PHYTOMELIORATION

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Contents

Summary

Two interconnected phenomena have provided preconditions for phytomelioration throughout much of the world. These are increase in land degradation and shortage of foodstuffs for the growing human population. Ill-considered expansion of arable land, and irrational use of water and ground resources has resulted in losses of huge areas of fertile land.

Alongside other kinds of land improvement, phytomelioration plays a valuable role as a system of measures for improvement of environmental conditions. This relies on the beneficial influence of plants on the condition of soil cover, water resources, air and other factors of the natural environment.

Phytomelioration can reduce or completely eliminate such negative processes as erosion by water and wind. It is used in stabilization of ravines and mobile sand, and improvement of degraded pastures. Protection of irrigated and drained land is often achieved with the help of phytomelioration. It is thus one of the key factors in stabilization of agricultural land.

1. Introduction

The term phytomelioration covers a complex of actions for improvement of the natural environment with the help of a cultivation or maintenance of natural vegetative communities (e.g. creation of forest belts, field edge plantings, undersowing of grasses, etc.). The different kinds of phytomelioration include: humanitarian (improvement of the human environment), interior (within premises), nature conservation (preservation and improvement of ecosystems and their components), bioproductive (increase of quantity and quality of useful production), resource-protective (preservation of habitats and species), and engineering (protection of property).

Programs of phytomelioration for degraded agro-landscapes in such countries as Israel and USA are based on solid achievements of plant breeding, genetics, and biotechnology. At the same time in Asian countries (e.g. China, Uzbekistan, Kazakhstan, Turkmenistan) programs of phytomelioration of arid agro-landscapes are based mainly on the use of the rich plant genetic resources of old grasslands, development of eco-evolutionary methods of selection, and creation of systems of geographically and ecologically differentiated communities of halophytes, xerophytes and psammophytes. Agro-technical methods of ecological restoration have also been developed, using a mixture of seeds of bushes, sub-shrubs and grasses. In Asian countries with arid climates, phytomelioration has transformed many agro-landscapes, mainly for production of fodder. The agro-phytocenoses created, containing bushes, sub-shrubs and grasses have proved to be both productive and self-perpetuating.

Phytomelioration is one component of the complex of measures used to combat drought—optimum combination of arable, meadow and woodland, creation of forest strips aligned against the prevailing winds, and afforestation of land not well suited to agriculture (e.g. woods, ravines, bare river margins, etc.) (*see Necessity of Development of Land Reclamation*).

Two major components of phytomelioration of land are forest improvement and agro-forestry. Forest improvement is a directed change of environment by growing trees and shrubs (by creation of plantations and shelterbelts, change of age and species composition of trees and shrubs, and optimization of the ratio of wooded to non-wooded land.

Agro-forestry involves creation of field-protecting forest strips, and planting of trees on slopes of ravines, steep slopes and sandy ground. Its effectiveness depends on how well suited the lay-out of strips is to the local conditions and the character of those strips (height, permeability to wind etc.). The ratio of the areas of woodland to open fields is also very important.

2. Phytomelioration: the concept and sphere of application

Phytomelioration of land has become, both in theory and practice, a dominant concept in world agriculture and one of the most important tools of land amelioration. It is a means of achieving purposeful improvement of the natural environment, and reconstruction and development of biological potential of degraded land. Phytomelioration is a key element in stabilization of agriculture (*see Global Amelioration Demand*).

Phytomelioration of degraded land relies on the natural potential of vegetation and reconstruction of soil fertility.

The kind of habitat created, and its rate of development, depends on the choice of plants, their life form, adaptations and ecological requirements. The adaptations of natural flora to widely varying ecological conditions and geographical areas—at the level of life forms, species, ecological types and populations—creates a wide spectrum of plants, providing a firm basis for selection of suitable phytomeliorants.

Phytomelioration as a science is based on the principle of restoration of the ecological potential for development of biocenoses. Since the early 1990s the wise use of the potential of higher plants (trees, bushes, sub-shrubs and grasses) to change environmental conditions and restore land potential has become fundamental to sustainable development of agriculture all over the world.

Habitat creation is best demonstrated at the biogeocenosis level. Lessons can be learned for controlled optimization of the ecological environment and the functional organization of agro-landscapes. Phytomelioration is often the only possible self-sustaining means of supporting the regenerative potential of degraded land.

Plants help to create and improve their environment by depositing onto the soil surface a layer of dead material which accumulates as a litter layer, from which soil humus develops, or, if conditions are wet enough, as a layer of peat. The products of decomposition of dead aerial and underground parts of plants increase the water-penetration and water-holding capacity of soils. It increases absorption of precipitation and reduces run-off. Organic debris retards surface flow, increases penetration and reduces erosion. The aerial parts of plants reduce retain both water and snow and reduce the rate of flow of melted snow, thereby also reducing washout of soil. As a result of reduction of the speed of flow of melt-water, sedimentation of particles occurs.

The habitat creation potential of plants, together with soil organisms (animals, mushrooms, actinomycetes, bacteria), raises the level of many biochemical and chemical processes, as well as cation exchange capacity and the rate of accumulation of humus in the soil.

The concept of phytomelioration is based on the ability that natural communities have to assimilate material and energy—to accumulate organic matter in soil and to recycle solar energy. This concept provides harmonious development and interaction of natural, biological, technogenic, economic and information factors. Phytomelioration is a major component of long-term ecologically balanced strategies for wildlife management directed at increasing the capacity of agro-phytocenoses and agro-ecosystems for maintenance of ecological equilibrium. This balance is reached by increase of the genetic variation of biological components (including cultivated and wild species, soil animals and micro-organisms).

Phytomelioration is always focused on increase of biological efficiency, stability and optimization of the structural and functional organization of agro-landscapes. It is thus a science, a technology and a branch of agriculture. As a science, phytomelioration systematizes the facts, has specific methods of research, encompasses experiments and reproduces the results of research. As a technology, phytomelioration is a system of ecologically-, biologically- and biotechnologically-proven methods and treatments directed at the reclaiming potential on all components of agro-biocenoses and agro-landscape—atmosphere, soil, micro-organisms, flora and fauna.

As a branch of agriculture, phytomelioration is a system of biotechnological and organizational measures directed at improvement of the meliorative condition of land, improvement of soil fertility, and optimization of the structural and functional organization of agro-landscapes.

3. Phytoclimatic zones

Phytoclimatic zones reflect the major geographic zones of the land surface. Starting from the north, the first phytozone is the tundra, then there is forest-tundra, then taiga, then deciduous forest, then the steppes, then deserts (the arid zone), then subtropical forest and finally tropical forest. Phytoclimatic zones are directly connected to soil zones. Each type of soil has a corresponding characteristic vegetation which, basically, should find wide application in phytomelioration within the relevant phytoclimatic zone. Each zone has its own particular kinds of plants, treatments and management methods for phytomelioration.

Our planet supports a huge variety of higher plants—more than 250 000 species. Through prolonged adaptation to natural-historical conditions and the geographical zones on the planet, they have formed distinct communities—phytocenoses—the natural vegetative layers of the biosphere and the primary source of life on Earth.

The evolution and development of plant life on Earth has produced a series of natural regions, each with their own suite of species The flora of Russia totals more than 15 000 species; South America has 56 000 species, tropical Africa has 15 500, and the Indian subcontinent 26 000. Each of these regions supports large numbers of endemic species. A good example of the extent of endemism in the flora is provided by the Philippine archipelago where, out of a total of 7620 species, 5532 are only found here.

4. Phytomelioration for protection of soil from water and wind erosion

Soil erosion is an extremely serious problem all over the world. This is because of the vital role that soil plays in the life of the biosphere, and the fact that in many countries, as a result of strong human influence, the soil cover is in a critical condition. Soil cover is subject to massive degradation. The UN Conference on Environment and Development (Rio de Janeiro, 1992) stressed the paramount importance of combating soil erosion (*see Erosion and Deflation Control*).

Soil erosion represents loss or destruction of soil, and consequent loss of fertility. It is primarily caused by either water or wind erosion. Water erosion occurs when soil is moved by surface flow of rainwater, melt-water, or irrigation water (*see Irrigation*). Wind erosion occurs under the influence of wind with a speed sufficient to lift soil particles from the surface.

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Biographical Sketch

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