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Methods and Tools for Rehabilitation of Irrigation Open Canals in Porous Soils and Its Impacts Technically, Economically, and Environmentally in Egypt

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Abstract

The projects of rehabilitating and lining irrigation canals are among the most recent projects adopted by the developed countries of the world, which Egypt is now pursuing in order to face the water deficit crisis, as it aims to preserve the quantities of water that is wasted as a result of infiltration operations in the porous soil in particular, as it limits the spread of harmful weeds in Irrigation canals, it is expected to save about 5 billion cubic meters of water that was wasted along the streams of the water network all over Egypt, and the rehabilitation of irrigation canals will contribute to a decrease in the amount of water evaporation, reduce the percentage of impurities that reach the end of the canals and reduce their efficiency and the amount of possible disposal. Using them directly without treatment, in addition to that the project will ensure faster water access without breakdowns to agricultural lands, with the ability to achieve justice in water distribution and increase productivity for those lands, and it will also reduce the annual maintenance costs of all kinds of waterways.

The project of rehabilitating irrigation canals has good impacts on the environment and preserving it by planting trees on the sides of the canals as well as limiting the dumping of waste and garbage into canals. The project can also be used as a fish farm, and this is all for a tangible economic returning in terms of saving maintenance costs as well as saving waste. In terms of water quantities and raising the efficiency of agricultural crops, as well as urging this project to use modern irrigation techniques such as sprinkler and drip irrigation, which in turn also contributes to rationalizing the use of irrigation water.

Keywords: Nile River; Hydrosphere; Watercourses; Waterlogging

Introduction

By virtue of its location within the arid zone belt, Egypt is very sensitive to its limited water resources and imported from outside its geographical borders, as it depends on the Nile River as the main source of water (93% of the total traditional resources and 97% of the fresh surface water). The traditional water resources are: Egypt's share of the Nile water, which is 55.5 billion cubic meters per year (according to the 1959 agreement), limited amounts of rain, and torrential water, and deep groundwater in the Sinai, the Western Desert and the Eastern Desert. In addition to non-traditional resources, which include reuse of agricultural, sanitary and industrial drainage water, and the exploitation of shallow aquifers in the valley and the delta? In light of the increasing demand for water with the limited resources available, Egypt attaches great importance to preserving, developing and managing its water resources properly. It is also working to find additional resources such as desalination of sea water and groundwater. In order to face current and future challenges, work must be done to develop appropriate and practical water strategies and policies, in addition to preparing flexible plans and programs. They can be modified according to any changes that may occur in the future, with the need to focus on the transition from the prevailing culture of abundance of water to a culture of water scarcity. It is certain that most of the solutions to water problems do not necessarily come from within the water sector. Rather, these solutions often stem from other sectors that are directly or indirectly related to the water sector. Therefore, water problems and management policies must be placed among the priorities of the development plans of all ministries, government agencies, civil society organizations, and the private sector, with all their technological and material capabilities [1].

Soil

Soil is the fragile or crumbling surface layer that covers the surface of the earth. Soil consists of crushed rock materials that have previously undergone changes due to exposure to environmental, biological and chemical factors, including weathering factors and erosion factors. It is worth noting that soils differ from their basic rock components, which is the reason for Altered by the interactions that occur between the four Earth's surface membranes; they are the lithosphere, hydrosphere, atmosphere and biosphere. We conclude from this that the soil is a mixture of the organic and mineral components that make up the soil in its liquid (water) and gaseous (air) states, that is where the materials that make up the soil retain between their disintegrating grains in porous gaps (or what is known as soil pores) and thus constitute the soil structure That fills these pores. These pores include aqueous solution (liquid) and air (gas). Accordingly, soils should often be treated as a three-phase system. The density of most soils ranges between 1 and 2 g / cm^3 [2].

Porosity can be expressed as a term that expresses the spaces between grains of solid soil, whether organic or mineral, or the aggregations of those particles. Porosity plays a big role in determining soil permeability (the rate of water or air infiltration through the soil per unit time) [3].

Sandy soils are considered to have high porosity, so the velocity of permeability is higher than clay soils and vice versa in clay soils with narrow porosity, which in turn lead to less permeability and water retention for the longest possible period. Therefore, porous soil is treated with special treatment for constructing irrigation canals in it or maintaining and rehabilitating the irrigation channels established in it due to the lack of cohesion of its grains in a stronger form and also for its high porosity, which also increases its permeability of water and the inefficiency of water access in it to the ends of the canals, which causes problems for farmers when irrigate their lands.

Open Irrigation Channels

In it, the flow of water is carried out in channels with a free surface (open), meaning that the water surface is not under pressure, and in this case the flow in these channels is under the influence of gravity. They can be formed naturally such as rivers or streams and valleys, and they can be constructed and built such as canals, irrigation channels and watercourses, as shown in Figure 1.

And open dusty waterways are exposed to several problems, the most important of which are:

a) Large losses resulting from leaching

b) Precipitation resulting from low water velocities

c) The erosion caused by the high velocities of the water

d) Continuous maintenance costs as a result of dredging and weed removal

e) Continuous maintenance of curved parts in canals as a result of continuous erosion and sedimentation, which may result from a change in the canal sector.

f) Lack of water reaching the ends of the canals due to changing levels of the bottom of the canals or increasing leaching rates due to porosity of the soil or excessive evaporation due to high temperatures

Figure 1: A canal as an example for an open irrigation canal.

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To avoid all these problems, lining and rehabilitating canals is the best solution to such problems.

Rehabilitation of Canals

Given that the country suffers from limited sources of irrigation water, as the Nile River is the first source of water in Egypt, in addition to the reuse of some non-traditional water resources such as treated agricultural drainage water, of which the agricultural sector consumes between 85%: 93% of the total water resources [1]. Also, the excessive population increase was among the challenges facing the country against water poverty, in addition to the establishment of development projects in upstream countries, which negatively affects Egypt's share of water, so it was imperative that we plan irrigation projects that are commensurate with water imports witch Expected in the future. This requires thinking of two axes: The first is to prepare irrigation projects according to the expected discharges and levels. The second is how to oblige the farmer to ration the water consumption.

First: Preparing irrigation projects

This requires taking several solutions, the most important of which are:

a) Rehabilitation of irrigation canals:

i. Lining of irrigation canals.

ii. Reducing the bottom levels of the channels to ensure that they operate at the expected levels.

iii. Reducing the levels of control installations.

iv. Rationing of water intakes for farmers.

v. Assisting in adjusting and leveling farmers' lands in a way that reduces wastage of water during irrigation.

b) Re-study the designs of future irrigation projects:

i. Designing irrigation canals at levels that do not allow the irrigation process easily, which obliges farmers to use their own pumps, which have become sufficiently available to them. This process has another effect, which is to reduce the earthy inclusions of the channels, which reduces construction costs and thus reduces wastes and reduces groundwater levels.

ii. Adopting the establishment of pumping systems for small projects that pump water into a network of iron pipes instead of open channels. This process has positive results in rationing water consumption and reducing waste to a minimum.

Second: Obliging farmers to use rationing of water

Given that farmers are accustomed to the abundance of water without restrictions, which requires a program and requirements to qualify the farmers for the stage of water scarcity, including the following:

a) Providing sprinkler or drip irrigation devices and facilitating farmers' access to them.

b) Opening awareness and education sessions for farmers on the importance of rationing water consumption with the use of modern technologies in irrigation and agriculture.

c) Measuring the discharge of small irrigation channels and calculating the irrigation fees accordingly.

d) Credit to farmers who want to buy equipment for amendment and settlement of lands.

e) Activating the irrigation laws, and the principle of calculation in the face of excess and violation.

Lining the Irrigation Canals

Figure 2: Rehabilitation of open irrigation canals.

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Lining means cladding the surface of the earthen channel with a fixed impermeable material, or any other similar material, and the purpose is to reduce leakage loss, in addition to some other benefits that the lining can provide as shown in figure 2, and these benefits can be summarized in terms of: It follows [4].

Control of leakiness and infusion

Certainly, the lining process reduces the water loss due to leaching, as the lined channel costs approximately 2 to 2.5 times as much as the unlined channel. In the event that there are large quantities of wastage as a result of leaching, the lining process in such a case gives a great economic return, especially as it provides a large part of the water that is usually invaluable.

Preventing the saturation of agricultural lands

Usually leaching from canals causes groundwater to rise in the agricultural lands surrounding the canals, and this leads to the transfer of alkaline salts to the soil surface, which in turn makes the land unfit for agriculture. This process is called land saturation, so lining canals prevents leaching and preserves agricultural soil. Executing agricultural drainage projects in addition to lining canals helps reclaim lands affected by waterlogging.

Increase channel capacity

The capacity of the channel can be increased by lining, as a channel whose surface is lined and smooth shows less resistance to water flow in it, so the water flows more quickly, that is, the discharge is greater compared to the unlined channel. The flow of water in unlined channels is usually obstructed by weeds growing in the floor and sides of the channel. Lining increases the capacity of the canal, and thus reduces the channel section, and thus the dimension of the channel sections in new projects are less, and thus reduces the earthwork when excavated. This leads to a great saving in excavation and filling, as well as in agricultural area.

Reducing maintenance costs

Unlined ducts usually require a high cost to maintain their proper functioning. These costs include annual repairs and maintenance, which can be summarized as follows:

a) The removal of sediments from time to time

b) Minor restorations

c) Removal of weeds and aquatic plants

Lining reduces these costs to a large extent, and lined ducts reduce maintenance costs for their durability and proper functioning.

Elimination of flood hazards

Un-lined canals are exposed to the risk of floods, especially when a break occurs in their sides, while channels lined with coherent materials are difficult for such floods to occur. There are many types of lining materials, as each type suits the conditions and the surrounding environment greatly to achieve optimal goals for that. The most important types of lining can be summarized in the following points [4].

Lining with low permeability soils

This is a clay material that prevents leakage by up to about 80%, and one of the disadvantages of this soil is that it cracks when exposed to drought, so it is suitable for channels that do not work in shifts, and the mixture that is suitable for use is as follows:

a) A mixture of sand and clay (50% - 75% sand, 30% - 40% clay)

b) A mixture of gravel and clay (30% - 40%)

c) A mixture of sand and a large proportion of clay (30% -40% sand, 70% -6% clay)

d) A mixture of silt and clay (30% - 5% clay, 60% - 4% silt, 10% sand)

Lining method

a) The floor and bottom of the channel shall be prepared according to the design section

b) The soil is well compacted and sprinkled with water before applying the clay

c) The floor and sides of the canal are divided into squares or rectangles (their dimensions range between 3 and 4 meters) by wooden blocks in the longitudinal direction

d) The clay mixture is placed in each square after the other with expansion joints, and the thickness of the clay layer changes according to the type of the mixture from 5 to 18 cm

e) The surface is covered with sand or straw, and completely wet for a period of two weeks.

Lining with stones or bricks

This is one of the oldest methods used in lining works. This allows water to flow at high speeds that may reach 3m/s, and usually stones are placed either without mixing or using a mixture for the purpose of increasing the cohesion strength, in the first case it does not prevent leakage from the channels, but rather increases the resistance against the canal erosion, and the lining using the mixture prevents leakage, The liner may be exposed to water pressures to up as a result of water trapped under the liner and without outlet. To reduce this risk, holes at distances of 1.0m - 1.2m are left without mixing. If the foundation soil is sandy or loamy, filters should be placed below the inlet to these openings.

As for lining with bricks, it is usually used in areas where manpower is abundant and cheap, and raw material is available in locations near the channels, and it is not possible to obtain other lining materials at competitive prices for bricks. The percentage of salts in the used bricks should not exceed 2%, and the percentage of clay in it should be between 10% - 20%, and openings must also

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be made to allow the water pressure to be reduced to up.

Concrete lining

Concrete lining is the most powerful method of lining, because it can transport water at high speeds of up to 3 m/s, and it reduces the costs of creating channel sections, in addition to reducing or preventing the growth of weeds, and if you pay attention to its design and implement it, it may last for long periods of up to 40 A year or more.

The lining process is carried out in the form of surfaces with dimensions not exceeding 5 × 5 meters to reduce cracks due to expansion and contraction, and the joints between the squares are filled with bitumen and rubber. The thickness of the concrete usually ranges between 7.5 and 10 cm, and the side slopes do not exceed 1: 1, and the lining may be done by one of the following methods:

a) Lining by pouring concrete on site: This is the cheapest method of lining with concrete, in which concrete is placed directly on the foundation soil, and the ratio of cement to gravel is 1: 7 or 1: 6, provided that 80% of the gravel is less than 18 mm in diameter, and the largest size It has no more than 37 mm. As for sand, it must be graded in size and its ratio to gravel ranges between 38% - 49%, as shown in Figure 3.

b) If the surfaces of the lining are exposed to external forces such as earth pressures and water pressures up or down, the concrete must be equipped with iron reinforcement, as is the case for reinforced concrete designs. In the absence of earthen pressures, the purpose of the reinforcement is only to prevent the occurrence of cracks due to contraction or expansion of the concrete, and to resist any other unseen influences such as subsidence.

c) Lining by spraying concrete on floor surfaces under pressure: This method is used for lining channels with small discharges, floors and sides are sprayed with the mixture to the required thickness by using a cement gun that sprinkles the mixture under air pressure on a mesh of reinforcing steel placed on the foundation soil with a diameter of 3 mm separated by An interlayer spaces ranging between 10 - 15 cm in both directions, with breaks left for expansion and contraction, and the thickness of the lining layer ranges between 4 cm and 6 cm, depending on the nature of the soil and the discharge of the channel, this type of lining is suitable for channels that cut into natural ground, as shown in the figure 4.

d) Lining with precast concrete slabs: This type is considered uneconomical in small projects, it is less resistant to water pressures and soil swelling, but it is inexpensive in terms of maintenance and repair, and its implementation and maintenance does not require high skills or special equipment. Ready-made tiles are manufactured with a thickness of 5 - 6.5 cm, while the length and width differ according to the dimensions of the channel, and the length is usually between 20 and 60 cm.

Figure 3: Lining by pouring concrete on the site.

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Figure 4: Lining by spraying concrete on the surfaces.

Lining with bitumen or asphalt

This method is characterized by being flexible and easy to repair, and the mixture consists of bitumen, gravel and graded sand, and is placed in the lining places with a thickness of 6 mm while it is at a high temperature, and this type of lining is one of the cheapest methods, but it is not suitable for clay soils that are subject to severe shrinkage when drought.

The disadvantages of this method are:

a) Its life is less than cement concrete

b) Do not allow large speeds (no more than 1.0 m / s)

c) It is exposed to damage due to the growth of some herbs in it

d) It needs continuous maintenance at intervals ranging between 2 - 3 years

Membrane lining

The channels are lined with different types of rubber or plastic membranes with a thickness of 0.2-1.0 mm. These layers are placed on the floor and sides of the channels and their ends are buried with soil, and these layers bear the intense sunlight and the weight of the feet, but it is preferable to cover with a layer of soil with a thickness of 15 cm, and sometimes it is used under concrete to prevent leakage, as shown in Figure 5.

Lining with materials that close the soil pores

The floor and sides of the channels are treated with impermeable substances that prevent leaching. Several studies are being conducted to date to inject these materials, such as bentonite, into the water flowing into the channel for the purpose of closing the soil pores. But this method has not proven its lasting success to this day, and this process may occur automatically due to the presence of suspended silt substances in the water that close the pores.

Geocell lining

The geocell material consists of high-density polyethylene, which is very close to the shape of the cell, as it takes the shape of a three-dimensional cell, and in which these cells are welded using ultrasound, where the cells are filled with sand or regular concrete. The shape of the cells is useful to prevent any side slips, and the advantage of it is being installed quickly and easily, and they bear high strength and intensity, and the bearing strength of the cell depends on the thickness of the cell wall.

It also has many benefits, including obtaining many designs to protect canals and all types of water channels and provides stability and protection for the floors and sides of canals from erosion resulting from even high water flows, and maintains the continuity of the quality of the surfaces of the canals if the water is continuous or intermittent and withstands all different water pressures In wide or narrow canals, it controls the loss of normal cement concrete inside the cells and protects the surfaces from subsidence, collapses and cracks. It does not need expansion joints and resists the movement of the soil below the surface of the canal by means of the elastic texture consisting of three cells together. Geocell also has the advantage of fast installation even the slopes, the strength of cement concrete inside the cells, and

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the lack of labor required even without trained workers, and saves costs compared to traditional systems and does not require difficult periodic maintenance work, and maintains the stability of the design sector of the canal. It is worth noting that Egypt started for the first time using Geocell lining in 2020 as part of the national project for the rehabilitation and lining of canals, as shown in Figure 6.

Figure 5: Lining with rubber membrane.

Figure 6: Geocell lining in the national project for canal lining - Egypt.

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The Economic Feasibility of Canal Lining

To assess the economic feasibility of irrigation canal lining projects, it is necessary to estimate all costs incurred on the project and also calculate the expected return from it. The results of the economic study are necessary and basic information that must be available to the investor in order to decide in light of them in making the appropriate decision to initiate the lining process or otherwise.

The economics of lining may differ from one place to another, but it has been found that lining may become economical in some cases. In special cases and for certain technical considerations, lining of channels may be necessary. For example, an irrigation channel located in Soil consisting of two layers, the upper is rocky and the lower one is highly permeable. In such cases, the channels may be unsafe unless they are lined. Usually, such channels are lined with a solid, stable material whose cost may be prohibitive in order to withstand the high flow velocity. Except in these cases, the engineer must provide justifications based on good economic foundations so that the capital can be invested for the purposes of the lining.

In general, it is necessary to evaluate the matters and the benefit that the lining process can provide, as well as the water loss with material values such as (dollars or the euro, for example), and then compare it with the cost of lining, and based on that the economic analysis is done, for example, taking the benefit-cost ratio as a guide or indicator to justify Lining or not, for example, an amount of $35,000 was spent on lining operations in an irrigation project in one of the countries, and as a result, 1.4 million cubic meters of water were saved, which was used to grow lands with sustainable crops of an area of 1600 dunams, meaning that the average What was spent on the lining process equals 20.5 dollars per acre, and since these lands were planted with citruses, the profit per acre was about 75 dollars annually, so the lining process in such a situation can be considered economically successful in this project. From a mathematical point of view, spending on a particular project can be justified if the annual returns exceed the annual cost (including the benefits that can be gained from the capital), that is, the ratio of returns to cost must be greater than one, as for the justifications for actually existing channels It differs from those justifications for the channels that are under implementation or to be implemented, because the excavation work in the new channels is less, in addition to many other advantages, and in any case, the lining costs must be balanced with the quantities of earthen excavations, the decrease in maintenance costs, and the lack of drainage requirements.

Economic feasibility of the national project for lining Egyptian irrigation canals

The national project for lining irrigation canals in Egypt is one of the effective means to maintain Egyptian water security, which is an integral part of the Egyptian national security, and this is a great gain in itself. Moreover, the project has a great economic return as it will limit the increasing expenditures that It is spent on the maintenance of canals and weeding and other things, which will save 20-25% of these expenditures in addition to improving the flow of water in these canals [5].

According to the studies conducted by the World Bank in 2016 to assess the feasibility of the project, which concluded with the following [6]:

a) The development of canals and mesqas leads to the provision of 7% of irrigation water.

b) The development leads to a reduction in field irrigation costs by 50% - 60%.

c) Development leads to an increase in agricultural productivity by up to 12%.

Environmental Impact Assessment for the Rehabilitation of Irrigation Canals

The project of rehabilitating open irrigation canals is one of the projects with a great environmental impact, as these projects work to reduce pollution and improve the environmental and health situation of citizens. The most important environmental goals desired from the rehabilitation projects can be reviewed as follows:

Afforestation of the sides of the rehabilitated canals

Afforestation of the sides and edges of canals is one of the most important things that have a direct and significant impact on the environment, as trees help to purify the air and improve its quality. They act as filters that purify the air from all impurities such as smoke, dust, and fumes from the atmosphere. Planting trees also helps reduce the air temperature by blocking the sun's rays. The afforestation process has other goals such as contributing to a decrease in soil erosion, and thus the ability to cultivate, in addition to keeping insects, animals, and birds in their place, which leads to improving the biodiversity of the area, and also absorb harmful gases from the atmosphere such as monoxide. Carbon, sulfur dioxide, in addition to the release of oxygen gas, as one huge tree can supply for one day of oxygen to four individuals [7].

Reducing aquatic weeds

Water weeds pose a great danger to the environment, especially in terms of agricultural, water and biological aspects, as they work to reduce agricultural productivity when they appear in agricultural fields and also work to increase the costs of irrigation, fertilization and harvesting, as there are many types, including those that float above the water, such as the Nile rose *(Eichhornia)*, and those that strikes by its root the bottom of canals, such as the water lily *(Nymphaeaceae)*, and the one that the vegetative group rises to the top , such as the *(Arundo)* and tiffa, and the Submersible which its green group may not appear as a whole, such as the *(Ceratophyllum demersum)*, the *(Equisetum hyemale)* and the *(heiderella)*, as shown in Figure 7 [8].

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Figure 7: Some undesirable aquatic plants.

The growth of these plants impedes movement in water channels, river navigation, current movement and water flow, and also threatens bridges and reservoirs with the accumulations and weights they represent in front of these facilities, as well as impedes fishing operations and threatens the lives of fishermen in small boats by impeding their movement when the water comes down, and pushing them to divert their activities to the Exposed water near the core of the stream, where the risk of depth and more rushing currents [9]. This plant species also provides a suitable climate for the growth and reproduction of harmful insects in the water, such as mosquitoes that transmit malaria and others, and helps to transfer dangerous snails from one place to another, such as snails that act as secondary hosts for schistosomiasis and hepatic worms, as well as providing a near-ideal environment for animals to hide Harmful wild such as crocodiles and poisonous snakes. This is in addition to affecting the food chain of fish by blocking the light necessary for the growth of phytoplankton that live in the water, working to reduce the percentage of oxygen and raise the percentage of dissolved carbon dioxide, change the pH and cause its shallowness during the deposition of plant leaves and ancient roots on the bottom, where the sediments under its dense accumulations amount to about a third of a meter each year [8].

Among the main problems caused by the invasion of *(Pistia stratiotes)* grass are those related to human and animal diseases associated with the presence of mosquitoes, as that grass plays its role as a preferred host for the larvae of many types of these insects, among which have there are two types that are considered to be the main carriers of many forms of encephalitis and elephant disease *(Filariasis)*, and the only way to control this mosquito is to remove that weed from the water [8]. Such types of weeds and other submerged species pose in one way or another a grave danger to irrigation systems, and once the weeds invade the water system, the water will not move according to the calculated flow, and the far fields are affected by this, so they will not be irrigated at the scheduled times. The reduced flow also contributes to the phenomenon of seepage from the ducts, as well as the significant increase in the loss due to evaporation [8].

Reducing water pollution and dumping garbage

The illegal disposal of industrial and household waste represents a huge environmental problem. From a health point of view, polluted water is associated with the transmission of many dangerous diseases such as cholera, diarrhea, dysentery, hepatitis A, typhoid and polio. An Egyptian environmental study, published in the Journal of Advanced Research, indicates that water-borne diseases are responsible for more than two million deaths and four billion cases of diarrhea worldwide annually, making water pollution one of the main causes of death and disease [9]. Because the waste contains many of these toxic organic compounds that are not degradable, or they decompose slowly, they persist in the ecosystem for long periods, and often turn into carcinogens, especially when they interact with chlorine used in water disinfection, as they affect fish and organism's other aquatic [9].

Promote fisheries

Rehabilitation of open canals is one of the reasons for reducing pollutants or harmful weeds, which provides the opportunity to develop fish wealth in these canals or to use some of them for fish farming safely, as the fish stocks are not contaminated with heavy metals such as lead, mercury, copper, zinc, cadmium, chromium and others, that have implications for general human health, just as fish farming will have a tangible economic impact [10].

It is also possible to raise some types of fish that depend mainly on seaweed and the remnants of algae in their food, as well as microorganisms from mosquito larvae such as mullet fish, and catfish can also be raised, which are meat-eating discarded fish as they feed on anything from aquatic plants, insects and worms to Reptiles, frogs, small mammals, and even other and small fish and waste from them, and this will have a role in disposing of any residues that may be present in the eligible irrigation channels [11].

The Technical Effect of Irrigation Canals Rehabilitation

The use of modern technologies in irrigation and agriculture is one of the most important things that governments pay great

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attention to during this period, and these technologies include sprinkler and drip irrigation, as well as the use of advanced technology in water management.

The effect of rehabilitation of irrigation canals on water resource management

Rehabilitation of open irrigation canals as well as agricultural drains works to raise the efficiency of irrigation as well as rationalizing water consumption and reducing the cost of maintenance of these channels, which in turn will have a great economic return as it is possible in one shift to irrigate the largest area of acres and stabilize the irrigation water, and moreover It will eliminate the problems of irrigation water shortage in some areas, especially in the summer months.

Rehabilitation of irrigation canals determines the shape and dimensions of the sector of these channels - which used to suffer from the deformation of these sectors before the rehabilitation operations - and thus technology and computers can be introduced into the management of their operation, it is easy to control the quantities of water and calculate its quantity at any point along the eligible irrigation canal.

The process of controlling open irrigation channels using computers includes two important points [12]:

a) Control of water levels in channels.

b) Control the flow within the ducts.

The control of water levels in the channels requires first the development of methods for monitoring these levels and transferring the information as soon as possible to the control center. The methods currently used depend on daily reading by channel monitors and transmitting information to the center using traditional methods, the best of which is by telephone, and there are methods of monitoring levels remotely and sending information to the center by means of wireless devices that record the information and send it to the center immediately and there are more sophisticated methods of using satellites to transmit information to the center, which greatly helps Channel control. In many irrigation networks, methods of remote monitoring and transmission of information have been introduced, which helped in developing the control of river and canal levels. As for the methods of flow control, they depend on demand, and they are good and advanced systems that operate automatically and regulate the flow according to demand, and this means passing the required quantities of water without increasing or decreasing. One of the most important advantages of using a computer in irrigation operations is the possibility of calculating water needs in advance with great accuracy and making integrated programs to schedule irrigation, operate equipment, confirm required flows, and maintain specified water levels.

The introduction of automatic control systems in the existing old irrigation networks may be somewhat complicated. There are many countries in the world with long experience in traditional surface irrigation systems, but they are currently developing irrigation networks, as it is no longer possible or acceptable to continue with these traditional systems that depend on Continuous irrigation day and night throughout the twenty-four hours. It has become necessary to adopt other more appropriate irrigation methods while preserving the existing water facilities (Figure 8).

Figure 8: One of the devices used in automatic irrigation operations.

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The effect of rehabilitating irrigation canals on modern irrigation methods

The projects for the rehabilitation and lining of canals aim to achieve fluidity and ease of flow of irrigation water, and to prevent lateral leakage of it to preserve the available resources and rationalize use, in addition to ending farmers' complaints about the lack of water reaching the ends of the canals sometimes as a result of leakage and cracks in the sides.

Since the main objective of rehabilitating open irrigation channels was to conserve water and rationalize its use, it was necessary to complete the irrigation water rationalization system through the use of modern irrigation techniques such as sprinkler irrigation, drip irrigation and others to reduce water losses.

Conclusion

The current report looks at the vital and important role of open irrigation canals rehabilitation projects, which the developed world resorted to in order to rationalize the quantities of irrigation water, as well as Egypt's effective role in advancing civilizational progress in various fields of life, and its adoption of Egypt's national project to rehabilitate and line irrigation canals All parts of the Republic, which in turn has a tangible role in maintaining national water security, which is an integral part of the Egyptian national security, as well as the economic return of the project and its impact on the environment. The project also achieves seven out of the seventeen goals of the sustainable development goals of the United Nations 2030 that Egypt pursues: (eradication of hunger, good health, clean water, economic growth, climate action, aquatic life, life on land).

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