 metres of the site is estimated to be approximately 2,000. This gives an aggregate willingness to pay a once-and-for-all sum of some £17,000 - 18,000 in 1988 prices. This is very low in relation to the costs of reclaiming the site, as Table 3 indicates. Table 3 shows the results of cost-benefit analyses of the Higher Folds reclamation scheme. The relevant costs and benefits are also itemised separately, as are land acquisition costs, which are not real resource costs. All figures are in constant 1987/88 prices and have been discounted over a twenty year time period at both 5 and 7% rates to provide sensitivity analysis.

The remaining vehicle used in the CVM approach was a hypothetical user charge. Table 2 shows that this was £18.5 per annum, suggesting an aggregate bid across the 2,000 households of £37,000 per annum. Over a twenty year time horizon, at a 5% discount rate this suggests a present value of some £480,000, and at 7% a value of £420,000.

Such figures are markedly higher than those for the 'one off' valuations based on the rent/rates and electricity bill vehicles. Table 4 shows that the unreclaimed site was used by over half the residents who lived next to the site before as well as after it was reclaimed. The proportion of these residents visiting the site increased only slightly after reclamation whilst their level of use of the site declined, although this effect was not statistically significant. If there was positive willingness to pay for the use of the unreclaimed site, this should ideally be deducted from the willingness to pay for the reclaimed site to obtain a net measure of welfare improvement. Unfortunately it was not possible to test for the possibility of a positive valuation of the unreclaimed site.

However, as Table 1 shows, the reclaimed site was preferred by the overwhelming majority of residents, suggesting a low valuation for the unreclaimed site. On this basis, therefore, net benefits from reclamation could be of the order of £400,000 - 500,000.

The marked difference in the results of the user charge vehicle compared with the other vehicles could be evidence of vehicle bias. Rents, rates and electricity bills have the image of being unavoidable, whereas a user charge is under the control of the respondent in that he or she can choose whether or not to incur it. It is also possible that the questions relating to the other vehicles did not adequately capture their intended 'one off' payment nature. Accordingly, we place greater faith in the user charge figure for benefits.

Despite this it remains the case that the benefit figure is significantly less than the reclamation costs by some £2.5 million. On cost-benefit criteria, the reclamation was not worthwhile.

Table 3 also shows the the post-reclamation value of the land based on estate valuers' assessments. These valuations may be interpreted as gross hedonic prices. However, Table 3 makes it clear that the valuations are actually significantly less than the cost of acquiring the land. Even allowing for some 10% of the acquisition costs being taken up in administrative costs, Table 3 suggests that land value <u>losses</u> of about £900,000 in present value terms were sustained, indicating either a <u>negative</u> environmental benefit if the values are constructed as hedonic prices, or, and this seems more likely, that the land was acquired at excessive prices.

No landscape maintenance works have been carried out on the tree-planted area of the Higher Folds reclamation scheme since the

abolition of the Metropolitan County Councils in April 1986. However, maintenance will soon resume and is expected to cost some £2,200 per annum in 1988 prices once initial works to catch up for the hiatus in maintenance have been undertaken. Grazing licences from the area reclaimed to agriculture provide about £6,000 in income per annum in 1988 prices, and so the site is currently generating net income of about £3,800 a year.

It is clear that the estimates of aggregate willingness to pay are extremely low in comparison with the reclamation costs presented in Table 3. For all the payment vehicles, the percentage of zero bids received was high; comprising 45% for the rent/rates vehicle, 48% for electricity bills and 65% for site use. However, the percentages of respondents who stated that their reason for a zero bid was that they couldn't afford to pay anything were only 11%, 11% and 5% for the respective payment vehicles. Thus in general it was an objection to the principle of paying for reclamation rather than the low average incomes of respondents which was the major reason for the high frequency of zero bids that was encountered.

The benefits of reclamation that more than 1% of respondents were willing to pay for are itemised in Table 5. The aesthetic improvement resulting from reclamation was the most commonly mentioned benefit, followed by recreational opportunities and walks. Respondents were also willing to pay for benefits in site safety and health. These included the prevention of spoil heaps collapsing into back gardens, the elimination of sulphurous smoke from burning spoil heaps which caused stomach aches and other health problems, and dangers from subsidence flashes in which one child drowned.

5. DISTRIBUTIONAL IMPACTS

A comparison of mean bids and yearly income for respondents who lived near the site prior to reclamation and those who did not is shown in Table 6. It was hypothesised that residents who had experienced living next to the unreclaimed site would have a lower willingness to pay for reclamation and mean incomes than those who moved to the area after reclamation, because they would be unable to afford to move from the area. This theory is generally supported by the results in Table 6; willingness to pay via rent or rates and a daily entrance charge and mean annual income were significantly lower for those respondents who lived next to the site prior to reclamation compared with those who did not. On average, the former group had lived next to the site for 34 years, whilst those who arrived after reclamation had lived there for a mean of 5 years. It is also likely that the newcomers were typically younger, more affluent and more mobile and may have been attracted to the area by the increased attractiveness of housing surrounding the site following reclamation.

Annual household incomes were obtained for 70 respondents. Overall, the mean percentage of income that respondents were willing to pay for reclamation was 0.4% for site use on an annual basis, and 0.2% via rent or rates and electricity bills. Willingness to pay via rent or rates and electricity bills were both positively correlated with mean annual income at the 5% significance level, whereas willingness to pay for site use on an annual basis was not. However, the data for both willingness to pay via rent or rates and electricity bills included an outlier, which when excluded from the data meant that the relationships were not statistically significant. Thus, as regards the distributional impacts of

reclamation, there was no strong relationship between willingness to pay and annual incomes. Income elasticities of demand were positive but less than one, indicating that demand for reclamation was not pro-rich (Pearce et al [1979]).

6. CONCLUSIONS

A bidding game interview technique was used to elicit a measure of the benefits of a major land reclamation scheme. The results in present value terms are shown in Table 7 and are compared with the costs of reclamation. The cost-benefit approach suggests strongly that the reclamation was not warranted on efficiency grounds. There is also evidence of this from the land value approach which indicates an actual loss in terms of post-reclamation land values compared with the cost of acquisition.

Evidence on the distribution of benefits was also adduced, and this shows that residents who moved to the immediate vicinity of the site following its reclamation generally had higher incomes and willingness to pay for reclamation than those who lived there prior to reclamation. Income elasticities of demand for reclamation were found to be less than unity.

It is possible that other benefits of reclamation might justify the scheme. These include the increased attractiveness of the area to business and potential developers, enhanced civic pride and social benefits in an area of above average unemployment and below average incomes.

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TABLE 1
Household characteristics

Yearly income (mean of 70 respondents)	£ 4,874.50
	(516.41)
Mean number of years spent living near to the site of the reclamation scheme	22.73
	(1.82)
Percentage of respondents who remembered what the unreclaimed site was like	77%
Percentage of respondents who preferred the site:-	
Unreclaimed	8%
Reclaimed	85%
No preference	7%

TABLE 2
Mean bids (£s)

Rent or rates	8.30	*
	(2.31)	
Electricity bills	9.06	*
	(2.60)	
Site use (per day)	0.16	
	(0.03)	
Site use (yearly)	18.47	
	(6.16)	

Standard errors are in parentheses.

* Indicates not significantly different at 10% level.

TABLE 3

Costs of reclamation and cost-benefit analyses of Higher Folds reclamation scheme, present values of willingness to pay figures and financial information (£s). Constant 1987/88 prices, 20 year time horizon.

1. Cost of reclamation including scheme design costs		
Discount rate		
r = 5%	-3,202,200	(-16,800 ha^{-1})
r = 7%	-2,843,000	(-14,900 ha^{-1})
2. Cost-benefit analyses of reclamation using CVM benefit measures		
(a) NPV using rent/rates		
r = 5%	-3,185,600	(-16,700 ha^{-1})
r = 7%	-2,826,400	(-14,800 ha^{-1})
(b) NPV using electricity bills		
r = 5%	-3,184,100	(-16,700 ha^{-1})
r = 7%	-2,824,900	(-14,800 ha^{-1})
(c) NPV using annual user charge		
r = 5%	-2,718,000	(-14,200 ha^{-1})
r = 7%	-2,423,600	(-12,700 ha^{-1})
3. Present value of aggregate one-off willingness to pay via rent/rates		
r = 5%	16,600	
r = 7%	16,600	
4. Present value of aggregate one-off willingness to pay via electricity bills		
r = 5%	18,100	
r = 7%	18,100	
5. Present value of aggregate willingness to pay via annual user charge bills		
r = 5%	484,200	
r = 7%	419,400	
6. Cost of land acquisition including associated administrative costs (financial analysis; not a real resource cost)		
r = 5%	-1,116,400	(-5,800 ha^{-1})
r = 7%	-1,056,400	(-5,500 ha^{-1})
7. The post-reclamation value of the reclaimed land (financial analysis)		
r = 5%	242,900	(1,300 ha^{-1})
r = 7%	190,100	(1,000 ha^{-1})

TABLE 4

Site usage by respondents who lived next to the site before and after reclamation (N=61)

Percentage of respondents who used the site before it was reclaimed	52%	
Mean number of times a week they used the unreclaimed site	2.92	*
	(0.42)	
Percentage of respondents who use the site after reclamation	56%	
Mean number of times a week they use the reclaimed site	2.34	*
	(0.39)	

Standard errors are in parentheses.

* Indicates not significantly different at 5% level.

TABLE 5

Those benefits of reclamation that more than 1% of respondents were willing to pay for.

Improved views	37%
Recreational opportunities and walks	18%
Site is safer	12%
Site is cleaner	7%
Creation of countryside	6%
Site is tidier	5%
Increased wildlife value of site	4%
Improved access to site	3%
Site no longer smells	3%
The land has been put to a good use	3%
Site is healthier	2%
Area now has a better reputation / morale	2%
House prices increase as a result of reclamation	2%

TABLE 6

Comparison of mean bids and annual income for respondents who lived near the site before reclamation with those who did not (£s).

	Those there before reclamation (N = 61)	Those there after reclamation (N = 39)	
Rent or rates	4.31	14.53	*
	(0.99)	(5.62)	
Electricity bills	5.54	14.56	
	(1.86)	(5.64)	
Site use (per day)	0.11	0.23	*
	(0.03)	(0.05)	
Site use (yearly)	16.03	22.29	
	(9.30)	(6.23)	
Yearly income	4,085	5,991	*
	(693.77)	(929.26)	
	(Mean of 41 responses)	(Mean of 29 responses)	

Standard errors are in parentheses.

* Indicates means are significantly different at the 5% level.

TABLE 7

Costs and benefits of reclamation at Higher Folds (£s)

Vehicle for Measuring Benefit	PV of benefits	
	5%	7%
(1) One-off rental/rate increase	16,600	16,600
(2) One-off electricity bill increase	18,100	18,100
(3) Annual user charge	480,000	420,000
Costs of reclamation		
NPV (a)	-3,186,600	-2,826,400
NPV (b)	-3,184,100	-2,824,900
NPV (c)	-2,718,000	-2,423,600

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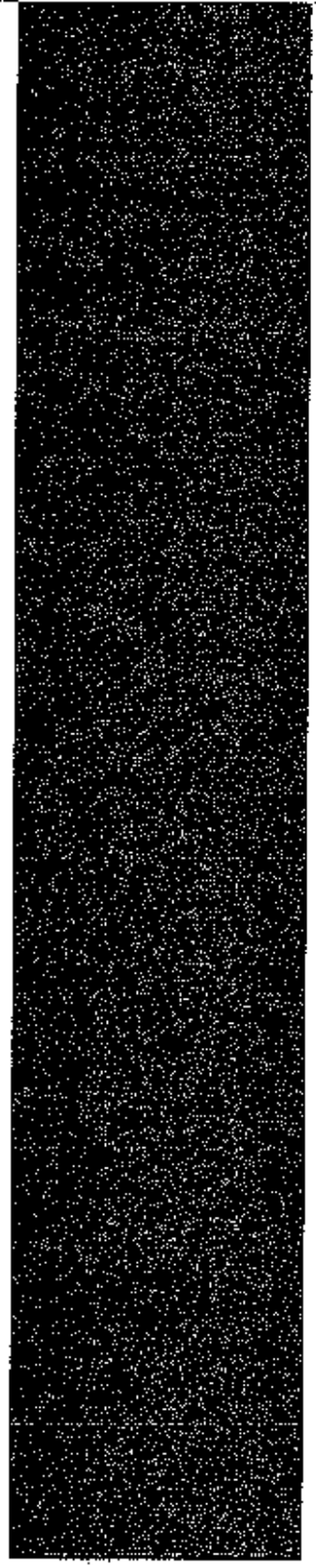

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