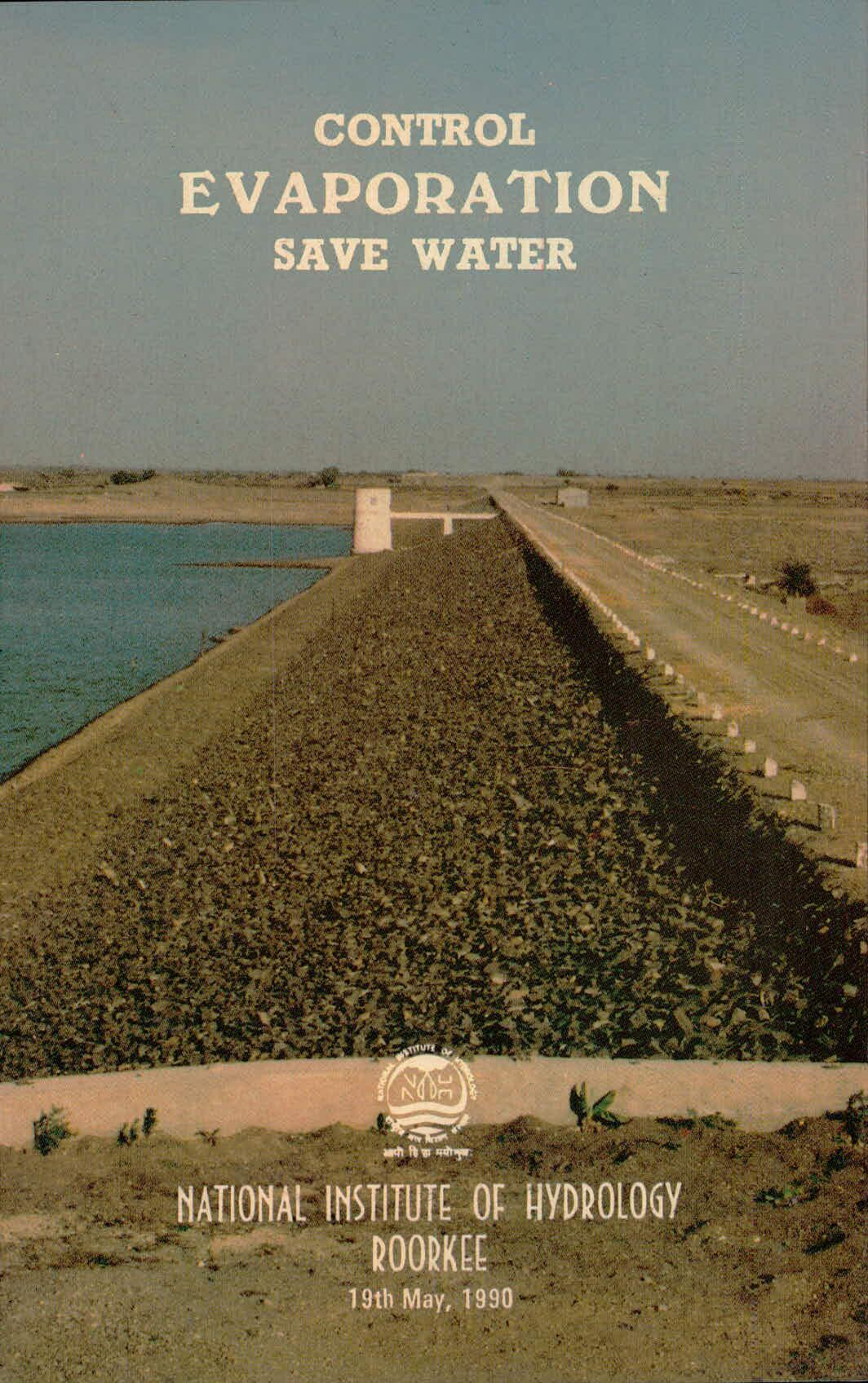

CONTROL EVAPORATION SAVE WATER

NATIONAL INSTITUTE OF HYDROLOGY
ROORKEE

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What is Evaporation

Evaporation is the process of conversion of water from liquid state to gaseous state and its transfer into atmosphere in this form. It is a natural process and occurs when solar radiation falls on a water body and the energy so transmitted is acquired by water molecules which in turn get separated and move upward causing the phenomenon called evaporation.

Evaporation of water has an important role in the hydrologic cycle of nature. It is the result of evaporation from larger water bodies that rainfall clouds are formed and rainfall occurs. However, the loss of water from water storage structures like reservoirs, irrigation tanks etc. through the process of evaporation causes reduction in storage meant for making water supply as smooth as possible for various uses. The huge costs involved in the construction of these storage structures make it imperative to utilise every single drop of water stored. It is for this purpose various kinds of measures to control evaporation are tried.

Evapotranspiration is the other form of water loss. This consists of evaporation from land surfaces and transpiration from plant bodies. Since transpiration cannot be measured separately to desired level of accuracy, these two components are clubbed together and called 'evapotranspiration'. The evapotranspiration can be estimated by various direct and indirect methods. Better irrigation method like drip irrigation, where water is directly applied to the root zone with the help of tubes are needed to be employed in order to reduce evaporation component of the evapotranspiration.

Evaporation accomplice

* Temperature of evaporating surface
* Water vapour in air
* Wind speed
* Atmospheric pressure
* Nature and size of the water body.

Temperature of both air and evaporating surface is important and is dependent on major source of energy i.e. sun. The higher the temperature of air the more water vapour it can hold. Similarly, if temperature of the evaporating body is high, it will accelerate evaporation. Thus evaporation amounts are high in tropical climates and tend to be low in polar regions. Similar contrast is found between summer and winter evaporation quantities in mid-latitudes. The water vapour capacity of air is directly related to its temperature. More evaporation occurs in inland areas where the air tends to be drier than in coastal regions with damp air from the sea. Wind speed at the surface is an important factor. Evaporation is greater in exposed areas that enjoy plenty of air movement than in sheltered localities where air tends to stagnate.

The prevailing weather pattern indicated by the atmospheric pressure affects evaporation. The edge of an anticyclone provides ideal conditions for evaporation as long as some air movement is operating in conjunction with the high air pressure. Low atmospheric pressure is well charged with water vapour and conditions are not conducive to aid evaporation. The condition of evaporating surface affects evaporation by modifying the wind pattern. Over a rough surface of water body the friction is more and the turbulence is also more with less wind speed. Hence, vertical component of wind causes evaporation. In case of smooth surfaces the horizontal component of wind velocity causes evaporation loss. The water body with larger exposed surface area will have more evaporation loss.

To catch hold of evaporation

A number of approaches/techniques have been developed to reduce evaporation from water bodies. Some of these are :

* Locating reservoirs at high altitudes
* Keeping the lower area/volume ratio of water body
* Minimising exposed surface through reservoir regulation
* Constructing artificial aquifers
* Application of monomolecular film
* Reducing energy available for evaporation
* Installing wind breaks

Locating reservoirs at high altitude reduces evaporation. This is due to increase in dew point temperature and reduction in surface water temperature at higher altitudes. Higher is the exposed surface, greater is the evaporation. So keeping lower surface area to volume ratio reduces evaporation. Artificial aquifers can be constructed in suitable geological formations and are emptied before the onset of monsoon. The water from the surface reservoirs is then charged in these aquifers which are not exposed to atmosphere thus reducing evaporation.

Chemicals either in form of solutions or powder are spread over the water body which reflect away energy input from atmosphere as a result of which evaporation is reduced.

The wind breaks are constructed by planting a row of trees which reduces wind turbulance and total wind travel ovei the watei surface resulting in reduced loss of water by evaporation.

Based on the trend of experiments reported from various places in the country, it has been found that most of the research efforts are being concentrated on devising suitable chemical retardants for reducing evaporation.

Some of the methods for reducing evaporation from soil surfaces are to make use of :

* Plant residues
* Gravel, paper, plastic and straw mulches
* Asphalt, oil mulches and chemicals

In the technique using plant residues, the new crop is planted directly without removing previous crops' residues which reduces evaporation. A layer of gravel, paper, plastic, straw mulches etc, are spread on the field to conserve the moisture in the method using these materials. Similarly use of asphalt, oil mulches and chemicals is done to conserve the soil moisture and reduce evaporation. Uses of chemicals, plastics and plant residues seem to have greater potential in reducing evaporation from land surfaces.

Evaporation loss - An estimate

Estimates of evaporation loss in the country indicate that the annual evaporation from a water surface in the semi-arid tropics is as high as 2000 mm. Annual average value of evaporation ranges from 1400 mm to 1800 mm over a large portion of the country. More information about spatial variation of evaporation reveals that values exceeding 2000 mm occur over west Rajasthan and parts of Saurashtra and Tamilnadu, while less than 1400 mm is reported at coastal Mysore, Bihar plateau and east M.P.

Reliable statistics reveal that about 70 M.ha.m of water evaporates from water bodies and land surfaces out of the total annual precipitation of 392 M.ha.m received in the country. The total evaporation losses from water surfaces only are about 5 M.ha.m from the total storage of 15 M.ha.m. in the reservoirs, tanks and lakes spread all over the country.

Studies disclose that evaporation loss from shallow lakes, small tanks and reservoirs can be of the order of about 50% of the capacity of the tank. As regards evaporation from cropped area, the total water loss due to evaporation is about 1/4 to 1/2 of the total water received or applied.

Studies about monthly distribution of evaporation loss confirm that the potential evaporation is highest in the month of May over most parts of the country while the month of January records lowest value of evaporation. Annual and monthly evaporation contours are shown in figures at the end of text.

An idea about the evaporation loss in global scale can be taken from the fact that about 62,000 km^3 of water evaporates annually from lakes and land surfaces of the earth while more than five times of it gets evaporated from the sea.

Do you know . . . . .

Availability of water

* that water is abundant on this planet, 97.3 percent occurs in the form of sea water and only 2.7 percent is fresh water.

* that there are 1.4 billion km^3 of water available in the form of liquid water, ice and water vapour.

* that average precipitation on land is 74 cm/yr and average evaporation from land is 49 cm/yr.

* that average precipitation on oceans is 107 cm/yr and average evaporation from oceans is 117 cm/yr.

* that total global precipitation on earth is 97 cm/yr and global evaporation is also 97 cm/yr.

* that the average annual requirement of fresh water in the country in 1985 was 540 km^3 which will be increased to 750 km^3 by 2000 A.D. and to 1050 km^3 by 2025 A.D.

* that the basinwise total annual utilisable water resource is 1110 km^3 (1982 figure).

Water loss through evaporation

* that the total loss of water due to evaporation by 2000 A.D. will be 96 km^3 which is equivalent to the projected fresh water requirement for entire population then.

* that 10,000 ha. of land surface would loose about 160 $m.m^3$ of water each year which is otherwise enough to support more than one million inhabitants of a modern industrial city or to irrigate 10,000 to 15,000 hectares of crop land.

* that the maximum evaporation in the country is in the month of May (4 to 10 mm/day) and minimum is in the month of January (1 to 6 mm/day)

* that annual evaporation is highest between 300 to 350 cm over the central part and lowest between 100 to 150 cm over the north part of the country.

Evaporation reduction techniques

* that the techniques have been developed to control evaporation losses and the success rate has been 10-60% in most experiments.

* that the average cost of evaporation reduction per 1000 litres of water has been estimated as Rs. 0.40 to 0.60.

* that the most promising approaches to evaporation reduction include reducing the energy available for evaporation, providing wind baffles on or above the water surface to reduce the transport of water vapour by wind and reducing surface area of water body.

* that the micron thick paraffin oil containing spreaders of high molecular weight may reduce evaporation of water upto 15%.

* that in various investigations the use of chemical retardants reduced the evaporation loss in the range of 10-35 percent at a cost of Rs. 0.40 to 0.60 per thousand litres of water saved with no toxic effect on aquatic life and no change in water quality.

* that hexadecanol and octadecanol are the chemicals which are thoroughly investigated for reduction of evaporation from water bodies.

* that the organic compounds such as cetyl alcohol and cetyl stearyl alcohol can reduce evaporation upto 50% at a wind speed of 16.55 km/hr.

* that it has been claimed that no evaporation takes place by the use of cetyl alcohol and cetyl stearyl alcohol at a wind velocity of 3.1 km/hr.

* that the effective dosage of water evaporation retardants varies in the range of 20 gms to 200 gms. per acre per day depending upon the factors like temperature and wind velocity.

* that the surface mulching increased the yield of wheat by 23% in a study conducted at Central Soil & Water Conservation Research & Training Institute, Dehradun.

* that the layers of coarse sand forming an artificial aquifer reduced evaporation loss by about 50% when the water-table was at 300 mm below surface of sand.

* that a bund was constructed to reduce the surface area of Nayka dam Gujarat on the tail of water body forming a shallow pocket and water from this pocket was pumped into deeper pocket, which resulted in the savings of about 39.6×10^3 m^3 of water from evaporation.

* that by providing wind breaks of spacing to height ratio of 16 : 1, reduction in evaporation loss of the order of 9% was observed when average wind speed was 16 km/hr.

Note : The information / statistics presented in this brochure have been extracted from the published literature and all authors are hereby acknowledged.

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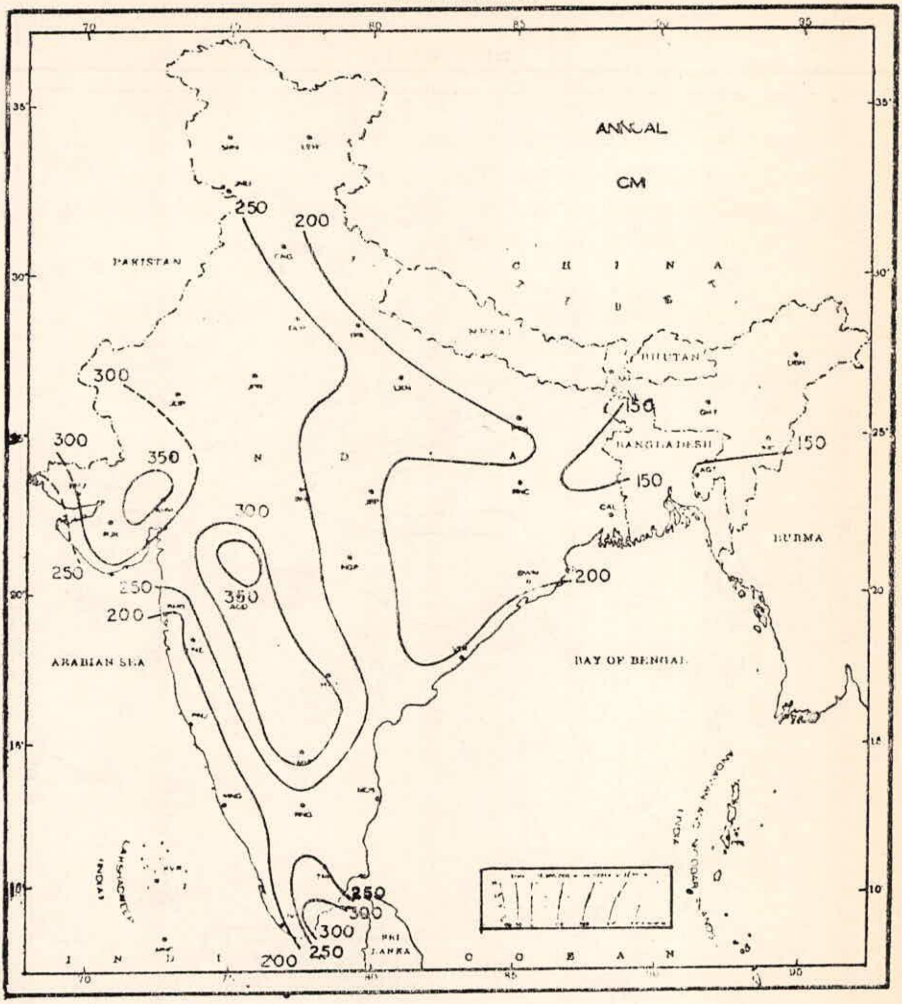

Note : Quoted from Agroclimatic Atlas of India, I.M.D., 1978

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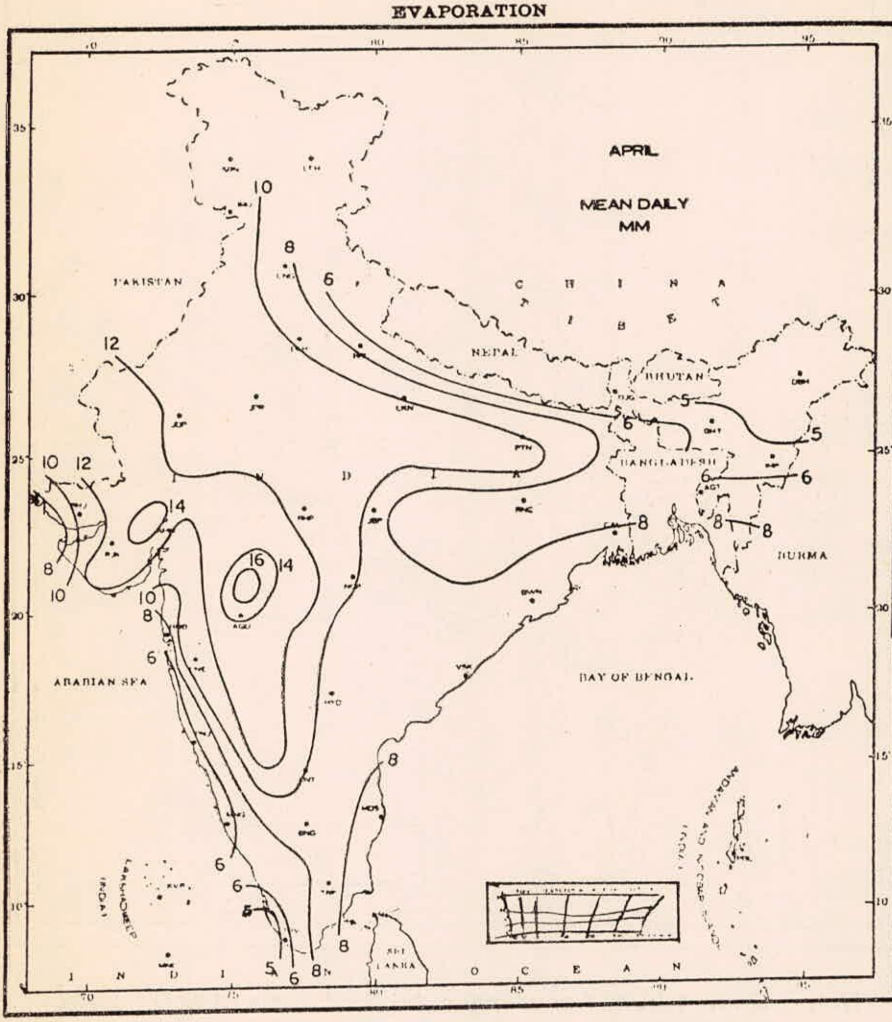

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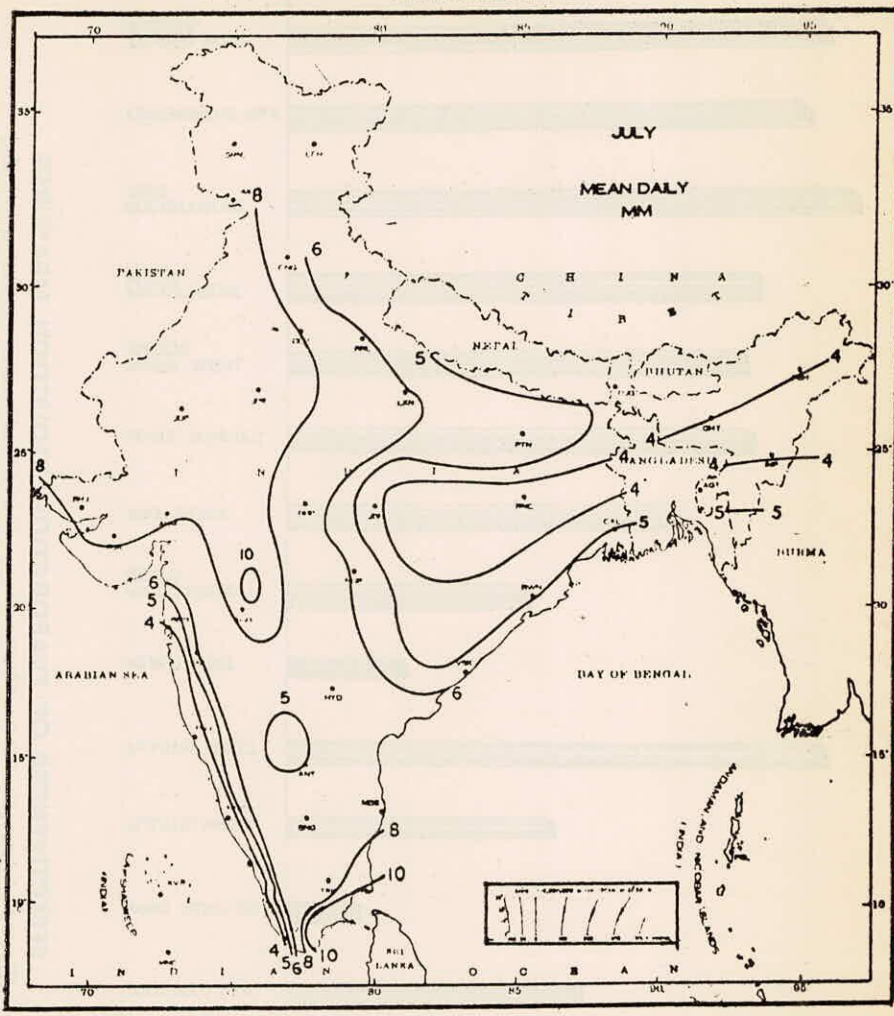

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