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LANDWARDS

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PatchSpray

Steering Systems

Restoration engineers

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Heavy soil handling equipment used in reclamation impart shear and compaction forces which destroy soil structure and biological communities. Only an inter-disciplinary approach will be able to restore the ecosystem services lost

THE RESTORATION ENGINEER

A NEW BREED OF ENVIRONMENTAL PROFESSIONAL

Jim Harris and Peter Leeds-Harrison

The state of our land

The pressures on the carrying capacity of the earth system have never been so great, nor the need to alleviate them so pressing. The decline in the capacity of the global ecosystem to provide those services essential to maintain life on Earth accelerated in the last quarter of the 20th Century. As a result of this pressure, we face some real challenges to our ingenuity. Particular issues to be addressed and managed are:

- global climate change;
- sea level rise;
- agricultural intensification;
- food and water security; and
- loss of biodiversity.

The pressures come from intensive agro-forestry; mineral extraction; degradative land-use and infrastructure engineering – these activities not only lead to disrupted soil profiles and contamination, but destroy biodiversity and sever the links between the biotic and abiotic components of systems, leading to loss of ecosystem functions and the services that they provide. It is suggested that there are four principal functions supplied by ecosystems (de Groot *et al.* (2002):

(1) regulation functions providing maintenance of essential ecological processes and life support systems;

(2) habitat functions providing suitable living space for 'wild' plant and animal species;

(3) production functions providing natural resources from which to make goods (consumable and structural); and

(4) information functions providing opportunities for cognitive development.

The links between components of systems are sometimes quite obvious, *e.g.* flood plains store excess water, whilst others are more subtle such as the soil microbial partnership which is essential for the health of legumes. Ignoring the losses of these components and links is not sustainable.

As a result of opencast coal mining operations, this re-instated soil sheds water, with little or no infiltration, leading to severe off site pollution problems from eroded soil. Both physical and biological manipulations need to be carried out to overcome this problem

Changes in land use

There are growing pressures to change how we manage our land resources, with an increasing emphasis on the need to conserve and increase the biodiversity and ecosystem functions of our countryside and urban areas. Coupled with the decline in traditional markets and competition from outside, the UK landowners are looking seriously at biodiversity and amenity as sustainable land uses. There is also increasing trends to

look at extensive solutions to the problem of diffuse pollution, such as restoring peat bogs and semi-natural woodlands to reduce run-off and groundwater transmission of nitrates.

Legislative pressures

Beyond the current drivers for change there are moves to strengthen the legislative framework at both EU and UK level. The Habitats Directive and Wild Birds Directive are already in force but lack provisions to enforce the 'polluter pays principle'. Hence the advent of the new directive on environmental liability which is currently at the draft stage and may be in force as early as 2005. This draft European Union directive mentions the word 'restoration' times (Commission of the European Communities, 2002). A lot will depend on how member states translate the directive into local law. The UK, among others, should take a tough stance. In the draft directive, restoration is defined as 'any action, or combination of actions, to restore, rehabilitate or replace damaged natural resources and/or impaired services, or to provide an equivalent alternative to those resources or services'

Importantly these baseline conditions are defined with respect to original biodiversity, water and soil resources, and ecosystem services. This means that the audit and demonstrable return of functioning and complete ecosystems will become a legislative requirement. Who is going to oversee such a programme?

BIO NOTE

Jim Harris is Professor of Environmental Technology in the Institute of Water and Environment, and Peter Leeds-Harrison is Professor of Soil and Water Management in the National Soil Resources Institute, both at Cranfield University, Silsoe, Bedfordshire MK45 4DT.

Landscape view of an opencast site showing, from the left, re-instated topsoil, subsoil and overburden horizons. In the background, storage bunds and settlement lagoons can be seen

Who will design and implement these restoration schemes?

How things have been done up to now

Up to the present day there has been a major focus on the need to decontaminate land to, make 'safe' and to provide some form of 'green' amenity. True 'ecological restoration' components of such schemes have been minimal or even absent. Traditional approaches to the treatment of land, after intensive use, has been to reinstate the final contour and establish, at best, some sort of grass or clover ley for a period of around five years. This has, primarily, been seen as a civil engineering matter but to properly encompass new and pending legislation simple re-contouring will no longer be enough.

A joined up approach

In order to carry out restoration to a sufficiently high standard to ensure compliance we shall need a new approach, one which encompasses physical, chemical, and biological constraints. Without this any restoration programme is likely to fail, resulting in major future costs for liable operators. We can identify the basic components that are needed, these are:
physical, particularly soil engineering;
chemical, particularly in respect of decontamination and nutrients status; and
biological, particularly in respect of soil health (microbiology) leading to the target vegetation mix and the desired ecological system.

Restoration usually involves manipulating soils and soil forming materials. The restoration engineer must be able to quantify the amounts of these materials that are required or that have to be moved. In addition, care has to be taken over the quality of the materials to be used because these will form the basis for the ecological system that is aimed for. It is not only the soil that must be considered, but also its water status and the hydrogeology of the underlying strata that must be taken into consideration.

Techniques such as digital terrain modelling linked to models of soil hydrology and habitat databases are the tools that are likely to be used by today's restoration engineer. These are powerful tools in the hands of someone who has a thorough grounding in soil engineering, hydraulics, hydrology, soil science, biology and ecology but may be no more than a computer game to someone without these skills. Additionally, the restorationist must be able to undertake the planning of the restoration and its execution from initial mapping to completion and, therefore, requires a good understanding of the policy and legislative framework of this type of work.

Re-instated sub and topsoil layers in close-up. Drainage and deep ripping is required to provide hydraulic connection between these layers, but this will ultimately fail unless the biological community is properly managed to stabilise and develop an open soil structure

An abandoned bauxite mine in Hungary. Although this would appear to be a good candidate for restoration, it is more valuable left as a scientifically important site for investigation of natural successional processes

Need for a new profession

We suggest that a new type of professional needs to be trained and accredited to oversee restoration programmes, one who might be called a restoration engineer or ecosystem architect. This involves those engineering disciplines that IAgrE have nurtured in the Institution and has always linked to biological systems. The professional will require an understanding of soil mechanics, hydrology, bio-engineering, plant eco-physiology, plant ecology, and soil biology tied together by land reclamation and ecological restoration. In order for this new type of expertise to be taken seriously there needs to be a professionally recognised accreditation. We need, in essence, professionals with a good understanding of land engineering and ecological systems. These skills are those that IAgrE has always incorporated and provided a professional home for in the past with its focus on agriculture. It continues to do so with the widening of its remit into amenity, forestry and environment. Perhaps no other organisation is so well placed to embrace this new professional.

A single species, single age plantation stand. This requires thinning and inter-planting to establish shrub and ground layers in order to restore a natural ecosystem architecture

References

Commission of the European Communities (2002). Proposal for a directive of the European Parliament and of the Council on environmental liability with regard to the prevention and remedying of environmental damage. COM(2002) 17 final 2002/0021(COD), EU, Brussels.

de Groot, R.S., Wilson, M., and Boumans, R.M.J. (2002). A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, **41**, 393-408.