# IMPORTANCE OF POST-DISTURBANCE LAND USES TO RECLAMATION/RESTORATION SUCCESS[1]

by

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Abstract. The potential for achieving long term success of any reclamation/restoration effort is set when the post-disturbance land use is determined. To be successful, the use(s) must be in harmony with the natural ecosystem of the region. Topographic, climatic, and edaphic characteristics of the ecosystem must support the proposed land use. Selections of less suitable land uses for a particular natural ecosystem can sometimes be made with the understanding that outside resource inputs will be needed to insure its long term success. In situations where reclamation/restoration success must be demonstrated, the selection of post-disturbance land use(s) defines the quantitative and qualitative parameter(s) of reclaimed/restored land that should be measured to document success. Currently, legal reclamation success for land disturbed by surface mining is considered achieved when the reclaimed land can successfully provide for the predetermined post-reclamation land use.

Additional Key Words: Ecological factors; Land resources; Natural ecosystems

## Introduction

Ecosystems and landscapes are often disturbed by man with highways, dams, housing projects, recreation, excessive livestock or wildlife grazing, mineral extraction, pipelines or powerlines, timber harvests, and general agriculture. Natural catastrophic events, such as wildfires, landslides, volcanic eruptions, floods, or droughts also cause ecosystem and landscape disturbances. Both man-caused and natural disturbed areas are partially or totally devoid of vegetation; and are often partially or totally devoid of soil, and need to be returned to a stable and productive condition. Recovery of disturbed ecosystems will occur naturally through ecological succession. This process can take considerable time and cause off site damages. These factors are of no concern to "nature". However, this time frame can be longer than a human life time and the final ecosystems achieved by ecological succession may result in land uses similar to or different from predisturbance uses. In order to speed recovery and limit off site damages, artificial site preparation and seeding in concert with ecological succession are often used to reclaim/restore disturbed ecosystems.

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Since the early 1970s, much of our experience with reclamation/restoration of disturbed ecosystems concerns areas disturbed by surface mining. Society, through legislation and enforcement, demanded timely reclamation/restoration of these disturbed lands. In this paper, reclamation is defined as the process of returning disturbed lands or ecosystems to their former or different productive uses; while, restoration is defined as the process of restoring site conditions and uses as they were before disturbance. A resulting question is: When are disturbed areas successfully reclaimed/restored? While this question was first raised in regards to surface mining disturbances, it is also relevant to other man-caused and natural disturbances.

The purpose of this paper is to discuss the importance of post-disturbance land uses to achieving and determining reclamation/restoration success.

## Land Resources as Ecosystems

The climatic, topographic, and edaphic (parent material/soils) characteristics of land are important to ecosystem development. Climatic conditions such as temperature, precipitation, and growing season length influence soil development and flora and fauna components of ecosystems (Newman and Dale 1983). Climatic conditions are affected by latitude, longitude, elevation, slope, and aspect. Edaphic characteristics, modified by topography, also influence the flora and fauna found in the ecosystems (Arnold 1983).

Natural ecosystems include land resources such as tundra (arctic and alpine), forests, deserts, rangelands (grasslands and shrublands), and wetlands (Safley and Pendleton 1983). These ecosystems are often minimally managed or managed within the limits of climate, topography, and soils of the land area. Outside inputs of labor, capital, and cultural practices are limited. Current and continuing production is achieved largely through natural ecological processes such as soil development, carbon and nutrient cycling, and plant succession.

Multiple land use and sustained yield are two important concepts for understanding the philosophy of natural ecosystem land use. Multiple land use is the harmonious use of land for more than one purpose. Sustained yield is the maintenance of the productive capacity of the land through proper use and management. Tundra (arctic or alpine) provides forage for domestic livestock, fish and wildlife habitat, watershed and aesthetic values. Forests provide forage for domestic livestock, fish and wildlife habitat, watershed values, wood, and aesthetic values. Deserts provide forage for domestic livestock, wildlife habitat, and aesthetic values. Rangelands provide livestock forage, fish and wildlife habitat, wood and aesthetic and watershed values. Wetlands provide fish and wildlife habitat and aesthetic and watershed values. These natural ecosystems are managed to provide for sustained yield and use for future generations.

Some natural ecosystems can include lands such as cropland, pastures, or tree farms (agroecosystems) that are intensively managed for specific and often singular use. Agroecosystem management should consider the ecological principles of the natural ecosystems in which these lands are located. These principles are important to current and sustained crop production. However, additions of outside inputs such as water, nutrients, labor, capital, and cultural practices such as seedbed

preparation, seeding, cultivation, thinning, spraying, fertilization, and irrigation to obtain current and sustained crop production are considered necessary, desirable, and should be economical.

## Determination of Post-disturbance Land Use(s) for Disturbed Ecosystems

After man-caused or natural disturbances, post-disturbance land use is reestablished. If man does not intervene, ecological processes (climatic, topographic, and edaphic factors interacting with flora and fauna) will determine the post-disturbance ecosystems and their inherent land uses. These natural ecosystems will by definition be compatible with their environments. The time required and final specific outcome of these ecological processes (primary and/or secondary succession) are of no concern to "nature" because ultimately, a functioning ecosystem will again be established.

However, human preferences for speedy recovery, limited off site damage, and desire for specific land use(s) often precludes reliance solely upon natural ecological processes for reclamation/restoration of disturbed areas. Society and/or land owners, through personal involvement and/or elected officials, land management and regulatory agencies, and the courts, often influence post-disturbance land use decisions for both man-caused and natural disturbed areas. Prior land uses, economic returns or values, or aesthetic values are often the criteria used to determine post-disturbance land use.

## Ecological Determination of Post-disturbance Land Use

Ecological factors should be considered when determining suitable post-disturbance land use. Proper matching of ecological factors with post-disturbance land uses sets the potential long term success of the reclamation/restoration of man-caused or natural disturbances. If minimal management and outside resource inputs are desired, the proposed post-disturbance land use(s) must be ecologically compatible with the environment of the natural ecosystem of the region. Post-disturbance land uses that are not in total ecological harmony with the natural ecosystem can often be used; however, certain outside resource inputs will be required to maintain these uses.

Of particular importance are the edaphic, topographic, and climatic factors of an ecosystem. As an example, cropland should have soil depth, texture, fertility, erodibility characteristics, and moderate slopes that will allow annual cropping. If crops are to be produced without irrigation, the climatic factors of precipitation and temperature must support cropping. Wildlife habitat should have slopes and aspects conducive to food and cover production. Shallow soils and steeper slopes may require continuous plant cover to protect these fragile areas from excessive wind and water erosion.

When man-caused disturbances are proposed, an ecologically sound post-disturbance land use decision prior to disturbance facilitates advanced planning. Good planning can assure the best use of soil and geologic resources and the use of the most effective and efficient reclamation/restoration operations. Both these factors greatly improve the likelihood of achieving post-disturbance success.

Regardless of how the post-disturbance use is determined, it is paramount that the use(s) be supported by the environmental

resources found in the natural ecosystem or be supplemented by the addition of outside resource inputs.

## What Is Reclamation/Restoration Success?

Successful reclamation/restoration can be defined in legal and/or ecological terms. For the reclamation of land disturbed by surface mining for coal, the legal definition was stated by Public Law 95-87 "Surface Mining Control and Reclamation Act of 1977 [SMACRA]" (U.S. Congress 1977), Section 515 (b) (2) as: "restore the land affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining, or higher or better uses of which there is reasonable likelihood, so long as such use or uses do not present any actual or probable hazard to public health or safety or pose any actual or probable threat of water diminution or pollution, and the permit applicants' declared proposed land use following reclamation is not deemed to be impractical or unreasonable, inconsistent with applicable land use policies and plans, involves unreasonable delay in implementation, or is violative of Federal, State, or local law."

This law further required: Section 515, (b) (19) "establish on the regraded areas, and all other lands affected, a diverse, effective, and permanent vegetative cover of the same seasonal variety native to the area of land to be affected and capable of self-regeneration and plant succession at least equal in extent of cover to the natural vegetation of the area; except, that introduced species may be used in the revegetation process where desirable and necessary to achieve the approved postmining land use plan."

If reclamation/restoration of disturbed areas is accomplished entirely by ecological processes, there is little need to be concerned with defining successful reclamation/restoration or when it is achieved. Disturbances and the successional recovery from disturbances are part of any natural ecosystem. Natural ecosystems are not static, but dynamic, providing various land use(s) throughout their successional stages. Stability and energy balance are a status achieved by a natural ecosystem after a period of succession (ecosystem success) and before another disturbance again causes imbalance.

## Evaluating Reclamation Success

Post-disturbance Land Use(s) Defines Critical Parameters. When determining reclamation/restoration success is required, the determination of the desired post-disturbed land use is the first step (Table 1). Land use defines the quantitative and qualitative parameter(s) of the reclaimed land that should be measured in order to document success. If possible, success should be defined quantitatively; however, some uses involving aesthetic values may have to be qualitatively evaluated. It is also important to recognize that reclamation/restoration success is documented at a point in time because reestablished systems and their use(s) will not remain stagnant, but will be dynamic. In the case of mineland reclamation, success is mandated near the end of a bonding liability period of 5 or 10 years.

Table 1. Steps to determine reclamation success.

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| 1. Determine desired post-disturbed land use. |
| 2. Determine characteristics of reclaimed land to be measured to show reclamation success. |
| 3. Determine reclamation success standard. |
| 4. Determine method of comparing reclaimed land characteristics to reclamation success standard. |

(Ries and Hofmann 1984)

Success Parameters Important to All Post-disturbance Uses. To be successful, any reclaimed/restored disturbed site must be geomorphologically and ecologically stable (Table 2). Plant and residue cover is a good measure of how well the soil is protected from excessive wind and water erosion. Proper slope and drainage engineering are important to landscape stability. Successful soil and landscape stability results in a stable land form.

Any reclaimed/restored land should also be able to sustain the desired post-disturbance land use. Will the land, if properly used, support the proposed land use for future generations? This is as important for industrial development land use as it is for multiple land uses. Depending on land use, stability and sustainability can be expected to occur with or without outside economic or resource inputs. Industrial development, housing, and agronomic cropping are examples of land uses where economic and resource inputs are expected and should be economically sound. Common multiple and sustained yield land uses are often expected to require minimal management and few, if any, major outside economic or resource inputs. Such uses must be in ecological harmony with the natural ecosystem of the region.

Table 2. Parameters measured to determine post-reclamation/restoration success.

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| Success parameters important to all post-disturbance uses. |
| 1. Soil and site stability |
| 2. Sustainability |
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| Success parameters important to specific post-disturbance uses. |
| 1. Vegetative (crop) production |
| 2. Vegetative cover |
| 3. Cover for wildlife or fish |
| 4. Food for wildlife or fish |
| 5. Plant species composition |
| 6. Plant species diversity |
| 7. Plant species longevity |
| 8. Plant species regenerative capacity |

Success Parameters Important to Specific Post-disturbance Uses. Crop production is an important measure of successful cropland reclamation/restoration (Table 2). Reclaimed/restored lands, such as rangelands, that are expected to provide multiple uses with sustained yield, require various plant species compositions and diversities to provide forage, browse, and cover needed for livestock and wildlife production, watershed values, and recreational opportunities. The plant species should also be long lived and the vegetative communities they form should have good regenerative characteristics. Vegetative cover and production measures are important to document the successful reclamation/restoration of cool-season or season-long pasture and occasional hayland that are expected to provide forage for livestock production and watershed values.

## Conclusions

The determination of post-disturbance land uses for man-caused or natural disturbances is important to successful reclamation/restoration of these areas. To be successful, any use must be in harmony with the natural ecosystem of the region. These ecosystems have developed in response to climate, topography, and edaphic conditions interacting with the flora and fauna of the region. Addition of outside resource inputs can, to a certain point, sustain uses that are not in total harmony with the natural ecosystem of the region.

If reclamation/restoration of disturbed areas is accomplished entirely by ecological processes, there is little need to be concerned with defining successful reclamation/restoration or when it is achieved. Disturbances and the successional recovery from disturbances are part of any natural ecosystem. Natural ecosystems are not static, but dynamic, providing various land use(s) throughout their successional stages. Where reclamation/restoration success must be documented, the post-disturbance land use(s) will dictate the parameter(s) to measure to evaluate reclamation/restoration success. Currently, legal reclamation success for land disturbed by surface mining is considered achieved when the reclaimed land can successfully provide for the predetermined post-reclamation land use(s).

## Literature Cited


Arnold, R.W. 1983. Soil sustains life if we treat it right. p. 6-17. In Yearbook of Agriculture. USDA. Washington, D.C.

Newman, J.E. and R.F. Dale. 1983. Climate--a key natural resource often overlooked in agriculture. p. 28-41. In Yearbook of Agriculture. USDA. Washington, D.C.

Ries, R.E. and L. Hofmann. 1984. Pasture and hayland: measures of reclamation success. Minerals and the Environment 6:85-90.


http://dx.doi.org/10.1007/BF02043985


Safley, J.M., Jr. and D.T. Pendleton. 1983. Tundra to Tropics: Living tapestry of our plant communities. p. 42-55. In Yearbook of Agriculture. USDA. Washington, D.C.

U. S. Congress. 1977. Public Law 95-87 "Surface Mining Control and Reclamation Act of 1977". 95th Congress. Washington, D.C. U.S.A.