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Mined-land reclamation in the Thar Desert, India—INDO-U.S. technology exchange

Gypsum mine, western Rajasthan. Hand of worker covers shallow (20 cm) overburden.

The Challenge

The reclamation (rehabilitation) of wastelands is expensive, labor intensive, and slow to demonstrate results. If carefully planned, however, the coordination of scientific research, industry needs, and community land-use requirements will result in landscape reclamation that is productive and sustainable. The human population in India will reach 1 billion by the year 2000. Estimates suggest that in order to adequately feed this many people, the agricultural output of 0.86 tonne/ha will have to double. In the Thar Desert region of Rajasthan State, mining is second in economic importance only to agriculture. Throughout India, industrial and mining activities, coupled with poorly managed agricultural and irrigation practices, have caused the degradation of an estimated 80 million hectares. New Federal mined land reclamation regulations have increased industrial stewardship awareness and interest in landscape rehabilitation but the scientific basis for understanding how sustainable reclamation systems are achieved, especially in the desert regions, is just beginning to be developed.

In 1987 the U.S. Department of Argiculture asked the USGS to participate in developing several cooperative projects that focused on dryland agriculture. This Indo-U.S. funded activity recognized the importance of two-way information transfer between the countries; in particular, the USGS was interested in learning about Indian agrogeology, mined land reclamation in desert regions, and land-use management practices. Three years of planning resulted in 26 projects, one of which was a cooperative land reclamation study between scientists at the Central Arid Zone Research Institute (CAZRI) in Jodhpur, and the USGS.

Mined Land Reclamation in Arid Lands: Links to Dryland Agriculture

The Thar Desert of western India is the most densely populated hot desert in the world. Irrigation water is now available following the completion of the Indira Gandhi Canal in western Rajasthan. However, dryland farming practices, where water for plant growth is supplied entirely by rainfall, still predominates. On average, irrigated lands are twice as productive as dryland agricultural lands (about 1.4 vs. 0.7 tonnes/ha). Nevertheless, India, and other countries with agriculture in arid lands, is beginning to recognize that, over the long term, well-managed dryland agriculture may be more sensible and cost-effective than irrigated agriculture for food production. New lands are not always available for irrigation development, the cost of development is often prohibitive, and soils that are available are often marginal (i.e., low fertility, sandy texture, and saline). Rain-fed agriculture has been 'rediscovered', as not only potentially highly productive but also as more sustainable and ecologically sound.

The reclamation of mined lands in arid regions has lagged behind efforts in more humid areas for several reasons.

- First, and most important, is the issue of available water for establishing growth of rehabilitation plant species. In the area near Jodhpur, on average, about 370 mm of precipitation is received during the summer monsoons. These rains begin in June and last only about 11 weeks. The probability of severe drought in this area (as occurred in 1985-87) is calculated at 40 percent. Because of a dependence on rain-fed agriculture over the centuries, India has developed field techniques for water harvesting. This information is of great interest for land reclamation in the U.S.
- Second, in India, it is important that the plant species utilized enhance soil fertility and stability and, at the same time, are agriculturally useful. Because the use of row crops is an impractical approach to land reclamation, the planting of a mixture of shrubs, used for animal browsing and nitrogen fixation, and grasses used for

land stabilization and animal grazing, seems appropriate. This kind of information, that has a long history of intense research in the U.S., is of great interest to India.

Indo-U.S. Joint Study

The Indo-U.S. joint study of mined land reclamation in the Thar Desert began in 1992 and has extended through four growing seasons. Approximately 26 ha of degraded land has been revegetated. Efforts were focused at a gypsum mine and limestone quarry. However, because of recent interest by Rajasthan State Mineral Development Corporation, Ltd., the team will begin work at a newly developed lignite (coal) mine. Understanding how to attain sustainable reclamation plant community systems is a paramount goal of the studies. This requires investigations of soil-development processes, soil moisture variability, soil fertility assessments (including both major and trace element deficiencies and excesses), soil microbial populations (and how these relate to plant establishment success), plant species testing (both indigenous and introduced), and importance of developed systems to local farmers and mine operators.

Accomplishments to date:

• Ongoing evaluation of sustainable plant community structure using multivariate techniques, including importance values derived from species abundance measurements of both planted species and species that are regenerating naturally.

• Nineteen species of trees, 10 species of shrubs, and 2 species of grasses have been evaluated as to their importance in soil development, animal utilization, and fuel-wood production. These include both indigenous and introduced plant species. Woody genera of particular importance include *Prosopis* (mesquite), *Acacia* (fever tree, acacia), and *Cercidium*.

• In general, mine overburden material is deficient in phosphorus, molybdenum, and iron as well as organic matter. The level of other nutrients is adequate except for boron, which can occur at phytotoxic levels.

Scientists examine the progress of desert shrub development in an area that harvests rain water using regraded land "micro-catchments"

• The harvesting of rain water using "micro-catchments" has proved critical to the long-term establishment of woody species. Several water harvesting techniques have been tested and utilize both natural and manipulated land micro-topography.

• An unusually cold winter in 1994 resulted in the loss of frost-sensitive species. When winter kill is not considered, the plant establishment success rate for the gypsum and limestone sites using the most promising plant species and water harvesting techniques, is commonly greater than 90 percent.

• Soil fungi, often critical to the successful establishment of rehabilitation species, have been isolated from mine overburden material. These fungi are being propagated and evaluated for their usefulness in studies of system sustainability and plant nutrient-use efficiency.

• To date, the work of the project has received several awards from industry and government in recognition of its contribution to solving problems of degraded land rehabilitation in arid regions.

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