"WORKING WITH NATURE", A REVIEW OF 25 YEARS OF SUCCESSFUL LAND RECLAMATION IN WALES[1]

by

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Abstract. A particularly rich and varied part of the United Kingdom in terms of its mineral resources, Wales has been an important part of the industrial base of the country for the last 250 years. A long lasting disregard for environmental impact followed by decline or concentration of heavy industries left many communities in the region in a desperate condition. A programme of reclamation and redevelopment which began in the '1960's has seen the development of a confident "savoir faire" in land reclamation which involves a wide range of disciplines ranging from engineering and landscape architecture to biochemistry, mineral processing and horticulture. A holistic approach to reclamation is now commonplace and the paper describes how this has come about and the benefits which have accrued in terms of cost effectiveness and quality of restoration.

Additional Key Works: holistic approach, economic regeneration.

Introduction

The British Isles enjoy a rich and varied environment brought about by an immensely varied geology and topography and a climate which consists of weather which varies on a daily basis. Add to this a long history of human occupation, mineral exploitation and more recently of scientific study and a growth in environmental awareness and one can perhaps appreciate that land reclamation is a topic which has gained in importance in the United Kingdom over this last 25 years. This is particularly true of Wales where the effect of the factors mentioned earlier is intense even by UK standards.

The industrial environment in the UK has experienced a revolution in the last 30 years. Writing in 1970, Nan Fairbrother described Planning as "the conscious control of our environment". Looking back from the environmentally aware nineties the sixties appear as a *laisser-faire* period which was shocked into reality by the dreadful disaster at Aberfan in 1966. An unstable colliery waste heap engulfed a school and part of a village. Some control, some environment!

Today we can see and feel that a confident - *savoir faire* is accelerating a holistic approach to the financing, design and implementation of urban development. Reclaiming or rehabilitating derelict land is a key stage in the development process and is providing a rare opportunity to develop a modern and varied industrial base in the UK's old industrial regions. How has this come about? What can it lead to? Can others appropriate it?

Briefly, extending our review beyond the sixties we can understand that the world scenes at the ends of the eighteenth, nineteenth and twentieth centuries are all utterly different from one another, and the changes, especially in Europe, have been brought about by three revolutions. The last half of the eighteenth century and the early years of the nineteenth century saw the beginnings of an industrialising process in which industry replaced agriculture as the basis of flourishing societies, and populations became urbanised. The industrial revolution of the nineteenth century was accompanied by, indeed was accomplished because of, a large increase in population, by 500% in the United Kingdom and Germany for example. An absence of famine, and improved health and sanitation contributed to a dramatic reduction in mortality. Populations not only grew more

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rapidly than before but also moved faster, further and more frequently than at any other time in history.

Industrialisation came first to the United Kingdom, the juxtaposition of iron ore, coal and limestone leading to significant exploitation of these resources in the second half of the eighteenth century. In 1809 a visitor to the Upper Valley in Germany described it as "a miniature England" as the coalfields in continental Europe also became centres of industrial growth, especially the Nord department of France, the Sambre and Meuse valleys in Belgium and the Ruhr in Germany. Large centres of communication also developed as a result of trade.

Communication was a vital ingredient in this frenzied industrialisation. By 1850 the railway network in Belgium was virtually complete and most of the German network had been built.

A feature of the industrialisation was the concentration of certain manufacturing industries in particular regions. Cotton in Lancashire, wool in Yorkshire, shipbuilding in the north-east of England and Scotland typify this specialisation within the United Kingdom. The same tendency was repeated elsewhere. The middle of the nineteenth century saw the removal of many hindrances to trade between regions in France and independent states in Germany. After 1870 Germany took up the role of industrial pacemaker. The first phase of industrial development has been described as "the coal and iron revolution", the second phase, after 1870 say, as "the steel and electricity revolution" as world output of steel rose from 540 000 tonnes in 1820 to 14 600 000 tonnes in 1895 - with a consequent drop in price which made it available for a variety of uses, some old, some new.

As well as being of fundamental importance in the production of steel, coal also became the source of numerous industrial chemicals which became increasingly important as the nineteenth century gave way to the twentieth. Coal carbonisation has also left a legacy of pollution, far more serious than mining itself has done.

Shortly after the opening of the twentieth century the early industrial areas in the United Kingdom and Belgium approached their peak and from then on experienced a long slow decline. Industrialisation continued in both the coal and steel industries however. On the coalfields the deepest coal seams were exploited last, about half of the Ruhr basin was still untouched in 1900 for example. The steel industry experienced a continuing series of developments allowing increases in scale, changes in processes and improvements in quality and the variety of products.

For obvious reasons coal production remained rooted in the coalfields. Some coalfields simply exported their product as a single raw material, other fields supported a complex mixture of by-product industries as well as steel making. The steel industry followed a different path. What we have witnessed in Europe is the development of two industries, intrinsically linked, of fundamental importance one to the other, and yet markedly different in character. The early iron industry was established on the coalfields but later developments allowed the centres of steel production to become huge enterprises for which communication and location were more important controls than were sources of raw material. Whilst steel making plants have grown in size and complexity, deep coal mines, by comparison, have altered little in 150 years.

Geology has dictated that numerous deep coalmines are required to exploit a particular deposit and as a result each mine has become the focus for a relatively small community composed in the main of people with a narrow band of skills. By contrast the large, integrated, modern steelworks employs many thousands of people with a wide variety of technical skills and competencies. Nevertheless despite these important differences in character, the general tendency has been for coal and steel producing areas to become heavily dependent on these single basic industries. Closure of mines and steelworks, because of loss of markets for the product in the case of coal, or concentration in still larger centres of production in the case of steel, has had similarly disastrous effects on the quality of life for the inhabitants and on the economy and environment in the regions affected.

(See Box 1 *Characteristics of steelworks sites and colliery sites*, summarises the characteristics of both industries) On account of the huge investment involved in their establishment, coal mines are usually active for a long time, frequently developing large quantities of waste materials which become an accepted feature of the landscape whilst the works are in operation. On closure, the situation changes most radically. The fabric of the buildings decays, roads, railways, canals and powerlines become redundant and waste heaps are suddenly recognised for what they are. Active, commercially vibrant establishments become derelict overnight and almost immediately it seems, attract the unwelcome activities of vandals and thieves and the unauthorised tipping of waste. An economic situation that can only be described as very grave is made desperate by the combined effects of a dispirited community and a degraded environment. Clearly these situations demand urgent and concerted programmes of reclamation and redevelopment.

Box 1 Characteristics of steelworks sites and colliery sites

Steelworks sites	Colliery sites
Complex layout;	Simple layout;
Variety of processes;	Few processes;
Many raw materials and products;	Few raw materials and products
Several waste products;	Single waste material; *
Contaminants many and varied;	Few contaminants; *
Many buildings and structures;	Degree of contamination slight; *
Buried structures;	Buried structures;
Mineworking may be present;	Mineworkings present;
Possibility of archaeological interest;	Possibility of archaeological interest;
Potential for re-use of materials.	Potential for re-use of materials

*except as coal carbonisation sites.

The reclamation of derelict land is constrained by various physical and chemical characteristics. Natural topography has a great influence on the reclamation of coalmines. Deep coalmines are relatively compact, consisting of a group of often substantial buildings closely grouped around the mine shaft. Some mining areas in Europe are characterised by a strongly varied and coarse topography, the valleys of South Wales for example, are in marked contrast to the open, gentle topography of Nord Pas de Calais. In areas where level ground was at a premium, waste tips were often created on sites unsuitable for the purpose and eventually produced concern for the stability of heaps and the communities situated close by. Coalmines generally produce large quantities of waste material which disfigure the landscape and can be a physical threat. Coalmines and coalwaste are not usually a source of serious pollution problems except where the coalwaste is highly pyretic. Leachates with a pH as low as 2 or 3 can be encountered in these circumstances and such acidic waters will degrade watercourses and kill vegetation.

Topography then plays an important role throughout the active life of an industrial enterprise and is no less significant when an abandoned site is being considered for reclamation and redevelopment. In most cases the original landform has been altered substantially in order to create the original development and then by subsequent tipping of wastes and possibly additional phases of development. In most respects in areas of gentle natural terrain the engineering problems faced by a reclamation team are less difficult than those which must be solved in areas of varied relief. Difficult access, steep slopes, fast running rivers, high rainfall, exposure to strong winds, acid soils, soil erosion and impeded soil drainage are commonplace problems in these latter areas.

Reclamation of derelict land has been a significant area of work for some engineers and contractors for many years. During this time experience has taught these practitioners that in order to improve the chances of success, the team involved needs to be multidisciplined incorporating specialists in many fields. Figure 1 illustrates how this approach has been developed in the United Kingdom and also indicates how initial responsibility lay entirely in the public sector when state industries such as coal and iron were the main concern. In South Wales in particular public safety was the first and easily established priority following events at Aberfan and a number of coal tips were singled-out as being potentially life threatening. It was also immediately apparent that carrying out safety work such as regrading and land drainage could create land for new industries and housing in an area where land suitable for modern development was virtually non-existent. The earliest reclamation schemes were produced to satisfy a simple brief:- produce a stable landform,

- control ground water and surface water,
- create as much "flat-land" as possible,
- make it green,
- spend as little money as possible,
- just "do it"!

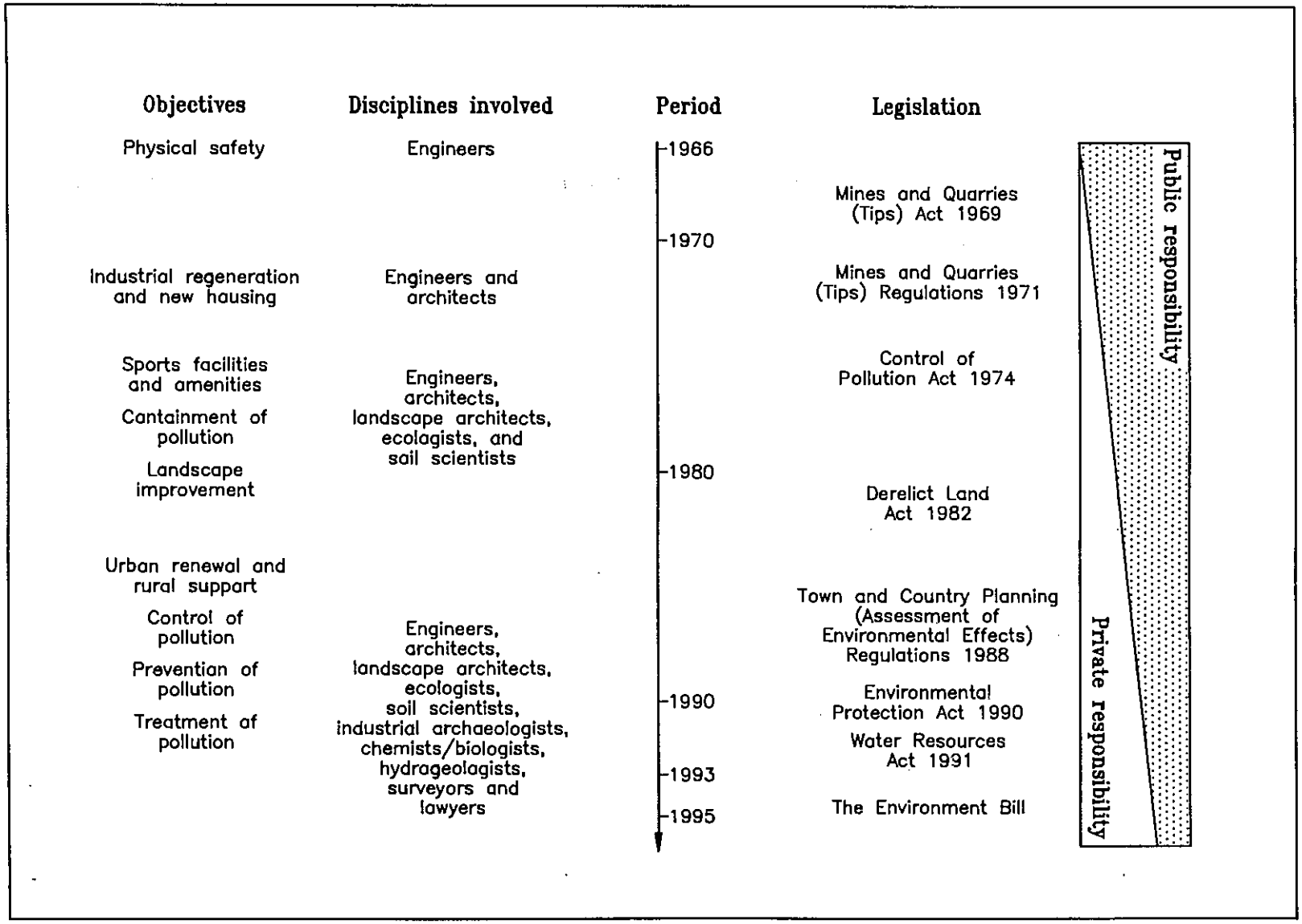

Figure 1: Treatment of derelict and contaminated land in the United Kingdom.

Whilst most reclamation schemes have thankfully disappeared under industrial, housing or playing field developments some remain stubbornly of little interest to developers but now provide interesting comparisons with the results of current work in terms of their impact on the landscape. Returning to reclamation projects over a period of years is a most valuable exercise.

Derelict land can be found in the UK in our National Parks and other areas of landscape importance. The direct and simple approach applied in the coalfield areas was inappropriate in sensitive areas such as the Snowdonia National Park, for example, where slate production by deep mining and open-pit methods had once been a major industry. Engineers, geologists, geographers, ecologists and landscape architects came together as early as 1972 to research planting and mulching techniques in advance of reclamation schemes.

With major programmes of work involving coal, iron, steel and slate underway by the mid-seventies attention focused on another problem, namely metalliferous wastes produced by the mining and processing of lead, zinc and copper ores. For the first time toxicity, caused by heavy metals, became an issue, and the process by which some plants are tolerant of heavy metals was put to effective and practical use to stabilise wastes. Vegetation had acquired a key role in the reclamation of derelict land. The continued management of vegetation as a healthy community of plants introduced yet another discipline into reclamation, namely landscape management.

In 1976 the government established the Welsh Development Agency to manage and accelerate the land reclamation programme in Wales and to couple this task with both economic and environmental repair. Observation of a wide range of long abandoned sites indicated that many more were already supporting a variety of plant communities and suggested that real advantage could be gained from studying the processes involved and mimicking them to as large an extent as possible. In 1982 a multidisciplined `Study to Investigate the Methods of Low Cost Reclamation and their Application to Derelict Land in Wales' led to the publication of a manual of low cost practice entitled Working with Nature.

In the UK it has been but a short step to move from derelict land to contaminated land, and from simple industrial processes like ore preparation to more involved ones involving coal carbonisation, steel production and finishing or semi-conductor manufacturing. Multidisciplined teams are the general rule, have developed out of our experience, and, compared with the earliest reclamation work are now providing;

- improved quality of site assessments
- greater relevance between site conditions and designs
- a balance between the approaches of different disciplines and different practitioners.

The real benefits have been:

- increased cost effectiveness and technical efficiency of solutions
- an enhanced image for redevelopment
- an enhanced financial and environmental value for reclaimed sites
- a reduced risk of failures
- a more sustainable approach.

This holistic approach can be summed up in John Ruskin's words:
"*not only is there one way of doing things rightly, but there is only one way of seeing them, and that is seeing the whole of them.*"

Developers spend a great deal of time and money searching for their "green field" sites which are, all too often, being denied to them because of environmental concerns involving loss of countryside. There is an overwhelming argument for the re-use of old industrial sites but abandoned works and derelict land suggest decay, neglect and failure, hardly the image for an industrial or commercial venture or a community planning for the year 2000 and beyond.

For those increasing number of people who understand these things, a well reclaimed site, levelled and graded, drained and serviced, will be recognised as a site eminently suitable for their development. However investment is a complex affair involving many people and experience proves that a well reclaimed site that has been "landscaped" is more attractive than one that has not been treated in this way simply because a well vegetated site gives a "good impression" of a greenfield site. Such a scheme also implies that the community places a value on aesthetics, has planned for the future by investing in landscape work and also understands that developers need encouragement. Initial perceptions are important.

For these reasons therefore, the re-vegetation of derelict sites is a most important part of the redevelopment process. Vegetation, that is healthy vegetation, has a key

role to play. Our understanding of how plants become established and survive in the most unlikely conditions has assisted in the development of techniques which now allow us to establish plant communities on many different kinds of materials, and also for them to perform a variety of roles, some with an engineering purpose. Without doubt vegetation reduces the visual impact of construction projects. When the earthmoving is complete, regraded derelict land will inevitably be devoid of vegetation and the rapid establishment of a grass sward improves the appearance of the land and reduces the problems created by water erosion and wind-blown dust.

Those situations where the vegetation which has been established matches the need of the proposed land use are probably the most successful. Figure 2 gives examples of the wide range of land uses and the vegetation types which are compatible and appropriate for these uses. The establishment and care of vegetation must be viewed as a long term commitment particularly in connection with reclaimed sites where natural fertile soil is likely to be only available in small quantities if at all. On many of the early reclamation schemes the initial overall improvement in the environment created by new landforms clothed in fresh vegetation has been lost because in time the vegetation has deteriorated. Maintaining vegetation in a healthy state whilst it is growing on materials which cannot be described as soil in a horticultural sense demands skilled management over a prolonged period.

Box 2 - *Vegetation in reclamation*, and Box 3 - *The process of vegetation design*, summarise an approach which is a balance between what is desirable to meet the objectives of the reclamation scheme and what is practically achievable within the limitations presented by the materials on site and the resources available. Box 4 - *Natural colonisation: a model for vegetation design* provides the basis of our approach to landscape design and creation which has long been in favour in Wales. By working with nature we have developed an approach which we consider to be an effective low cost method of reclamation. Box 5 - *Principles of low cost reclamation*, summarises the method.

Vegetation will develop and change in response to the site characteristics, especially soil and climate as well as to the management regime applied to it. Management should control the development of the vegetation so that it will eventually fulfil the intended purpose. Figure 3 illustrates how species diversity and land management will vary with time.

Every derelict and contaminated site will be found to be supporting vegetation of some kind. Many sites will be supporting unusual and therefore valuable plant communities because the site has some special physical or chemical characteristic or indeed because man and his domesticated animals have been excluded for many years.

John Ruskin's advice that the right approach to solving a problem is "to see the whole" can be applied in full to the treatment of derelict land since it is well appreciated now that a multidisciplined approach is the only one which will lead to success.

Ruskin's view of the importance of an overall view would be described or defined today as an holistic approach. Certainly it seems right for design teams to be thinking more in terms of site characterisation rather than site investigation which promotes too narrow a view of what is now recognised as being necessary when preparing a clean-up of contaminated land. This approach has been exemplified in great detail in guidelines on the reclamation of abandoned coalmines and steelworks which were prepared for the European Commission (Richards et al 1993).

Adopting an holistic approach involves:

- Identifying and assessing all relevant issues
- Being analytical
- Taking the overview
- Establishing reclamation objectives
- Addressing all of the reclamation objectives
- Ensuring effective team work.

Examples of the activities involved in such an approach are:

- Looking beyond the site boundaries
- Searching out positive attributes
- Avoiding detail early on
- Considering options
- Getting agreement on general principles.

Success can only be measured if an aim and purpose have been established, put simply, what one wants to do and why it needs to be done. Answer these two key questions and a scope of work is readily determined for a reclamation project. Typically an aim and purpose could be stated as:

"our aim is to create an attractive location for modern industries, our purpose is to create opportunities for new industries to be established, reducing local unemployment and removing an eyesore".

New use / Vegetation type	Individual trees	Forest tree species	Native tree species	Mixed woodland	Shrubs	Pasture grasses	Mown grass	Rough grass	Wildflower mixture	Wetland species	Aquatic species
Productive grazing						⊠					
Marginal grazing						○		○			
Commercial forestry		⊠									
Marginal forestry		○	○	○							
Sport							⊠	○			
Caravan and campsites	○		○	○	○			○			
Car parks	○				○			○			
Picnic sites	○		○	○	○		○	○	○		
Walking	○	○	○	○	○	○	○	○	○		
Ball games							○	○			
Childrens play	○			○	○		○	○			
Wildlife	○	○	○	○	○	○	○	○	○	○	○
Landscape improvement	○			○	○				○		

⊠ : Essential ○ : Possible

Figure 2: Vegetation types for new uses of land.

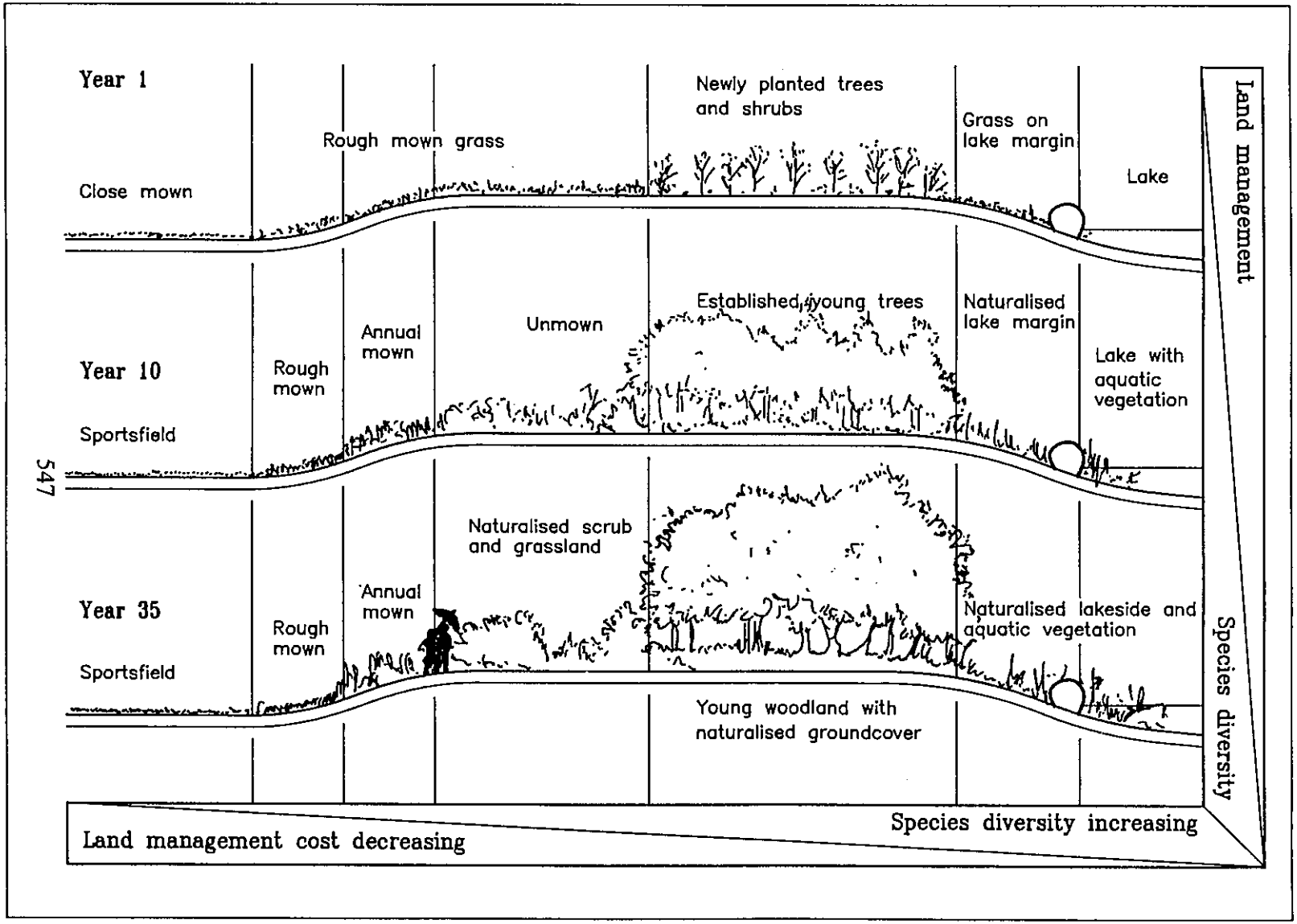

Figure 3: Changes in species diversity and land management with time

Box 2 Vegetation in reclamation

The nature of the vegetation required will be determined by the objectives of reclamation.

Land use objectives

Vegetation may be fundamental to the intended use of land which has been reclaimed; *e.g.* agriculture, forestry, sport, wildlife conservation. In these cases it is essential that the intended use of the land is decided before reclamation begins so that ground preparation, fertility, species selection and plant establishment can be designed correctly.

Environmental improvement objectives

In some circumstances there may be no particular use to which land will be put after reclamation; *e.g.* where the objectives of reclamation are to improve the environment by controlling erosion, absorbing dust and noise, reducing wind speeds and improving the landscape. In these circumstances it is essential that the nature of the required improvement is known so that this objective may guide the revegetation process.

Box 3 The process of vegetation design

The process of vegetation design must include much more than just the selection of species.

Objectives of reclamation	*e.g.* provision of recreation facilities and improvement of the landscape
Roles of vegetation	*e.g.* creation of scale and enclosure, visual interest
Survey of vegetation	*e.g.* shapes and sizes of masses and spaces, types of woodland, hedgerow, individual trees and grassland
Analysis of surroundings and proposed uses viewpoints	*e.g.* likely site users, access routes,
Outline landscape design	*e.g.* proposed distribution of main vegetation types
Detailed design	*e.g.* refinement of distribution, selection of species, implementation methods

Box 4 Natural colonisation: a model for vegetation design

The natural development of a vegetation cover on some derelict sites provides important lessons and principles for the reclamation team.

1. **Nature and time have combined to produce a vegetative cover on some sites;**
2. **Some of these plant communities are interesting and of ecological value;**
3. **Similar results can be obtained in a shorter time scale by using species which demonstrate that they can survive in a particular environment;**
4. **Management is an important part of the development process;**
5. **Survey and conservation play a significant part - site assessment, plant selection, use of local materials, care with fertilisers, natural colonisation - and achieves a diverse and robust vegetation cover at low cost.**

Box 5 Principals of low cost reclamation

The application of these principles will be most appropriate on land designated as "public open space" or "amenity land", where there are fewer constraints on topography.

1. **match the objectives to the site characteristics;**
2. **utilise the assets of a derelict site and avoid problems;**
3. **adopt a simple approach, avoid fussy details;**
4. **establish a vegetation cover appropriate to the after-use;**
5. **select a vegetation cover which requires a low level of management;**
6. **take and promote a long term view;**
7. **work with nature and the site rather than against them.**

Or else:

"our aim is to reduce the threat which pollutants pose to would be developers and occupiers of the site, our purpose is to render the site suitable for a range of after-uses".

And again:

"our aim is to reduce the visual impact of a derelict site, our purpose is to effect a general improvement in the local environment involving minimal expenditure".

Both aims and purposes can be spread across a wide spectrum of technical, aesthetic and financial parameters. In addition time will usually play a role in all reclamation projects and in some circumstances the strategy will involve an extended time-scale. Filling the last plot of land in an industrial park, achieving ecological diversity on a regraded coaltip are long term objectives and are typical of cases where patience and perserverance play their part in maintaining forward momentum. Bearing in mind that reclamation frequently does produce startling environmental improvements in the short term and that our own personal life span is relatively short, intermediate goals are well worthwhile building into the strategy as well as a long term commitment to management and monitoring.

Conclusion

Reclamation is not only about clearing away and cleaning up and building anew, it is about fostering pride and rejuvenating entire communities. Each generation creates and leaves behind its own brief pattern as a record of the interaction between environment and society. The industrial patterns of the nineteenth and twentieth centuries have not been benign and mineral exploitation in particular has produced many deep scars.

Fortunately the final quarter of the twentieth century has seen a remarkable growth in the understanding of the problems. The resolution to tackle them has been the driving force behind a fourth revolution, the substitution of clean technology for the dirt and grime of earlier mineral exploitation.

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