Primer

Revegetation for Brownfield Regeneration

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Version 1, December 2010

INTERREG IVC
INNOVATION & ENVIRONMENT
REGIONS OF EUROPE SHARING SOLUTIONS

European Union
European Regional Development Fund

Introduction

As cities become more congested and green space and landscape disappear, new methods of urban regeneration are increasingly important. The loss of biodiversity through unsustainable consumption of land still persists and the need increases to create sustainable communities which are able to use and manage resources efficiently. Revegetating and reclamation as important parts in brownfield regeneration face special challenges compared to other, comparable ecological restoration activities. This primer wants to give a short overview on planning, methods and what can be realistically achieved to bring green back to the brownfields. Sustainable rehabilitation, following the state of the art should lead to appealing surroundings, giving the best pre-conditions for redeveloping, formerly derelict areas.

Planning and Implementation

The intensive management of decontamination and the sustainable ecological approach taken to cleaning and remediating land contributes to environmental sustainability and long term benefits. Costs for decontamination can be reduced by matching the level of remediation to the planned land use through early assessment of potential uses and agreed principles for the development. To ensure early consideration of issues which will affect the sustainability of the development in terms of its construction, its use, its whole life costs and its impact on the environment, developers should prepare a Sustainable Development Profile for the site.

A planning framework (development plan or masterplan for a wider area) ensures that the functions established in the project are in accordance with the general development objectives for the wider city or neighbourhood.
Brownfields are often more complex to develop than other sites. This complexity can cause risks (delays, financial risks) and requires an effective planning process involving all stakeholders. A Brownfield project should be integrated in a larger regeneration plan to set the context and to provide more security for potential developers and local communities. A robust planning process offers the opportunity to achieve or secure this integration.
Clarity in planning policies and simplification of planning procedures are crucial to attract investment as well as common visions and goals. Simple processes and clarity is needed to overcome the more complex development process and to reduce risks or perceptions of risk for investors/developers.
In order to plan for sustainable management of land resources, a clearly formulated objective is necessary. The objective may be based on a common vision for the land resources and their associated society or on attempts to solve an immediate problem. In either case, once the objective is clear, detailed target of the plan elements will begin to fall into place. Objectives are typically scale-dependent and will be different at a plot level, urban district

or city level. Stakeholders within a given level will be responsible for formulating the objective to meet their needs.
Already at defining targets, the assessability of both the methods and ways to reach the goal, as well as the targets itself has to be considered. In the field of project managment, this is done by controlling and evaluation measures. For a target being able to fulfill these requirements, there exist five principles: A target has to be **s**pecific, **m**easureable, **a**chievable, **r**elevant and **t**ime bond – SMART.
All that was aid above is also valid for targets in the field of rehabilitation and revegetation: The basis for this part of the efforts has to be founded on ecological, but also on economic grounds, considering limits and interactions. Examples of parameters for such targets are spieces richness, total vegetation cover, cover of certain target species, absence of unwanted species etc.
Those goals are the ideal states and conditions that the measurements attempt to achieve. Written expressions of goals provide the basis for all activities, and later they become the basis for project evaluation. The importance of expressing each and every project goal with a succinct and carefully crafted statement can not be overstated!

Defining targets and reaching them, considering the things said above should follow five stages:

- Development of a model, derived from the strategic objective
- Identification of the current state
- Trials or pilot actions
- Formulating SMART targets, followed by the implementation
- Monitoring and Evaluation

Essential to all revegetation/restoration projects is an expert selection of methods and suitable materials, which are to be selected to ensure that site-specific restoration is achieved. This would be part two and three of the above mentioned five stages.
To achieve the restoration objective, above all in the selection of restoration techniques and seed mixtures, at least the following criteria are to be observed.

- Altitude
- Exposure
- Inclination
- Precipitation conditions, climatic conditions in general
- Neighbouring vegetation
- Soil properties
- Function, cultivation or subsequent use
- Seed availability
- Estimation of costs

Definition of terms

In respect of definitions, guidelines for planning and execution of site-specific revegetation/restoration and related measurements, the "SER International Primer on Ecological Restoration" and the „Guidelines for Developing and Managing Ecological Restoration Projects, 2nd Edition", both by the Society for Ecological Restoration International (SER) are a recommended read. Both documents are available online:
http://www.ser.org/pdf/primer3.pdf
http://www.ser.org/pdf/SER_International_Guidelines.pdf.

Reclamation

This term, as commonly used in the context of mined lands in North America and the UK, has a broad application The main objectives of reclamation include the stabilization of the terrain, assurance of public safety, aesthetic improvement, and usually a return of the land to what, within the regional context, is considered to be a useful purpose.

Site-specific restoration / revegetation

The sum of measures that support the restoration of **site-specific vegetation**, or the ecological system that has been degraded, damaged or destroyed.
Revegetation, which is normally a component of land reclamation, may entail the establishment of only one or few species. Reclamation projects that are more ecologically based can qualify as rehabilitation or even restoration.

Site-specific vegetation in the strictest sense

Vegetation created by humans is site-specific in the strictest sense if the three following criteria are fulfilled.

- The ecological amplitudes (the "demands") of the plant species set out are in accord with the properties of the site.
- The plant species used are to be seen as "native" because in the geographic region, but at least in the same province in which the restoration takes place, they are, or have been found in appropriate natural growth areas.
- Seeds or plant materials are used that on the one hand originate from the immediate vicinity of the project area, and on the other are won in habitats that contain the type of vegetation to be produced in respect of their essential location factors. This means, value is placed not only on the maintenance of correct, traditional and site-specific selection of matching species, but moreover that local ecological types and small populations of the respective plant species are exclusively used.

Site-specific vegetation in a wider sense

Other than point 3 above, the same criteria, as given for site-specific vegetation in the strictest sense, are valid. It is endeavoured to use regional seed to the highest possible degree, whereby the use of regional seed is not obligatory.
According to the latest technological developments, "site-specific vegetation in the strictest sense" can only be achieved through

collecting in the wild, hay threshing, a hay mulch process, the covering of grassland soil and such similar methods. At this time, "site-specific vegetation in the strictest sense" cannot be produced with the use of commercial agricultural seed for forage planting.

Cover crops

A component of the seed in site-specific revegetation/restoration in which short-lived species promote development of the strived-for vegetation type through the reduction of soil erosion and the creation of favourable microclimatic conditions. After the rooting phase, the annual cover-crop species (e.g. oats, rye, barley, Egyptian clover) generally disappear completely from the recultivation area.

Nursery grasses and herbs

The components of the seed material used in site-specific restoration that favour the development of the type of site-specific vegetation strived for, but are no longer a component of this vegetation type. Contrary to cover-crop species, nursery grasses- and herbs are more durable and their emerging stand in site-specific revegetation/restoration generally lasts between one and ten vegetation periods.

Cultivation

- **Concluding cultivation:**
  A collective term for contractually defined cultivation methods in a period between seeding/planting and inspection; these activities are a part of constructional development.
- **Development cultivation:**
  A general term for contractually defined cultivation measures in the period between inspection and acceptance (final assessment).
- **Maintenance cultivation:**
  A general term for all activities necessary for the permanent maintenance of a restored/planted area in a proper state appropriate to the normal appearance of the tendered/existing restoration; maintenance cultivation begins after the final assessment.

Creation: Revegetation

The following methods are generally most suitable for the creation of extensive meadows and grasslands: sowing of collections made in the wild, seeding with hay flowers, hay thresh and hay mulch. Due to their sparse growth, unfertilised meadows are always difficult to transplant. Hydro-seeding methods are most of the time the best suited, nevertheless the fertiliser components in a sprayed mixture must be reduced to a minimum in this respect. For the creation of special grassland, the covering of vegetation parts has developed into a well-suited method. Hay flower seeding is also the latest development in respect of the creation of extensive grassland, the special creation of hay flower seed through the mowing of appropriate areas with staggered mowing times has proved excellent.

Manual collection

With the aid of manual collection individual species can be harvested at the respective optimum time. With small-area restoration plans this is the simplest method of acquiring site-specific material. This method is also very suitable for the collection of basis seed for seed multiplication or the nursery production of plants. Finally, it is also possible to specifically mix rare or especially valuable species with restoration material won with other methods.

Hay-flower seeding

This is a restoration method undertaken through the collecting of seed-rich remains of hay from threshing floors in hay barns or from lofts, which is then used for site-specific restoration.

Hay-mulch seeding

This is a restoration method undertaken by harvesting hay from natural, or naturally similar, plant stands, including ripe and viable seeds, and sowing the same as a 3cm to 4cm, growth-fostering mulch cover.

Hay threshing

Seed won as the basis for site-specific restoration through the mechanical threshing of plant stands at natural, or naturally similar, locations. To acquire a broad spectrum of the plants that form the desired type of vegetation, hay threshing at two to three staggered intervals is generally necessary.

Production of local plants

Plant material or seed is taken from suitable donor areas and plants that will be used on restoration areas are cultivated in nurseries. This method may well ensure the use of site-specific materials in the strictest sense, but due to high production costs can be used only rarely or on small areas.

Regional seeds from seed growers

A good method that is meanwhile practiced in several countries is the nursery or large-area production of seed of suitable species with the aid of agricultural techniques. Above all species used often and in larger amounts can be produced at a comparatively reasonable price and implemented on appropriately large project areas. A special condition is seen as given for plants that are used as cover fruit or nursery grasses- and herbs. Cover fruits may be used within the amounts of expenditure according to common practice. Nursery grasses- and herbs may be included to five percent of the weight of the site-specific seed mixtures. Mixtures must comprise at least five species; the share of an individual species must not exceed 40% of the total weight. Legumes should be contained to the extent of 10% of the total weight.

General fertilisation measures

In respect of clearly undersupplied soil in respect of the restoration objective, an upper limit of 40kg Nitrogen per hectare and year is to be maintained. Due to slow decomposition and better germination tolerance, organic fertiliser should be used when seeding.

On humus-poor soils (humus content < 3%), organic fertiliser is to be preferred for subsequent fertilisation. With mineral fertiliser, and some organic-mineral fertilisers, dependent on precipitation, the nitrogen is already used up or washed out four to six weeks after spreading and subsequent fertilisation must generally take place. Organic-mineral fertiliser containing slowly released nitrogen can, according to the form of fusion, release nitrogen over a longer period. Instructions given by the producer must be observed.

General cultivation measures, maintenance

Fertilisation should generally not take place in extensive grassland. Annual or biannual mowing with removal of the organic matter is to be undertaken in respect of cultivation. If from zoological considerations no other mowing times have been stipulated, mowing in summer following fruit ripening and/or the early spring (late winter) as biotope care should be sufficient. To compensate nutrient accumulation through airborne introduction, the organic matter is to be fundamentally removed.

Cleansing cut (before regular mowing starts)

This is to be carried out at the latest when an added cover fruit (nursery plant) or weeds have achieved ground cover of over 50% and a maximum growth height of 30 cm.

(Regular) Mowing

Mechanical mowing with a cutter bar- or rotary mower can be undertaken when the terrain is sufficiently level. Long hay or grass is to be removed as are fine cuttings with an overly dense cover of the grass sods. Mulching- and vacuum mowers are to be rejected for ecological reasons. Part of the grass/herb stocks should not be mowed in respect of the fauna on areas not used for agriculture (grazing for birds, development of insect species). It is to be assessed whether a cut is necessary after the start of the vegetation rest period.

Sprinkling / Watering

Sufficient watering following seeding is to be assured. The frequency, intensity and modalities are to be agreed upon in the contract. Great consideration is to be given to the restoration objective in respect of watering to avoid “indulging” the plant stocks.

Reseeding / Improvement

Reseeding is to take place if the development of a restoration shows a lack within six months and no expectancy of achieving the restoration objective and a state of acceptance (75% cover). Special, additional measures (local soil loosening, fertilising, etc.) are to be carried out during reseeding.

Seed amounts

For dry seeding (other than tree- and shrub seeding), the following seed amounts are to be used to achieve a minimum degree of cover which should bring the measurements taken to a success.
Level areas, good conditions: 3 to 10g/m²
Steep areas, poor conditions: 15 to 20g/m²

Reference Biotopes

Extensive fields and grassland

Compared to areas used for farming, extensive fields and grassland are green areas dominated by grasses and herbs are marked by a lack of nutrients and slight cultivation. The substrate ratio generally lies in a damp to wet or a dry to very dry sphere. Bush tendencies are comparatively slight and can be restrained by extensive cultivation, respectively, agricultural measures (e.g. annual or biannual mowing). Parameters to be essentially observed in planning are the maintenance of specific topsoil conditions (nutrient-poor and dry or damp) and if necessary instructions for cultivation measures. For larger planning purposes (e.g. rough- and compensation areas of a golf course), a management concept is essential.

Wild-flower meadows

Florid plant communities dominated by grasses and herbs, which are mowed 1 - 3 times annually.

Site-specific grassland plants with great ecological amplitudes should be constantly used for the creation and maintenance of wild-flower meadows.

Mowing takes place once- to three-times annually, whereby the organic matter is dried on the meadow and subsequently removed. The term "meadow" is applicable to the method of rural agriculture and urban, flower-rich meadows should also be similarly cultivated with the exception that no yield-rich harvest must be considered and thus not to be fertilised. Unfertilised grasslands are generally richer in flowers than so-called fertilised meadows

Blossoming turf meadows

Low growth stocks of grasses and herbs resistant to cutting and trampling as an alternative to agricultural grassland in a settlement area.

Contrary to wild-flower meadows, blossoming turf meadows are resilient and should replace playing fields and be used as typical functional grassland in the hope that following intensive research greatly burdened areas of grass can be mixed with resilient herbs in the future.

The following properties are necessary for the creation and maintenance of blossoming turf meadows!

Grasses resistant to trampling

A large number of resilient herbs, whereby ecological-pasture types are more suitable than commercial varieties because they lie better on the soil and grow to a lesser height

- Low-growth height
- Cut with a lawnmower (cut resistant)
- A colourful florescence aspect
- High-resistance to pests
- Non-demanding

Failures

Restoration can easily fail especially in extreme locations like brownfields might represent. The most common causes for such a lack of success are listed below:

False restoration methods

The more extreme the conditions, the more specific must be the planning of the restoration or rehabilitation measures. The gathering, restoration, intermediate storing and expert application of the topsoil, the subsequent prevention against erosion, the use of special restoration methods and the choice of donor areas for hay-mulch seeding, require planning by appropriately experienced experts.

False seed

A common mistake, even in less than extreme conditions, is the choice of unsuitable seed. The lack of attention given to decisive criteria, such as the degree of acidity of the soil, or the availability of nutrients, are causes for insufficient restoration success. Also valid here is the maxim that the more extreme the conditions, the more necessary are trained experts.

False fertilisation

As already mentioned, fertilisation at the restoration site and the restoration method are to be mutually adapted. Too little, as well as too much, can hinder the desired success.

Inexpert work

Grass swards as well as seeds are living materials and therefore careful handling and expert attention is indispensable. Badly stored grass swards, inexpert fixing of the sward in the soil, a lack of adequate bedding-in and the connected drying-out phenomenon can even destroy restoration undertaken with high expenditure. The false laying and insufficient anchoring of organic nets is more trouble than it is worth and is a typical side effect of well-meaning but badly executed restoration projects

Above all, under difficult conditions one must call in competent constructional supervision.

Lack of subsequent management

In many cases, a certain degree of subsequent management is required for the success of restoration: whether mowing is to be undertaken, exactly dosed post-fertilisation or additional seeding for the achievement of the projected level of restoration. All of these measures are essential restoration elements that must not be forgotten if one wishes to achieve appropriate success.