HISTORY OF LAND IMPROVEMENT

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Summary

Land amelioration is a system of measures aimed at raising soil fertility. It ensures the efficient agricultural use of bogs, waterlogged soils, scorched deserts, semideserts, and lands degraded under irrational anthropogenic loads. It is one of the most important means for sustainable production of food and industrial raw materials.

Over the history of human development, considerable experience has been gained in the field of land amelioration, and a separate branch of applied science—amelioration science—has been developed. The science and practice of amelioration are based on the achievements of fundamental sciences such as physics, mathematics, chemistry, and biology. At present land amelioration is performed in virtually all countries of the world, and it is essential for the food and ecological security of individual countries and the world community. Current demographic growth and industrial development have created a grave problem of competition in the use of water and land resources and water quality preservation.

Agenda 21 of the UN Conference on Environment and Development (UNCED) held in Rio de Janeiro in June 1992 orients the world community toward the involvement of all interested parties at all levels, including water consumers, designers, managers, and

politicians, because water is of economic value for all competitive forms of usage.

The multipurpose approach, and ecological, social, and economic principles of land amelioration should provide the basis for new systems of land and water management to enable the sustainable development of modern civilization.

1. Introduction

Amelioration—the improvement of agricultural land for obtaining high and steady crop yields—became a human profession at the time this word appeared, to denote work on land improvement. The assimilation of new lands for agricultural production and the expansion of agricultural areas started at the very beginning of ancient agriculture. The notion of land amelioration formalized a definite sequence of operations for increasing crop yields. Land irrigation systems in the droughty regions of ancient Egypt, Mesopotamia, India, China, and some other parts of the world can be considered the first historical monuments of land amelioration. At present, the term "amelioration" (improvement) has the most general meaning. The particular kinds of land amelioration are: land irrigation and drainage, assimilation of new lands, slope terracing, flood and erosion control measures, land sanitation, rehabilitation of degraded and polluted soils, reclamation of low-productive soils, and the application of fertilizers, soil amendments, and conditioners.

The history of land amelioration reflects the progressive development of productive forces, scientific achievements, and practices in different countries. An analysis of the history of amelioration is important for evaluating modern attitudes about the subject and developing optimal lines of inquiry for the future.

2. Land Amelioration in the Ancient World (Egypt, Mesopotamia, China, India, etc.)

Primitive gatherers and hunters led a nomadic life. The Neolithic revolution, marked by the domestication of wild animals and plant species and the appearance of primitive stone tools for use on cultivated land, made it possible for people to organize permanent settlements. The first permanent settlements of ancient farmers were along rivers. Periodically flooded lands had better moisture and were fertilized by the silt brought by floodwater, and this permitted high yields without any artificial measures.

As the human population increased, the lack of free space on flood plains forced people to cultivate the less fertile land deprived of vivifying floods. Under these unfavorable conditions humans tended to replace the effect of natural floods by artificial measures, and as a result irrigation was invented. Irrigation rapidly extended over the land where drought ensured that wild plants and crops perished. Artificial canals and basins for water accumulation crossed the newly assimilated land and supplied it with water.

Some tribes went to the north in the search of new lands. In the severe northern environment, they found vast forests and bogs with isolated areas under meadows. The lea tillage enabled the first migrants to live, but the soils gradually lost their fertility and became sterile, especially during drought years. With the growth in population, the need

for agricultural land increased, and the soils under forests and bogs were developed. Two amelioration practices (irrigation and flooding) were supplemented by drainage and deforestation. The use of fire for the development of forested lands ensured the additional fertilization of soil with ash, which increased the crop yield. Thus, a system of "slash and burn" agriculture was established in forested areas.

The development of human civilization is inseparable from the development of land amelioration. In fact, the need to ameliorate lands was one of the main driving forces of the development of human societies.

Historians note that the first states with permanent settlements (towns) encircled by agricultural areas appeared about 4000 BC in the fertile flood plains of the Nile, Tigris, Euphrates, Yangtze, Huang He, and central Indus, as well as in the Syrian and Iranian foothills. The labor-consuming drainage of waterlogged land by means of canals, land irrigation, and construction of water-collecting basins "not only accelerated the union of tribes, but also developed their material and spiritual cultures," as Bunin puts it.

The lower Nile basin was populated as far back as the Paleolithic period. Work on the protection of croplands from floods, drainage of waterlogged territories, and artificial delivery of Nile water to the territories lying far from the river, initiated the early formation of territorial communities. The latter formed the basis for the politically independent regions (nomes) that were consolidated under the supreme power of the Pharaoh in the end of the fourth millennium BC. The Nile played an essential role in the life of the ancient Egypt. It irrigated the flood plain during the high-water period in the fall; the precipitated river drifts sustained soil fertility; the Nile was also the single throughway. Therefore, Egyptians made a cult of the Nile at the earliest stage of the civilization. From the evidence of Herodotus and Plutarch, they called irrigation the marriage of the Nile with the Earth: "Osiridis cum Nephti coitum." Ancient Egyptians idolized any manifestation of soil fertility.

To protect their settlements from high Nile floods, special engineering measures were performed. These measures included the preparation of the territory for the construction of temples and palaces, the diking of towns, the construction of dams and water-collecting basins, irrigation, and drainage. These works were supported by the state. Their scale was really impressive: the remains of a 12 m high and 100 m long ancient dam date back to 5000 years ago.

In ancient Rome, irrigation played an important role. Cato repeatedly mentioned the artificial irrigation in his treatise on agriculture and unequivocally noted irrigated land as the best estate. Virgil, Pliny, Columella, and others considered it necessary to irrigate haylands along with plowlands. Pliny recommended starting irrigation after the spring equinox, ceasing it during the period of grass flowering, and recommencing it after haying. Many ruins of locks, canals, and water pipelines, dating from the Age of Emperors (between Augustan and Theodosius), can be found today and attest to the wide development of irrigation in ancient Rome.

It should be noted that the Romans were well aware of the harm caused to crops by excessive moisture and moisture deficiency during periods of drought. They paid

attention to the arrangement of canals to discharge excessive water after irrigation. Since then, drainage has been considered as a component of irrigation.

Irrigation was performed in Egypt (as well as in India and China) by flooding basins. This oldest irrigation method was perfected gradually. For flooding irrigation, the territory was divided by dikes into a network of terraces forming basins. The flood water was taken in the upper basin, passed through it, and entered the lower basin through a lock gate in the under dam. The basins were up to 150 km^2 in area. The moistening–fertilizing irrigation process was used.

Pliny presented examples of the extreme fertility of irrigated land: the soil fertility in the African sands near watersheds (Takan) increased to a miraculous level due to irrigation. The water was distributed between landlords according to schedule, and irrigation favored a peculiar farming system: olives grew under high palms; fig trees grew under the olives; pomegranates grew under the fig trees; vineyards were located still lower, and wheat, vegetables, and fodder grasses were planted in turn between vineyards. The soil yielded fruits all the year round, and its fertility depended on the art of the land cultivators.

Egypt presented a great example of agricultural reclamation. According to Herodotus, so strong was the belief of the Romans in irrigation that when they learned that all land was not irrigated in ancient Greece they expressed their apprehension that all Greeks would die of famine in the case of drought.

In Mesopotamia, irrigation began with the colonization of land, at the same time as in Egypt. An ardent heat to the south of Babylon lasted for nine months per year, and therefore irrigation was indispensable. The fertile loess soils gave abundant yields under irrigating conditions, date palm being the main culture.

About 6000 years ago, dams on the Tigris and Euphrates rivers were constructed almost simultaneously with the dams on Nile and Yangtze. Irrigation was impossible without the water from these rivers. Water shortages did not limit the development of irrigation until the mid-nineteenth century.

Large irrigation systems with water extraction from the Tigris were constructed between 2600 BC and 1400 BC.

The first measures of soil salinization control by leaching and constructing drainage canals in the territory of modern Iraq date back to 2400 BC.

The development of irrigation systems in Mesopotamia and Egypt between 4000 BC and 2000 BC, and large-scale work on the construction of canals, outfalls, and flood (detention) pools stimulated the emergence of exact sciences and the flourishing of handicrafts. Distribution of water and construction of canals and hydraulic structures accelerated the evolution of engineering and geometry.

The farmer needed an accurate calculation of time and this resulted in the development of the calendar. In this way the evolution of skill and experience in irrigation farming in

the most ancient agricultural centers stimulated the evolution of science and the progress of society.

Israelites transferred the art of irrigation from Egypt to Palestine, where it also became an essential part of life. The Book of Genesis says that all Jordanian fields were irrigated by means of artificial water supply, as well as the Egyptian land. Water-engines were also known: for instance, Moses mentions a treadle water-lifting gear.

Very high yields were obtained because of irrigation: the yield of wheat was between 100 and 300 times as much as the amount of wheat seeds sown in Assyria, Egypt, and Syria. In ancient Greece, land was irrigated from springs and rivers; the irrigated land was highly prized, especially in Attica, where special irrigation legislation was put in force.

After the fall of the Roman Empire agriculture fell into decay around the world, and knowledge of irrigation practices remained only in some regions of Europe, mainly in the monasteries. From ancient history, the Pont du Gard, the aqueduct over the Tarn River in France constructed by Romans, should be mentioned. The evolution of digging tools has played an important role in the development of irrigation practices. The first tool utilized by farmers for irrigation was a stick. Early on there was no tillage, and sowing was directly into wet soil. However, even in this case, the stick was often used for seed incorporation, as was testified by ethnographical observations. In 1968, Axel Steensberg, a great connoisseur of the history of agricultural tools, discovered a number of wooden agricultural tools in the mountain regions of New Guinea, including a small stick with a sharp edge and a short paddle-like spade for ditch digging.

In China, flood control came into practice about 200 BC. At that time, treatises were published on the management of river water, flood control, and canal construction. The famous dam on the Tu-Klang River with a water reserve sufficient to irrigate more than 2000 km^2 of paddy fields was constructed during the Chin dynasty in the third century BC. The equipment for lifting water from a river for irrigation was under development. The 1125 km long Grand Canal was constructed during the Sui dynasty, in the late sixth and early seventh centuries of our era. Irrigation, drainage, and flood control in China have a history dating back more than 5000 years. The history of irrigation in southern India and the island that is known now as Sri Lanka covers more than 3000 years. Sri Lanka was totally covered with an irrigation network as early as 3000 BC, and irrigation ensured two yields per year. Protective dams and distribution canals have been in use for 6000 years. In Latin America, the remains of irrigation canals, dams, and drainage have been found from the ancient Maya culture.

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Biographical Sketches

Ivan Vasil'evich Minaev was born in 1931. In 1954 he graduated from the Moscow Institute of Hydraulic Engineering and Water Management with a diploma in hydraulic engineering. He gained a doctorate in technical sciences and became a senior researcher. For many years he was Head of the Laboratory of Nature Conservation at the Belarussian Institute of Amelioration and Meadow Management in Minsk. Until recently, he was a professor at the Belarussian State Polytechnical Academy.

His major scientific interests were in the area of land reclamation, improvement of drainage regimes and techniques, and the development of environmentally safe ameliorative systems. He wrote several monographs: *Amelioration and Environmental Conservation* (1985), *Ecological Perfection of Ameliorative Systems* (1986), *Handbook on Land Reclamation* (1989), and *Drainage Systems in the XXI Century*.

Boris Stepanovich Maslov was born in 1929. In 1954 he graduated from the Moscow Institute of Hydraulic Engineering and Water Management with a diploma of hydraulic engineer, specialist in hydromeliorative works. In 1965 he took training courses at the University of California. In 1976 he defended his doctoral dissertation; in 1979 received the title of professor; and in 1991 was elected academician of the Russian Academy of Agricultural Sciences (RAAS).

He was the Head of the Science Department of the Ministry of Melioration and Water Management of the USSR (1975–1985); Professor of the Moscow Institute of Hydromelioration, Director of the A.N.

Kostyakov All-Union Research Institute of Hydraulic Engineering and Melioration (1985–1988); and the head of the Department of Melioration and Water Management of the RAAS (1991–1999). In 2000 he was appointed the Senior Specialist of the Engineering and Production Center on Water Management, Melioration, and Ecology.

Professor Maslov is the author of more than 500 published works, including 40 monographs, on soil reclamation, meliorative hydrogeology, environmental protection issues related to land reclamation works, and the history of amelioration science. The main titles are: *The Regime of Groundwater in Waterlogged Areas and Its Regulation* (1970), *Agricultural Amelioration: Textbook* (1984), *Amelioration and Scientific and Technological Progress* (1986), *Essays on the History of Land Amelioration in Russia* (1999), *Drainage Systems in the XXI Century* (1999), and *Amelioration of Water and Land Areas* (2000). He participated in the work of several international congresses and symposia organized by the International Commission on Irrigation and Drainage (ICID), International Peat Society (IPS), the Society of Agricultural Engineers, and so on.

He is an Honored Worker of Science and Technology of the Russian Federation and Laureate of the A.N. Kostyakov Gold Medal. His work in amelioration science was acknowledged by the jubilee diploma and medal of the ICID.