REACTION
Restoration Actions to Combat Desertification in the Northern Mediterranean

Conceptual framework, criteria, and methodology for the evaluation of restoration projects. The REACTION approach

July 2004

Project Co-ordinator: **Dr. V. Ramon Vallejo (CEAM)**
Contract number: **EVK2-CT2002-80025**
Duration of the project: **January 2003- December 2005**

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Introduction

The efficiency of restoration initiatives can be improved through the evaluation and transfer of technologies that are environmentally sound, economically viable, and socially acceptable. To approach the evaluation of restoration efforts from ecological, economical, and social perspectives there is a need of incorporating recent advances on indicators and evaluation methodologies, of defining the fundamental information needed and of harmonising evaluation protocols. REACTION consortium aims to define a suitable analytical framework, criteria, and methodology for the evaluation of restoration projects in the Mediterranean, and to establish a database on evaluated restoration projects.

During the first REACTION workshop on *Methodologies and Indicators for the Evaluation of Restoration Projects*, Alicante 13-15 June 2003, and the following discussion period after the workshop, the key elements of the analytical framework for evaluation of restoration projects and the REACTION evaluation protocol (*The Questionnaire*) were defined. The following sections summarise the REACTION approach.

The concept and extent of restoration actions

Following the concepts of the Forest Landscape Restoration (Lamb and Gilmour, 2003) and the definitions of the Society of Ecological Restoration (SER 2002), REACTION approaches restoration as the process of assisting the recovery of ecological integrity and enhance human well-being in degraded ecosystems and landscapes.

Ecological integrity means the maintenance of ecosystem structure and function comparable to that of natural habitats of the region or to model systems deemed satisfactory to society (Cairns 1977). However, a 'true' restoration process aimed at reconstructing a prior ecosystem and re-establishing former functions, communities and structure is very ambitious, extremely expensive, and almost impossible task, particularly at the landscape level (Henry and Amoros 1995, Hobbs and Norton 1996, Bradshaw 1997, van Diggelen et al. 2001). Attempts just to provide specific services, to reintroduce certain functions, or to revegetate damaged lands, often called rehabilitation or reclamation, are more appropriate goals in most situations. In addition, restoration options are determined by the current state of the system and its ecological potential for restoration in relation to biotic and abiotic thresholds (Hobbs Harris, 2001). There is therefore a need of realism about what restoration ecology can accomplish (Ehrenfeld, 2000). Whatever the overall approach is, social values play and important role in

defining restoration goals (Diamond 1987). Ecological integrity also reflects the capability of the system to support services of value to humans (De Leo and Levin 1997). Thus, ecological restoration can be considered as the process of restoring valued processes or attributes of a ecosystem or landscape (Davis and Slobodkin 2004).

A wide range of restoration efforts can be recognized in the Mediterranean, from the promotion of autogenic restoration to a variety of reforestation activities, though most of the restoration programmes has been implemented in the form of reforestation actions (Cortina and Vallejo, 1999, Vallejo et al. 2003a). REACTION evaluation protocol takes into account this variety of actions and the main role performed by reforestation activities. Since the achievement of most restoration goals needs an ecologically meaningful time period, the protocol is designed mainly for *a poteriori* long-term evaluation of restoration projects. The restoration or reclamation of heavily disturbed or toxic sites, such as mining sites or polluted soils, require very specific approaches (Wong and Bradshaw 2002) and its evaluation is not considered at this stage of the REACTION methodology.

Restoration goals and evaluation

Evaluation criteria need to relate back to specific restoration goals (Aronson et al. 1993, Hobbs & Harris 2001). However, defining restoration goals is fundamentally a valued-based activity (Davis and Slobodkin 2004). For example, in the past objectives of reforestation were wood production, soil protection from erosion, and water flow management. However, in the last decades the objectives have been moved to the achievement of other socio-economic benefits, ecosystems goods and services, such as water quality, recreation, improvement of wildlife habitats, etc. (Vallejo et al. 2003a).

To evaluate old restoration actions, both initial and current restoration objectives should be taken into account, as the objectives defined when the project was conceived may not necessarily match current environmental perspectives and social demands.

REACTION methodology considers three major types of objectives: structure goals, functional goals, and socio-economic and cultural goals; and two scales for setting goals: community/ecosystem and landscape.

Target systems as references for restoration

Restoration scientists usually advocate the use of target or model communities as reference systems to the setting of restoration goals and to evaluate restoration success (Aronson et al. 1993, Aronson and Le Floc'h 1996, Brinson and Rheinhardt 1996), particularly if evaluation criteria are focused on the functional aspects of the reference system (Brinson and Rheinhardt 1996, Choi, 2004). A reference system is any ecosystem or landscape showing the structure and function that is expected for the restored area in case of successful restoration. Thus, the target system can be considered as an advanced stage within the foreseen trajectory and a model for planning the restoration project (SER, 2002). Remnants of historic natural areas, naturally restored areas, and nearby but less degraded areas are often candidates for reference systems (Holl and Cairns 2000, Hobbs and Harris, 2001). Besides the fact that definition of 'naturalness' is a tricky one (Hobbs and Norton 1996), candidates for natural reference areas in the Mediterranean, after centuries of land use and degradation, are difficult to find (Vallauri et al. 2002).

Though a reference site is a useful tool for explicit goals for restoration (Aronson et al. 1995), some authors discuss the limitations of assuming a predictable outcome of restoration trajectory and pointed out the dynamic nature of communities in a changing environment and socio-economic context (Pickett and Parker 1994, Hobbs and Norton 1996, Choi 2004). Some recent results suggest that ecosystems not always undergo predictable and more or less gradual trajectories but they are likely to change between alternative metastable states (Zedler y Callaway, 1999, Vallejo et al. 2003b). There is therefore a range of potential outcomes of restoration projects, and criteria about success should focus on the desired characteristics for the system, considering both the ecological potential for restoration and the societal desires (Higgs 1997, Hobbs and Harris 2001).

REACTION approach gives room for further comparisons with a reference site, if any. Notwithstanding, the evaluation protocol focuses mainly on the analysis of the current state of the system in relation to proposed goals and current social demands (see below), rather than in relation to reference systems.

Success criteria

The evaluation of restoration activities commonly lies on qualitative assessments (Matney and Hodges 1991, Gaboury and Wong 1999, Robichaud et al. 2000). There is a need for effective and easily measured success criteria (Hobbs and Harris, 2001); the approaches can be diverse: comparisons with natural range of variability (Hobbs and Norton 1996, Parker and Pickett 1997), comparisons between restored and non-restored areas or between restored and reference target areas (Ffolliott et al. 1994, Brinson and Rheinhardt 1996, Gaboury and Wong, 1999), degree of achievement of specific goals (Zedler, 1995), degree of self-sustainability of the restored ecosystem (Lugo, 1992), comparative functional analysis of restored systems (Tongway and Hindley 1995). According to SER (2000), most of the current approaches can be grouped into one of the following types:

1. Direct comparison with reference sites by measuring selected attributes in both the restored and the reference areas.
2. Analysis of qualitative and quantitative attributes in order to test the achievement of specific objectives and stages.
3. Analysis of trajectories, by establishing trends from periodic assessments of the restored area.

REACTION approach lies on three main elements: (1) degree of achievement of specific project objectives, (2) comparative analysis between pre-restored, degraded conditions and current conditions, and (3) analysis of current quality of the restored system. The approach results from the trade-off between the need for fitting to specific characteristics of any particular restoration effort and for providing a common methodology for baseline evaluation of restoration projects. Thus, project evaluation includes the analysis of qualitative and quantitative attributes in order to test the achievement of initial objectives but also to measure the current quality of the restored system -in terms of structure, function, socio-economic and cultural values- according to current perspectives and taken into account recent advances in indicators for land quality assessment (e.g. IUCN 1999, WWF 2002).

Indicators

A large number of qualitative and quantitative descriptors and indicators can be used to evaluate a restored system. These variables should be simple, sensitive and reliable, measurable, relevant, with potential for early warnings of impending problems, they should be measured at several spatial and temporal scales, they should measure structure and function of the ecosystem, and also human well-being (socio-economic and cultural factors) (Henry and Amoros 1995, Tongway and Hindley 1995, Gaboury and Wong 1999, Noss 1999, Block et al. 2001, Aronson et al. 2003, Lamb and Gilmour, 2003).

REACTION protocol is conceived not only as an evaluation methodology but also as an information system and aims at using the available information about the projects. Therefore, though it is mainly focused on functional attributes, it has been designed as a broad framework, with a wide variety of indicators, requiring minimum field assessment and optimizing the use of existing and available information (see annex: *REACTION Questionnaire*).

The selected indicators include ecological, environmental, socio-economic and cultural attributes that are relevant for Mediterranean conditions. Scales for evaluation include stand, ecosystem and landscape levels. Indicators of regional land use such as population density, area of forest and woodland surface, etc., precise socio-economic indicators, including ecosystem goods and services. have been selected; always bearing in mind the need for a suitable trade-off between information and simplicity. The ecological evaluation prioritizes indicators reflecting hydrological and nutrient cycling processes, as they are particularly relevant for the conservation of limiting resources in Mediterranean degraded and desertification-prone lands.

Site environmental conditions and technical description of the project are main parts of the evaluation protocol, in order to analyze constraints and opportunities for restoration and to allow comparisons between different technical approaches.

The REACTION Questionnaire

The evaluation approach summarized above is expressed in the REACTION protocol for compiling and evaluating restoration projects: The Questionnaire (see attached annex, also available at: http://www.gva.es/ceam/reaction).

The REACTION Questionnaire includes 8 sections:

I. GENERAL INFORMATION: Location, Time frame, Size, Data sources, etc..
II. SITE DESCRIPTION: Climate, Geology, Soils, Degradation Impacts and drivers, etc.
III. RESTORATION PROCESS: Goals, Planning, Financing, Technology, etc.
IV. TECHNICAL DESCRIPTION by RESTORATION UNITS. Specific environmental characteristics and technical description of the restoration action for each different unit within the restoration project.
V. ASSESSMENT by RESTORATION UNITS: plantation/seeding results, Structure and diversity, Functions and processes, etc.
VI. PROJECT ASSESSMENT: Landscape and environmental assessment, Socio-economic and cultural assessment.

VII. SUMMARY
VIII. EXPERT JUDGEMENT

Sections I, II, III, and VI deal with information about the whole restoration project. Sections IV and V allow compiling detailed information for any different unit included within the project, and are to be replicated as many times as units in the project. Section VII summarizes project assessment and evaluation. The answer of each question is to be derived from the information compiled in specific previous sections and items. Section VIII, expert judgement, is devoted to capture the opinion of any expert who knows the project and/or has the expertise to evaluate the assessments compiled in the questionnaire. Sections I to VII have been designed to lie as much as possible on objective, quantitative data, whereas section VIII gives room for subjective expert-based evaluation.

The main outcome of the REACTION Project is the *Database for Mediterranean Restoration Projects*, which includes the projects compiled and evaluated in the questionnaires. Accounting for the need to rapidly and efficiently transfer knowledge and data, an Internet-based facility will be deployed that allows the users to retrieve and query data information on the compiled restoration projects.

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