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WATER CONSERVATION

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Technology Transfer and Change:
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C O N T E N T S

1. INTRODUCTION

The Eastern , Central and northern regions of the Arab Middle East are beset with the problem of aridity . These arid zones grade westwards and northward into semi-arid belts and to highlands of higher precipitation. Although the latter humid areas are of limited areal extent they contain a considerable propo - rtion of the region renewable water resources. Several perennial streams originate in these humid highlands. Several large aquifers which extend into arid and semi-arid regions are recharged from precipitation falling on such humid and sub-humid mountainous belts . Several hydrogeological problems do exist however , in some of the highlands particularly in Lebanon Western Jordan and Syria. In this region the calcareous massifs have developed extensive fissure systems and salution channels. Precipitation falling on them is quickly transmitted into the sea or inland disharge areas and a considerable amount of valuable water resources is either lost or is available in times when demand is low - A deep rift system also traverse the highlands and acts as a major drain to ground water resdrvoirs. The arid and semi-arid zones lying further east thus are deprived of a significant recharge source.

In vast areas of the Arab Middle East rainfall is seanty and highly variable. For as long as history remembers bedouins have pastured their herds in the arid rangelands that grade into desert regions whose rainfall is insufficient to produce pasture.

It is evident that the application of certain water conservation techniques is urgently needed regardles of the degree of aridity. Underground storage of surface runoff is required in the humid and semi-humid helts bordering the Mideterranean as well as in other region where arid and semi-arid conditions prevail. some techniques and practices developed in temperat climate may not work in arid arid regions for technological environmental and cultural reasons. Traditional technologies developped in the Arab world sould be considered the before introduction of new concept and innovative approaches to water technology . Desirably traditonal technologies can be complemented , if necessary with intermediate and transitional modern technologies.

2. TRADITONAL WATER CONSERVATION PRACTICES IN THE REGION:

Human activities were centered in the past around perennial water courses and areas of discharge of ground water. The oases of true deserts are located where shallow or deep aquifers fermed natural discharge areas. Aeolian erosion working on favorable geological structures has cut down the desert surfaces until an aquifer was tapped and seepages and springs developed. Moisture in the form of swamps and lakes arrested aeolian erosion. In all cases the oases accur in closed depression and the problem of drainage was always present . Water logging and salinity are natural features of oases. Palm trees were formenly planted in oases and are well suited to such enviroment . They serve to suppress direct evaporation from soil surfaces by providing shade cover and make use of the high water table , thus utilizing a part of the water which otherwise would have been lost by evaporation. They can be considered in fact as one of the most practical and efficient water conservation practices in arid zones.

Water spreading techniques are widely practiced in the Arab Middle East. Water spreading is normally aimed at increasing the moisture stored in the soil by diverting flood water out of the wadis or streams and spreading this water over adjacent flood plains and lowlands. Stored moisture is used to grow crops without further irrigation. Water spreading has been practiced successfull in Jordan , in the Aawaj basin in southern Syria and in the Queik basin in the Aleppo region.

While water spreading is aimed basically at increasing the amount of water stored in the soil , it is evident that surplus water will infiltrate into deeper zones and under favorable hydrogeological conditions will recharge the groundwater . The great wadis in Badiet Esh-Sham (wadi el Miah , wadi Souab) and in the Dawaa basin west of Palmyra seem to be entirely suitable for water spreading , especially in the Fidat areas. Excellent crops of wheat have been observed in some years on their flood plains. Water spreading would conserve the surface runoff and allows more land to be cultivated in these areas.

Ground water recharge has been recently carried out in the Beirut region using surface water of Nahr Beirut on an experimental basis. In spite of its importance it is a rare water conservation practice in the region.

The construction of terraces to intercept and control runoff and consequently increase inflitration and soil moisture is a common practice in Lebanon , Syria , Jordan and Northern Iraq . In certain areas (e.g. Qalamoun area in Syria) evaporation from soil surface is suppressed by placing water retardant mulches: gravels and plant residues are commonly used. Shallow ground water aquifers of limited thickness , storage capacity and recharge are usually tapped by kanat systems. The discharge of kanat in Syria usually ranges between 25 and 80 l/sec. The same aquifers may not yield more than 5 l/sec. when they are tapped by wells and boreholes. The weathered chalk and marl of upper cretaceous age are favorable for such development. The kanat systems (aflaje, fogarra) have been adapted for use in the arid zones of Oman, the United Arab Emerates and Tunisia. By using such systems problems of over development of shallow or minor aquifers have been avoided.

Cisterns have been constructed in the Arab Middle East for thousands of years to catch rainwater or flood water. Other water conservation techniques in the region include fallowing and sub-soiling .

3. APPLICATION OF RELEVANT TECHNOLOGIES TO IMPROVE WATER CONSERVATION PARACTICES

Conserving water resources should ideally cover all uses of water A major opportunity to save water exists, however , in conventional irrigated agriculture , by a the world's largest user of water . Conservation of surface and ground water resources could be achieved by increasing the supply of available water and reducing the demand for water. supply and demond as well as delivery have to be considered as an integrad system. Furthermore , particular attention shuld be given to soil moisture conservation practices. Soil moisture, can be used only by vegetation. In considering water conservation in semi-arid zones , emphasis should be placed on the use of water to produce vegetation . Vegetation cover will reduce soil erosion and can be consumed by animals . Thus water which has been transpired has been used beneficially while water which has been evaporated has been lost. Relevant and promissing technologies for soil moisture conservation and for the conservation of surface and ground water resources are breifly outlined and discussed below:

3.1. Conservation of ground water resources:aquifer recharge

Management of ground water should be based on throught assessment of available resources . The amount of ground water storage in major aquifers ususally exceed considerably overage annual recharge . By using ground water for irrigation it is almost certain that some ground water is being withdrawn from storage. Water levels fall uhtil aversted not by technical or legal control but by economic factors. However steps should be taken to conserve valuable ground water resources.

Only a small fraction of the annual precipitation percalates downward to the water table. A large proporation of precipitation runs over land to streams or is diseharged by the process of evapotranspiration before it reaches the aquifers. The amount of precipitation that reaches the zone of saturation depends on several factors. Among these topography, vegetation , soil , climate and hydrogeology are the most important factors.

Artificial recharge techniques have been employed to supplement natural recharge and conserve surface runoff and flood waters. The need for artificial recharge has been throught about by an increasing demand for ground water. In some areas artificial recharge has been used to arrest salt water intrusion from the sea or from saline aquifers.

In the case of confined aquifers infiltration may be carried out from wells sunk through the impervious cover into the aquifer. In unconfined aquifer systems recharge may be carried out by infiltration from the stream channel or by water spreading over permeable beds. This latter method is particulary suited to piedmont . The piedemont zone of the gravel plain which extends from Ras El Kheime to El Ain is an excellent recharge area where artificial recharge could be successfully praticed. Surface runoff originating in the Oman Mountains could be used for this purpose. Areas of potential recharge have been defined in several Arab Countries. Artifical recharge is , however, practiced on a limited scale and frequenly on an experimental basis. Small dams have been constructed in the Qalamoun basin and Badiet El Sham in Syria for recharge unconfined gravel or cabonate aquifers. Practical defficulties and technical problems arising from aquifer recharge are well documented in current literature.

Each application of artificial recharge must be evaluated in order to determine whether it is physically and economically feasible. The geologic and hydrologic conditions that may affect the recharge must be investigated. The recharge water must be analysed to determine its adequacy . In addition the most suitable method of recharge for the application must be selected.

3.2. Conservation of surface water resources

3.2.1. Storage of runoff in surface reservoirs

The main function of reservoirs is to stabilize the flow of water , either by regulating a varying supply in a natural stream or by stabilizing a varying demand by the consumer .

The design of dams and other hydraulic structures in humid regions utilize standard techniques of civil engineering , Engineers make use of similer , large dams technique for the design and construction of large dams in arid zones. They do encounter , however some problems pertaining to heavy evaporation , in addition to the common problems of sedimentation. and perhaps leakage. Water stored behind such dams in usually derived from watersheds which extend beyond the limits of arid zones into semi-humid or even humid regions.

The following techniques should be seen as supplements to standard large scale methods. They may have immediate value for small - scale water development and conservation. They utilize wadi- runoff derived from precipitation actually occurring within the region.

a. Cisterns

There are various types and they could be designed to catch flood water or rainwater. A typpical flood water cistern has an area of 100 m2 and 6 m depth, giving storage capacity of 600 m3 . Several cisterns could be constructed in arid and semi-zones to provide water for a small village. The cost of construction is usually low and it depends on the hardness of local geological formations.

b. Rainwater catchments with a sand - filled water storage tank

These reservoirs are filled with sand and fine gravel. The sands filter the runoff water and reduces evaporation . The tank is usually lined with plastic.

3.2.2. Sub- surface storage of runoff

underground storage of runoff could have several advantage :

It reduces evaporation losses and avoids the problems of sedimentation. small sub- surface dams could be constructed in wadis or ephemeral streams.

Small sand - filled dams have been built in south-west Africa and Kenya during the last 50 years. They can store water for longer periods than conventioned surface storage reservoirs . When the water table is about one meter below the surface evaopration ceases or is suppressed considerably. Such dams can there fore provide water during drought periods.

The dam wall is built across the wadi or river-bed during the dry season. Later flash floods will deposit sand and gravel. Sediments carried by flood waters consist of clay , sand and gravel . To ensure that mainly sand and gravel is deposited , the dam is heightened in stages of about one meter. Flood waters deposit the coarse sediments silt and clay is carried over the top by speeding waters. Each 1- m stage is added after the dam is filled with sand and gravel until the operating height of about 10 m is reached.

When sand dams are built over impervious formation , the water can be stored for along period of time . The water is withdrawn by a drainange pipe through the dam wall or by a borehole . Sand dams built over perviousor fissured rocks that lead underground to natural aquifers may also be useful and can be considered as promising techniques for induced recharge.

The sites of sand dams should be carefully se - lected and the hydrogeology of the site and adjoining areas should be investigaged . Geophysical techniques.. (Geoelectrical , refraction seismic) could be used for the study of unconsolidated deposits in the wadi or river channel and for investigating neighbouring aquifers which might occur in the region. The flood waters must contain gravel and sand and the dam site must be made absolutely watertight . Since sand dams require time and can only be built in stages the technology has not yet been widely accepted.

3.2.3. rainwater harvesting

This technique could be applied in areas with as little as 75 mm average annual rainfall. The catchment usually needs modification by making the soil surface more impermeable to increase runoff. In some cases it is sufficient to clear away rocks and vegetation and compact the surface. If erosion is not excessive such simple modifications can be avery economical way to harvest rainwater in arid lands.

In many arid rangelands rainwater harvesting may be the only source of extra water. Catchment construction costs have , recently fallen . Oil producing countries could use asphalt. Promising techniques for rainwater harvesting include the treatment of soils with chemicals such as sodium salts , silicones, latexes or by covering it with a water proof cover (plastic , sheets butyl rubber).

Such techniques could fail in drought years and care is often needed to minimize soil erosion.

3.2.4. Reduction of evaporation and seepage losses

Annual evaporation losses from water surfaces particularly in arid lands , are very great . Evaporation reduction merits increased attention as a way to conserve water. Both reservoirs and canals are subject to heavy evaporation losses.

Water surfaces in Ponds and small reservoirs may be covered by a barrier that inhibits or reduce evaporation.Aliphati alcohol molecular monolayer has been used. It is nontoxic to fish and humans. Methods utilizing such materials are potentially rewarding. The one molecule thick film covering water surfaces does not , however, reduce the amount of energy the water absobs. Furthermore it is impossible to maintain an intact alohol barrier . These problems and others makes them impractical at the present time.

Floating blocks of wa , concrete , rubber and plastic are under trial as evaporation retardants.

In many cases it costs less to reduce evaporation than to collect and store an equivalent amount of water from other sources. Suppressing evaporation in reservoirs also suppresses the increase in salt concentration.

At the present time large resërvoirs are still beyond the reach of available technologies , and for small reservoirs evaporation suppression is still in the experimental stage. Research in this area is urgently need.

Recent technology has produced many inexpensive water proof materials that may prove valuable for reducing seepage losses for canals and reservoirs and numerous studies and exprements , were conducted on the use of such materials : Chemical treatment of soil , soil compaction , soil covers (butyl rubber, sheet plastic , asphalt , ferrocement). Sodium carbonate has been used for the treatment of soil with high calcium content.

Seepage from shallow reservoirs can be reduced by using low cost palyetheline and palyprophylene films , but deeper reservoirs require thicker films of vinyl or rein-foced polyprophyline.

In general reduction of seepage losses in resdrvoirs and conduits is simpler and more economical than reducing evaporation losses. The main limitation is cost . More field trials are required to conpare the efficiency of different techniques and to consider the economics of their applica-tion .

3.3. Soil moisture conservation

Since agriculture is by far the largest consumer of water, the storage of water , in certain cases , in the soil meny prove to be more effective and economic than the storage of water in sur-face or ground water reservoirs and later using such water resources for agricultural production. Several methods have been employed or tested for soil moisture conservation. Only two main techniques are considered here.

3.3.1. Tied ridge cultivation

Land is maintained in ridges laid out across the slope . The furrows are dammed into a series of rectangular depressions. This method controls soil erosion and improves water use efficiency under rainfed agricultural conditions. A back - up system of conventional channel terranes is recommen-ded by hudson (1971) to cope with runcff resulting from exeptional storms.

a. Mulching

About 1/4 to 1/2 of the water lost from a crops is evaporated from the soil surfaces . The loss can be reduced by placing moisture barriers or water re ardant mulches on soil surfaces. Suppressing evaporation from the soil surfaces conserves water where its effect is great : within the root zone of the plants. Moisture barries made of porous materials include asphalt, latex and plastic films. Porous materials can also substantially reduce evaporation and has been sucessfully used in the Arab Middle East .Such materials include straw , wood , hark, cotton burs , gravel and sand.

For the majority of muches , the principal limitation in cost . At the present time soil treatment is suitable only for intensive agriculture of high income crops.

4. CONSTRAINTS ON THE APPLICATION OF PROMISING TECHNOLOGIES

Modern water conservation techniques and methods present many problems and challenges even in the development of virgin lands. The traditional users of land and water resources often believe that they have survived because of careful adherence to procedures and practices that have stood the test of time . The main constrints on the application of new techniques comprise the following :

a. the availability of expertise and skilled manpower to use new techniques effectively , of energy supplies to power equipments , of adequate transport and communication.

b. Inability to take full advantage of modern concepts due to the diffuclty of applying technical knowledge to the development and conservation of water resources.

c. Danger of overextraction of groundwater and failure to plan ahead for falling pressures and water levels , for increased salinity and for the new economy that must be established.

d. techelogies that require a high level of technical competence to operate and maintain are costly , require materials and equipments that are hard to get. Developing nations initially require techniques that are generally low cost , easy to use , small scale , culturally fitting and environmentally accept table .

e. Clean fallowing provides a way of conservating soil moisture . It increases however , the land's vulnerability to desertification.

One of the significant characteristics of the development , use and conservation of water resources is its complex nature. There should therefore be interconnections with other branches of the national economy , a requirement often neglected . The value of water in comparision with ofter raw materials and natural resources is often underestimated . One consequence is that water conservation institutions lag behind in development.

The sectorial (use - oriented) approach of existing water laws and institutions are not conductive to adequate protection and conservation of water resources. Institutions and administration do not look on water as a basic natural resource to be managed in its entirety . Such sectorial approch results in overlapping of authorities, inadequate planning or co-ordination and waste of technical and human resources.

The decisions of many countries are often affected by the poorly co-ordinated executive power of governmental agencies and by pre-existing social and legal institutional arrangements . Thus in addition to the more obvious physical limits, a number of other constraints must be considered by decision makers.

5. ACQUISITION OF RELEVANT WATER CONSERVATION TECHNOLOGIES

The above mentional considerations and constraints require that adequate attention be paid to the whole range of problems raised by water , among which are the most important are those connected with the formulation of a policy to be implemented by adequate legislation , administration and water institutions. Such policy mast be viewed within the context of a national plan as an important element for the rational mangement , conservation and presevation of water and other natural resources.

Irrigation demand , the largest consumptive use , is destined to increase in response to the imperative need to increase food production , both on the national and international level. Although efficiency in the use and conservation of watef is improving to some degree , water losses are still large and much irrigated land is deteriorating . Meeting new demands will involve more costly projects and intensified competition for available runoff.

Throughout the world the essential water problem is how best to reconcible increasing use of a fixed supply with the needs and constraints of human society . In most regions , there are two alternatives for balancing supply and demand. Increase availbility of supplies or alternatively decrease net demand by making more effecient use of existing water resources.

In arid regions the national strategy for water resources mangement and conservation must take into account the uneven distribution of rainfall and water resources over space and time. and the relatively high cost of water resources investigations and development. Systematic training of téchnicians is required to cope with the mangement and maintenance of problems over large ereas with scattered population.

Acquisition of relevant technologies requires first identification and utilization of the existing and potential capacities and promotion of technical cooperations among the countries of the region. The role of International inter-governmental and non governmental organizations can be summarized as follows :

a. Upgrade national skills in the field of water technology through trqining courses workshops and seminars.

b. Inprove the capacities and capabilities of national institutions and water resources departments in the region.

c. Formulate activities of an innovative nature designed to assist. countries in the region to acquire and evaluate new technologies in the field water resources development use and conservation.

d. Formulate and implement pilot and regional projects which aim to introduce test and evaluate new water conservation techniques.

e. Identify constraints to effecient water resources development use and conservation in the region.

f. Extend , apply and dissiminate the results obtained in national and regional research centres and institutions whose activities include testing and comparing the effectiveness of different water conservation technologies and the evaluation of the economics of their application.

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