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RIGHTS TO CLEARED LAND AND THE CONTROL OF DRYLAND-SEEPAGE SALINITY*

IAN HODGE
University of Queensland, St. Lucia, Queensland, 4067.

The phenomenon of the clearance of deep-rooting vegetation leading to dryland salinity exhibits a number of characteristics which indicate the presence of market failure. These are discussed in the context of identifying an optimal level of clearance in a particular catchment. Various policies could be applied in order to correct for these problems. The potential for the use of taxes and regulations is examined and their limitations are identified. A scheme involving the use of transferable rights to cleared land is described and evaluated by means of a hypothetical example. Controls over land clearance will be more easily achieved when they are introduced at an early stage in the land development process.

Introduction

The problem of the loss of productive potential of agricultural land as a result of salinity, both in irrigation and dryland agricultural areas, is being increasingly recognised. To date there have been relatively few governmental efforts to influence the changes taking place but controls are likely to be implemented in the future. The subject of this paper is the phenomenon of dryland-seepage salinity. In this case (see, for example, Malcolm 1977 and Hamilton and Lang 1978), the clearance of deep-rooting vegetation from agricultural areas reduces the rates of evapotranspiration with the consequence of raising the level of the water-table in areas of restricted drainage. Once the water-table approaches the land surface in the valley floors, capillary rise can draw groundwater containing salts to the soil surface where evaporation leads to salt concentration in the soil. Shaw and Hughes (1981) estimate that the area affected by dryland-seepage salting has increased by about 88 per cent in the period 1972 through 1980, the total area affected now being 370 000 ha or 0.82 per cent of the cultivated area of Australia. The process of land becoming saline may take several decades, or it could occur within a few years subsequent to excessive land clearance, thus rendering land unproductive over a substantial period in the future. Furthermore, where it occurs in water catchment areas, the quality of water is affected, resulting in saline water supplies to other users. This effect has been experienced in several states (Peck 1980).

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While salting occurs only on lower areas, those occupiers clearing higher areas may nevertheless be at least partially responsible for the loss of productive land without bearing any cost. Thus, the cost is external to at least some producers. Furthermore, if the quality of water is reduced to downstream users, all those contributing to the problem are in some degree responsible for causing external costs. Finally, there may be intertemporal externalities if the loss of future production is not fully taken into account by present day producers. Arguments analagous to these have been more commonly aired in the context of soil erosion (e.g. Department of Environment, Housing and Community Development 1978).

While the consequences of salting may, in some instances, be mitigated through the use of salt-tolerant species, two types of approach may be adopted in the control of dryland-seepage salinity. Engineering methods can involve either intercepting water before it reaches the poorly drained areas or improving surface and subsurface drainage in these areas. However, the high costs involved in this approach, and the relatively low value of dryland production, mean that it is unlikely to be adopted on a widespread basis (Hamilton and Lang 1978). A more appropriate method of control lies in the revegetation and the protection of vegetation in the affected and susceptible areas. The levels of water-tables can be lowered by deep-rooting trees and shrubs. This implies that it would be necessary to achieve cover over a certain proportion of the land area in order to protect the land against salinity. For instance, Dawson and Johnston (1981) have indicated that there is considerable scope in Queensland for preventative measures against saline seepages through identifying salt-susceptible areas and maintaining a protective vegetative cover. They suggest that the most effective way to control future outbreaks is to avoid or limit clearing of susceptible catchments.

The objective in this paper is to investigate the potential of alternative schemes to control the extent of land clearance in areas susceptible to salinity. They are compared on the basis of efficiency and equity. The possibility of using a scheme involving transferable rights is illustrated by means of a hypothetical example. Before this, some issues associated with the optimal extent of land clearance are discussed.

The Optimal Extent of Uncleared Land

The optimal extent of clearance will depend upon the nature of the physical environment, the interactions between physical variables, relative prices and technology. It is suggested above, however, that the extent of clearance undertaken in the absence of control is likely to exceed the socially-optimal level. In this example, the source of the externality lies in the producer's ability to influence the level of the water-table, which transmits costs to other areas of the catchment. Thus, the water-table represents a form of common property. The issues involved are similar to those associated with the use of other common property resources, such as recreation areas (e.g. Cesario 1980) and fishing grounds (e.g. Gordon 1954).

The situation in a catchment, within which the externalities associated with clearance may be internalised, is illustrated in Figure 1. Land in this area may either be used for agriculture or be uncleared. It is assumed, for

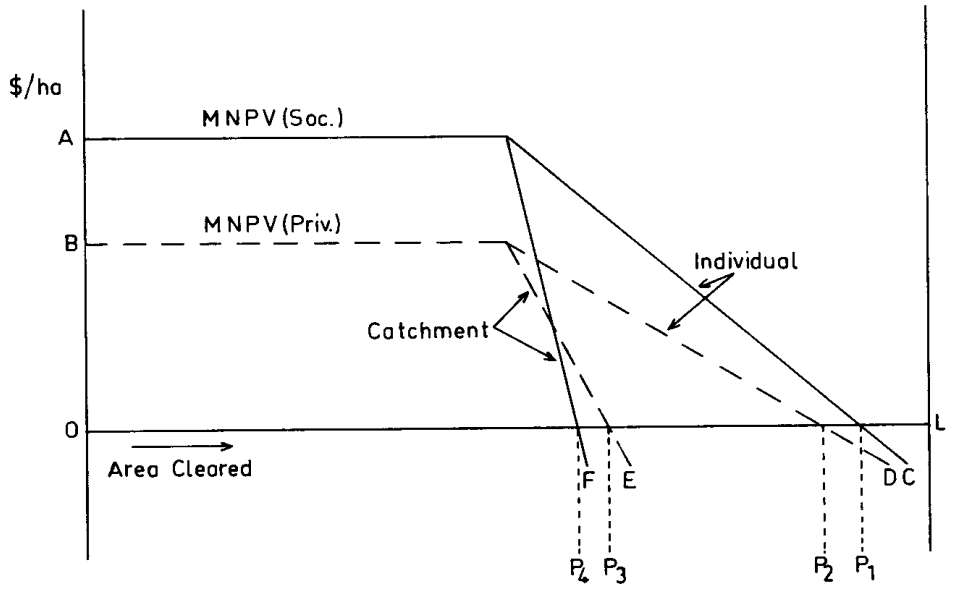

FIGURE 1—Benefits from Alternative Levels of Clearance.

simplicity, that there are no benefits to be gained from uncleared land other than through its impact on agricultural productivity, and dryland salting is treated as an irreversible process. The land is of even agricultural quality throughout the catchment and it is managed as a number of separate properties. All benefits associated with the use of cleared land accrue to the owner. The additions to salinity arising from the clearance of one hectare of land have an equal impact on all other hectares in the catchment.

In the figure, *OL* represents the total area of land available in a catchment which is susceptible to salinity problems. The extent of land cleared ranges from zero to the entire area, *L*. The marginal net present value (MNPV) of clearance, measured on the basis of a private discount rate denoted *MNPV (Priv)*, represents the present value of the stream of the costs of clearance and the net benefits from production, adjusted for any loss due to salinity incurred on that property. The relationship between *MNPV (Priv)* and land clearance from the point of view of the individual property manager is shown by *BD*. It is assumed that, up to the point where 50 per cent of the catchment is cleared, there is no incidence of salinity. In practice, this percentage would be very difficult to estimate and would vary from one area to another. Beyond this, the individual manager experiences a decreasing MNPV due to losses from salinity. From the point of view of each individual it will be worth clearing OP_2 of the total catchment. However, the clearance of one property increases the incidence of salinity on the others and therefore reduces the overall, or catchment, MNPV. This situation is indicated by *BE*, which is derived as *MNPV (Priv)* less the losses incurred on other properties. This demonstrates a lower optimal extent of clearance at OP_3.

A further possible difference between the privately and socially optimal amount of clearance could arise from a divergence between the

private and social discount rate. The implications of adopting a social (assumed lower) discount rate (see, for example, Howe 1979) are illustrated by *MNPV (Soc)*. From the point of view of the individual, who will not use land in any period unless the returns exceed the costs, and who will not clear land unless the MNPV is positive, the lower discount rate implies a higher level of clearance. However, due to the impact in the future of the losses due to salinity which are incurred throughout the catchment, the MNPV for the catchment declines steeply with the onset of salinity. The lower discount rate, placing greater significance on these losses in the future, causes *MNPV (Soc)* to decline more rapidly than *MNPV (Priv)*. The optimal extent of clearance from the catchment point of view, assessed at a social discount rate, is OP_4. Whether the lower discount rate necessarily implies a lower optimal extent of clearance or not depends upon the physical interrelationsips and the difference between the two discount rates. It appears likely that, given the long-term nature of the losses involved, this would be the case. One final point to note is that individual or collective decision making throughout the catchment does not necessarily imply a socially-optimal extent of clearance. This would be the case only if the discount rate used coincided with the social rate, so that *BE* represented the social MNPV.

While relaxing the assumptions made earlier would not alter the main conclusions of this analysis, it would make the relationship between the value and the extent of clearance more complex. For example, if each unit of land cleared made a different contribution to salinity, there would not be a steady decrease in MNPV. Rather, it would fall erratically, depending upon the specific area of land cleared. Similarly, if this assumption was relaxed, or if the quality of land in the catchment varied, the relationship would be influenced by the sequence in which land was cleared between O and L.

The identification of the socially-optimal extent of clearance in a catchment susceptible to salinity involves a large number of complex factors. The illustration here involved a number of simplifying assumptions which clearly influence the results. Data on the physical variables and the use of sophisticated analytical techiques would be likely to shed more light on these issues, but would be unlikely to identify conclusively the optimal solution. Identification of how much land should remain uncleared would need to be made on the basis of imperfect information and in the light of the economic principles involved.

Property Rights and Market Solutions to Salinity Externalities

The assignment of property rights influences the incentives which people face in making economic decisions. In general, in the absence of public intervention, a comprehensive system of well-defined and enforceable property rights is a necessary, if not sufficient, condition for a Pareto-optimal allocation of resources. (This raises a number of issues concerning the specific conditions required in order to achieve efficiency, which will not be discussed here—see Coase 1960 and Randall 1972, 1975.) Increased demands placed on rural land have produced the need for a changed and more detailed definition of the rights associated with land ownership. The issue here concerns the influence which an increased intensity of land use in the one area can have on the rights of other rural

land users. Other examples of emerging rights have been examined by Braden (1982). In the case of salinity, as already noted, the action of land clearance by some producers can impose costs on others of which they need take no account. There is no reason why, in principle, producers should not come to some arrangement so as to internalise these externalities, even though, as already indicated, this arrangement may not be socially optimal.

There are two market options available (Demsetz 1967). First, producers could come to some contractural arrangement whereby those who are affected by salinity would pay those desiring to clear land to keep it vegetated. This would involve the *de facto* separation of the rights to clear land from the rest of the 'bundle' of rights associated with land ownership. In this case these clearance rights would be transferred voluntarily to other land owners in the catchment in return for some compensation. The second option is for the affected producers to buy out the others. There are, however, a number of barriers to such market solutions, essentially concerning the level of transactions costs and lack of information (Chisholm, Walsh and Brennan 1974). First, the number of producers involved and the uncertainty as to the probable impact of clearance at one location on the extent of salinity at all others would make the establishment of generally acceptable contracts extremely expensive, if not impossible. Further, it might be regarded as inequitable that one group of producers should have to bribe another to prevent them interfering with their property. Second, for these reasons, and because affected producers may not have sufficient capital or because those initiating salinity may be unwilling to sell, the option of one group buying out the other would also seem unlikely to be widely adopted as a solution. In practice, there would appear to be a need for some form of external intervention.

Approaches to Public Control

Given that a privately negotiated solution to the problem is unlikely to occur, a number of approaches to control may be adopted by a public agency. These may be considered under three categories: the use of taxes and subsidies, the introduction of some form of direct control, and the application of composite approaches. In the latter case, direct controls are used to establish an acceptable level of externality and a system of taxes or a market is introduced so as to allocate the allowable externality between alternative sources.

A number of criteria are relevant to the question of choosing which of these approaches is appropriate to any particular externality problem. These would include the issues of economic efficiency, equity, transactions costs and acceptability. In terms of economic efficiency, a scheme would be aimed at producing an optimal adjustment on the part of the organisation causing the externality.This would involve a reduction in the level of external cost to the point at which the marginal cost of control equalled the marginal benefits from abatement. This adjustment should be made by means of the method involving the least cost. In situations where the scheme does not seek to promote an optimal degree of abatement, but rather a predetermined standard, the objective of efficiency may be regarded as a question of cost-effectiveness, whereby

the standard should be achieved at minimum cost. Any scheme to control an externality will leave some people better off and others worse off than they had been previously. The distribution of costs and benefits should coincide with social judgments as to who should be responsible for the costs and who should benefit from the reduced externality. The transactions costs of a scheme arise from the need to collect information so as to identify the appropriate form and extent of control and from the costs of implementation and management. One further condition of economic efficiency is that the total benefits from the control of the externality should exceed the total costs, including transactions costs. The final criterion relates to acceptability. A scheme is unlikely to be implemented unless it is acceptable to those who will have to administer it, does not involve excessive interference with private operations and meets with the approval of legislators and voters. The potential approaches to the control of dryland salinity are considered in the context of these criteria.

The use of taxes and subsidies

The complexity of the hydrological system means that considerable uncertainty surrounds the relationships between the clearance of any specific area, the level of the water-table and the general severity of salting. Therefore, any regulations would need to operate on some proxy which is associated with the cause of salinity rather than dealing directly with the problem, such as by taxing each land owner's 'output' of salinity.

In the context of the impact of clearance on stream salinity, Greig and Devonshire (1981) have suggested that a tax on land clearing would be appropriate. This form of control would appear to present a number of problems, especially in the context of limiting dryland salinity. First, a tax should, presumably, be levied on the use of cleared land rather than on land clearing. If this is not the case it provides no incentive for the re-vegetation of marginal land so that this option will not be promoted even though it might, in some cases, represent a less costly approach. Furthermore, it could be considered inequitable in that charges are levied only on a group of landholders who happen to clear after some arbitrary point in time. A second problem lies in identifying the appropriate level of tax. If the tax is intended to promote the optimal extent of clearance, it should be set at a level equal to the marginal external cost which cleared land generates at its optimal extent (see Baumol and Oates 1971). This is not, in general, the same as the marginal cost at the existing extent of clearance. Finally, in taxing cleared land itself, rather than its contribution to salinity, it will not promote an optimal distribution of vegetation unless each unit of cleared land has an equal impact on salinity. This problem seems likely to be of particular importance where the primary objective is to protect agricultural land. A tax on land clearing would, then, be most unlikely to provide the incentives for landholders to maintain an optimal area of vegetated land.

An alternative possibility would be to levy a tax on agricultural production in areas causing salting. The level of the tax could be varied according to the extent of the damage caused by different commodities. While this would provide an incentive for the re-vegetation of, or at least an end to production on that land, it would introduce an extra

degree of uncertainty. This would result from the need to anticipate the impact of changes in output prices on the amount of land cleared. The issue of controlling externalities by means of taxing output has been discussed by Plott (1966) who concluded that, in general, it is impossible to place a tax on output which will assure optimality.

A further problem with schemes seeking to control the level of clearance by means of taxes relates to the difficulty of predicting the impact of any particular tax level and the potential long-term effect of excessive clearance. Thus, it could be difficult to identify accurately a specific level of tax, either on land clearance or on agricultural products, which would achieve the desired objectives in terms of maintaining an adequate area of vegetated land. Taxes which may be adjusted in order to achieve environmental quality objectives may be appropriate where the effects of pollution are short lived, but not where the consequences of an excessive level of externality are perpetuated over a long period of time, as is the case with salinity.

Because of the difficulties involved in designing a scheme which will promote an optimal amount of land clearance, an environmental objective will need to be determined externally and then imposed. This standard will be identified primarily on the basis of the physical requirements involved in limiting salinity to an acceptable level.

Direct controls over salinity externalities

Direct control over land clearance may be achieved through a variety of channels. Essentially, control results through the acquisition of the appropriate rights, in this case to hold cleared land. This is the basis of most existing land use controls, such as where public objectives are achieved through zoning regulations. Compensation may or may not be paid and the rights may be acquired separately or together with the other rights attached to the property. In the latter case the government could purchase the land and then manage it itself in such a way as to achieve the required objectives. This would not appear to be a politically acceptable approach to the general control of salinity and is not discussed further.

Controls have been implemented in W.A. by means of regulations under the Country Areas Water Supply Act, 1947. These regulations seek to influence the level of stream salinity in watercourses which can provide potable water for public supplies (B. Swan, personal communication, 1981). They do so through controls over land clearance in certain catchments. These are divided into four zones, based on rainfall levels, and the severity of control depends upon the zone in which a property is located. The largest proportion of the area is zoned A, in which clearing of natural vegetation is almost totally prohibited. A variety of measures are available for compensating farmers for any losses which they may have incurred as a consequence of the scheme (Rural Adjustment Authority of Western Australia, undated). The Government has given an undertaking that no landholder would be financially disadvantaged by the scheme (B. Swan, personal communication, 1981).

However, for a variety of reasons, this type of scheme may not be the most satisfactory approach to the problem, or one suitable for the control of the impact of salting on agriculture. First, with regard to efficien-

cy, the land which is retained as uncleared is determined primarily on an historical basis. The controls essentially freeze the existing distribution of vegetation and in no way ensure that this is the most efficient solution. This would be relatively unimportant where the most productive land is always the first to be developed. However, in practice, development is influenced by a large number of factors, such as the availability of capital to individual farmers, their perceptions of risk and climate and their attitudes to income maximisation (see Brooks 1981). It might also be the case that, in time, the relative value of land could change, perhaps due to the development of a more profitable deep-rooted crop.

Second, assuming that all farmers are fully compensated, and that there are no consequent changes in prices other than of land, the government bears the full cost of control. In view of the wide acceptance of the polluter pays principle, it could be held that those responsible for causing salinity should bear a substantial share of the costs of its control. The alternative of not paying compensation would leave some farmers who had bought into the land market, on the expectation of being able to clear their land, to suffer a loss of value due to the narrower range of land use options which is allowed, while others whose land is already cleared, would bear no loss at all and could even gain from the restriction in the supply of cleared land. Finally, in areas where such a scheme is anticipated, landholders will face an incentive to undertake pre-emptive clearance. Thus, they would clear land which would otherwise have remained uncleared in order to avoid losses due to the introduced regulations. Both increased efficiency and equity would appear to be possible through the use of schemes involving transferable rights.

Composite approaches

The fact that the objective of a scheme is to achieve an externally determined standard does not preclude the use of market-based solutions. A scheme could be similar in concept to the Baumol and Oates (1971) proposal for the use of pricing mechanisms to achieve predetermined environmental standards at least cost. Dales (1968) has proposed the establishment of a market in pollution rights which could achieve specified outputs of waste into watercourses at least cost (see also Montgomery 1972).

The adoption of a market-based scheme could represent a more efficient solution to the problem than the approaches discussed above. It could enable the achievement of a given level of vegetation with the minimum loss of agricultural production. Those occupying the most productive land would be prepared to bid most to have land cleared and thereby ensure that the less valuable land would be taken out of production. Where relatively poor land had already been cleared, the landholder would have an incentive to re-vegetate and sell his allocation of rights to those on more productive land. This would minimise the loss of agricultural output associated with the introduction of controls over clearance.

Tietenberg (1974) has noted, in the context of air pollution, the implications of regional variations in the relationship between air pollution emissions and air quality and has proposed regional variations in the uniform tax rates, recommended by Baumol and Oates (1971), in order

to reduce the resource cost of achieving air quality standards. With respect to salinity, where there are likely to be different relationships between clearance and salinity in different parts of the catchment, some form of zoning could be appropriate. This would recognise that the marginal contribution of vegetated land to salinity reduction or prevention depends upon its location.

A market in rights to cleared land

Any scheme involving transferable rights would need to determine two issues: first, how the initial assignment of rights is to be achieved and, second, how the market should be allowed to operate.

Given that the objective of the scheme is to restrict the extent of clearance, some rights must necessarily be withdrawn. One approach would be for the regulatory agency to simply offer to purchase rights from landholders. The price offered would be gradually raised until sufficient rights had been bought so as to safeguard an adequate area of land. In principle, so long as the landholders acted competitively, they would be willing to sell the rights over sections of their properties when the price exceeded the difference between the present values of the value of output from land, with and without the right for the land to be cleared (less the costs of clearance, if currently uncleared). In many areas, some land which is not suitable for clearance will exist. In these cases, any positive price would attract sales. The efficiency objective would be achieved through those with the least productive land standing to gain most by selling their rights. Any necessary changes in environmental standards could be achieved by further purchases or sales by the regulatory authority. The burden of control would be borne entirely by the state. Anybody offering his rights for sale, in the absence of coercion, would only do so at a price which, at worst, left him indifferent between selling and retaining his rights.

In practice, the behaviour of landholders in these circumstances would be hard to predict. Given the likely small number of participants, coupled with their knowledge that a certain number of rights had to be purchased, there would be opportunity for co-operative action to withhold rights and so raise the overall costs of acquisition. Thus, considering the cost of the scheme and the potential difficulties of the initial rights purchase, this would not be a favoured approach from an administrative point of view. An analagous method would be for the state to withdraw all clearance rights and then to sell the appropriate, limited quantity back to landholders by means of an auction. However, the occupiers would be likely to resent the need to buy something which had been theirs anyway, especially where their land was already cleared. This latter approach might be seen as appropriate if the rights are considered to belong to the community as a whole.

The alternative approach involves the withdrawal of a proportion of rights from landholders. The total number of rights which would need to be withdrawn from a catchment would already have been defined; the question here is how these losses should be distributed. Given that these rights are transferable, so that the efficiency criterion can be met, the issue here is largely one of equity. Field and Conrad (1975) have noted two approaches to allocating development rights to landowners. First, a

certain number of rights could be assigned per unit or area regardless of the characteristics of the land. This would imply that, if the overall objective was to maintain vegetation on 20 per cent of the area, each landowner would be assigned rights equivalent to being able to clear 80 per cent of his property. Second, rights could be assigned to a landholder in some way related to the development value forgone so that compensation could be more directly related to value lost. However, determination of the initial allocation would be complex and agreement on an appropriate formula could be hard to reach.

For rights to be transferable, they would need to be well defined and enforceable. Thus, there would need to be records kept of who holds such rights and what exactly they entail (for instance, whether timber may be removed for fencing). Their value would need to be maintained through some form of policing. This could be achieved by means of aerial surveys over the relevant areas coupled with careful definition of land clearance, so that those clearing land without rights could be fined and forced to re-vegetate their land. The levels of fines would need to be sufficiently high, in relation to the gains to be achieved from clearance, so as to act as a deterrent. In view of the long-term and relatively obvious nature of the changes involved, the administrative costs would probably be tolerable.

The operation of the market in rights would depend upon a variety of factors influencing their supply and demand. These will be largely determined by the value of land clearance and the extent to which the scheme restricts the availability of rights. Clearly, for them to have value, the area allowed to be cleared must be less than the area which can be cleared profitably. If this were not the case there would be no problem.

Zoning and transferable rights

In practice, given the likelihood that clearance in some areas will have a greater impact than in others, a more realistic scheme would be based on a combination of zoning and transferable rights. This bears many similarities to transferable development rights schemes (see Ervin et al. 1977). However, a number of variations in this type of approach would be possible. Here, a scheme which combines zoning and transferable rights is illustrated in relation to a hypothetical catchment of 10 000 ha. In recognition of the different contributions which clearance can make to salinity in different areas, 20 per cent of the area is identified as high risk, where all clearance is prohibited. In the remainder of the area, 80 per cent of the land may be cleared. These details are shown in Table 1. Overall, 64 per cent of the area may be cleared.

TABLE 1

Allowable Clearance in Two Zones

Zone	Allowable clearance	Total area in each zone
	%	ha
1	0	2 000
2	80	8 000
Total	64	10 000

The initial step would be to withdraw from every landholder the right to have a certain proportion of his land cleared. The extent of this would be based upon the overall environmental standard; that is, each landholder would lose rights equivalent to 36 per cent of his land area. They would be able to use the remaining rights on their own land, subject to the zoning constraint. This regulation would not come into effect immediately, but would be followed by a period, say of one year, in which landholders could exchange rights. Thus, those on the more productive land would want to acquire extra rights in order to avoid the need to revegetate their land or to guarantee their ability to clear it. Those on poor land would be willing to sell. Given that it makes no difference to the scheme whether land is actually cleared or not when the scheme begins, the danger of encouraging pre-emptive clearance is avoided.

It is assumed that the catchment is made up of ten properties, each of 1000 ha and that the agricultural productivity of the land within each of these properties is the same, although their land may be covered by more than one zone. The distribution of land between zones, the net present value of land clearance and the current state of vegetation are shown for each property in Table 2.

It is assumed that all land could potentially be profitably cleared but that, as yet, only half the catchment has been cleared. The initial allocation of clearance rights is of 640 to each landholder (each right entitling the owner to one hectare of cleared land). However, the actual allowable level of cleared land is restricted by the zoning pattern. Details of the allocation of rights are shown in Table 3.

In the initial exchange period, a price will be determined on the basis of the value of clearance. Each landholder starts with 640 rights. Properties A to G may wish to purchase up to 360 extra in order to be able to have their entire properties cleared. Properties H and I have 140 rights in excess of the number which they can use and property J has 640 in excess. Each owner will be prepared to pay up to the value of clearance to purchase rights, while he will be prepared to sell his rights at a price above this figure. Those with rights which are of no use to them (H, I, and J)

TABLE 2

Distribution of Land Between Properties

Property	Total area	Area in Zone 1	Area in Zone 2	Value of clearance	State of land[a]
	ha	ha	ha	$/ha	
A	1 000	–	1 000	150	C
B	1 000	–	1 000	130	C
C	1 000	–	1 000	110	U
D	1 000	–	1 000	90	C
E	1 000	–	1 000	70	U
F	1 000	–	1 000	50	C
G	1 000	–	1 000	40	C
H	1 000	500	500	30	U
I	1 000	500	500	20	U
J	1 000	1 000	–	10	U
Total	10 000	2 000	8 000		

[a] C = Cleared; U = Uncleared.

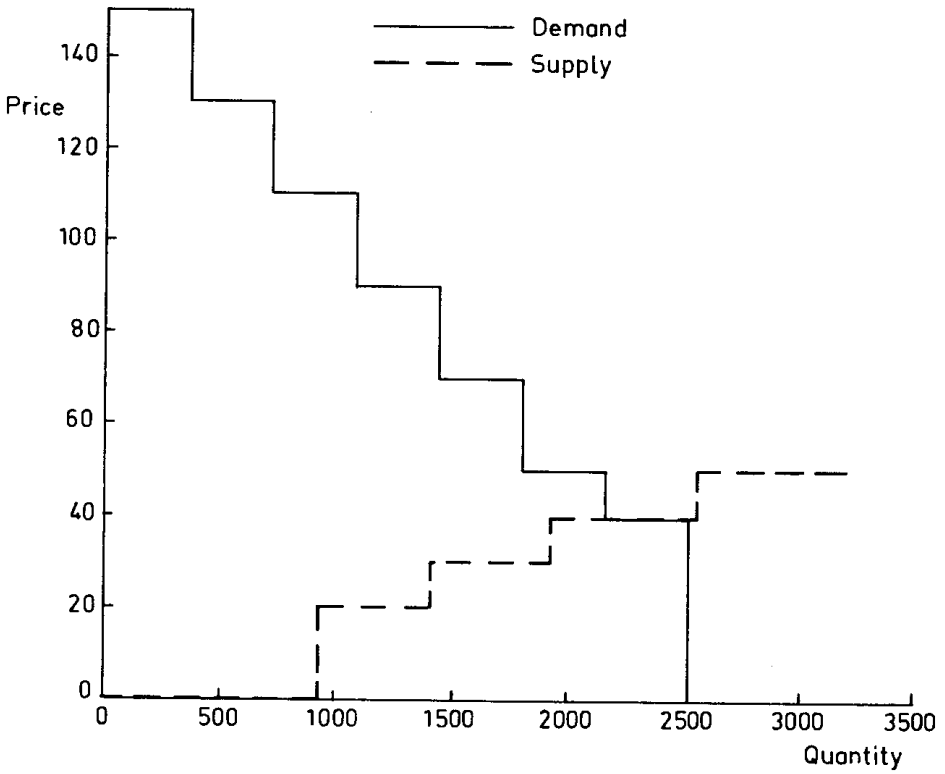

FIGURE 2—Demand and Supply of Rights to Cleared Land.

will be prepared to sell them for any positive price. On this basis, supply and demand schedules may be calculated and an equilibrium price predicted. The supply and demand schedules for this example are shown in Figure 2. The equilibrium price would be $40 per right.

The behaviour associated with this price is shown in Table 3. Landholders A to F purchase 360 rights and have all their land cleared. Landholder G sells some rights (implying a need to re-vegetate) and land holders H, I and J sell all of theirs. The net financial position due to the scheme is shown in the final column. The last two landholders gain from the scheme due to the assumed low productivity of their land. The resource cost of the scheme to the landholders, representing lost production opportunities, is $84 000. There is no cost to the regulating agency beyond the administration and control of the scheme and this could be covered by a levy on transactions. A scheme which simply froze the initial level of clearance (see Table 2) would represent a resource cost of $240 000. This would achieve a more severe standard than the example (i.e. 50 per cent of the area covered) but, in practice, it might be difficult to allow, selectively, clearance in areas once a general prohibition had been enacted. The scheme provides incentives for landholders to re-vegetate low-grade land and for them to seek profitable forms of land use that involve deep-rooting species. This could further reduce the resource cost of achieving the environmental objective. While these figures are clearly a figment of the example chosen, they illustrate the workings and

TABLE 3

Exchange of Rights and Private Costs of Scheme

Property	Allowable area cleared	Initial rights held	Rights exchanged	Costs and returns from sales of rights @ $40	Cost of prevented clearance	Net position due to scheme
	ha			$	$	$
A	1 000	640	+360	−14 400	—	−14 400
B	1 000	640	+360	−14 400	—	−14 400
C	1 000	640	+360	−14 400	—	−14 400
D	1 000	640	+360	−14 400	—	−14 400
E	1 000	640	+360	−14 400	—	−14 400
F	1 000	640	+360	−14 400	—	−14 400
G	1 000	640	−240	+ 9 600	−24 000	−14 400
H	500	640	−640	+25 600	−30 000	− 4 400
I	500	640	−640	+25 600	−20 000	+ 5 600
J	—	640	−640	+25 600	−10 000	+15 600

implications of this type of scheme. Generally, the more even is the quality of land in the catchment, the more even will be the distribution of costs. Where there are greater variations in land quality, the flexible approach to controlling clearance is likely to be more advantageous. In cases where a high proportion of land has been cleared prior to the implementation of a scheme, those landholders who are forced to revegetate their land face a greater loss than those whose land has not been cleared. This would arise from the decline in the value of other forms of investment associated with land, such as in buildings or fencing, which have little or no resale value. Similar problems could arise where the area of land held becomes too small to generate an adequate income. Some form of extra compensation might be regarded as desirable for those suffering from these losses.

In practice, the transactions might not be made immediately and individuals would have little information on the value of rights to other people and perhaps to themselves, where their land was uncleared. Barrows and Prenguber (1975) have examined elements of private markets in development rights. It might be expected that there could be more than one price in the market as agreements are struck between pairs of landholders. Those standing to gain most could pay more and those losing least could accept a lower price. Those without any immediate requirement (i.e. with more than the necessary proportion of their land uncleared) could hold back until they saw how the market was developing. Conrad and Le Blanc (1979), in a survey of landowners' willingness to sell development rights, found evidence that the supply of rights would depend upon a variety of socio-economic factors including expected development value, variance of development value and the land use intentions of prospective heirs. Similar factors could affect the supply of clearance rights.

The distribution of the benefits to be achieved from land clearance, between those buying rights and those selling them, would be dependent upon their relative market power. Where the market was not likely to be well-organised and well-informed, a government agency could act as an intermediary (Field and Conrad 1975). The actual development of the

market is uncertain, but would depend upon the quality of the land, the extent of the restriction and the proportion of land previously cleared. The opportunity for individuals to gain from such a scheme, as was the case in the example, would be limited, in that schemes are unlikely to be required in areas where there is little or no gain to be made from land clearance. In general, however, such a scheme would be likely to generate an efficient solution and to distribute the costs amongst those farming on cleared land.

This type of scheme could be operated with a number of variations. For instance, a more sophisticated zoning system could be introduced, such as by requiring different numbers of rights per hectare to clear land in different zones depending upon the contribution that land makes to salinity. Thus, the clearance of relatively sensitive areas would require the maintenance of vegetation over larger areas of less sensitive land. Similarly, restrictions could be placed over the maximum clearance allowable on individual properties.

Individuals and institutions who do not own land in the area, but whose interests are affected by it through their use of water from the catchment, could also be allowed to purchase rights. They could thus achieve a greater reduction in clearance in order to further reduce water salinity.

Finally, the issue of equity is unlikely to be resolved fully. It might be possible that alternative initial allocations of rights could come closer to achieving an even distribution of costs. This could take into account the existing distribution of cleared land, the value of land or the anticipated loss in land value. Political aspects are important in identifying who should be responsible for the costs involved. It also needs to be established what represents 'fair compensation' (see Knetsch 1980).

Timing of the Introduction of Policy

The introduction of any scheme which involves the curtailment of land use options is likely to lead to a reduction in land values. Where this option has not yet been taken up (i.e. where land has not been cleared, but will be at some time in the future), the extent of the loss will depend upon the level of the reduction of annual income due to the restriction (R), the period of time before the change will take place (d) and the discount rate (r). If there is perfect knowledge of R, then the capital loss (CL) will be approximated by:

$$CL = R/r\ (1 + r)^d.$$

The loss of capital value at the time when a restriction is placed over clearance will decline, initially quite rapidly, as the change is expected to occur further into the future. This effect will be emphasised if, as the time of clearance approaches, the people involved gain knowledge about the value of clearance (assuming that this increases confidence that it is worthwhile).

These costs are what Tullock (1975) has described as 'transitional losses'. That is to say, they will be borne by current landowners, who will sustain the capital loss, while those buying into the market after any restrictions have been imposed will earn a normal return on their investment. The extent of these losses will increase, both in financial terms as

well as in terms of frustrated expectations, as the implementation of controls is delayed.

This raises a further attraction of schemes incorporating the use of transferable rights. The introduction of a ban on land clearance can presumably be implemented only at the point when the desirable land area has already been cleared. In the period immediately prior to this, there will, therefore, be an incentive for landholders to ensure that they will be able to have cleared land by undertaking pre-emptive clearance. Alternatively, a scheme restricting rights can be implemented at any time and landholders will have their allocation of rights protected. Thus the earlier a scheme involving transferable rights is introduced, the better.

Conclusions

The issue as to whether the restrictions over clearance of land would show a positive economic return has not been considered. The evidence suggests this to be the case (e.g. Lumley 1982), and it appears that landholders face incentives to clear an excessive land area. The value of restrictions over clearance has been assumed in this paper but would benefit from further empirical testing.

The treatment of the problem on a catchment by catchment basis involves the danger that restrictions on clearance in one area will shift development pressure and exacerbate problems elsewhere. Thus, controls need to be part of a general policy to control salinity.

The use of transferable rights to cleared land presents an opportunity for the achievement of land management objectives with more efficiency and with greater fairness than appears likely to result from more conventional practices, such as simply making further land clearance illegal. The schemes discussed here represent the types which could be adopted. A number of problems have not been resolved, especially those concerning equity aspects. The details of their implementation and their consequences for individual landholders need to be further examined in the context of specific catchments. Having identified the most promising approach, the next stage would be to declare areas in which experimental schemes could be introduced. The legal aspects and possible administrative arrangements for such schemes also need to be examined.

Transferable rights are unlikely to represent a complete solution to the problem, especially in areas which are already suffering from severe salinity problems. They will need to be accompanied by the encouragement of specific management practices and by extension advice. It may also be appropriate to examine other approaches, such as those involving engineering, to see whether these can be useful, perhaps in raising the proportion of land that may be cleared.

Finally, the introduction of any scheme which involves the restriction of land-use options causes a fall in land values and imposes losses. However the scheme is designed, some people will regard it as being 'unfair'. These costs, and the consequent problems of implementation, will be much greater the further development proceeds and the greater is the area of land which has been cleared. Because of the increased extent of salting, the potential benefits are greater too. The expectations involved in land development become embodied in capital values, so that greater losses are sustained when those expectations are not fulfilled. It is impor-

tant, therefore, to mould land use into desirable patterns before they become set into undesirable ones.

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