Irrigation and Water Management

Course: Integrated Water Resources Management

Module 2: Water Supply and Water Use

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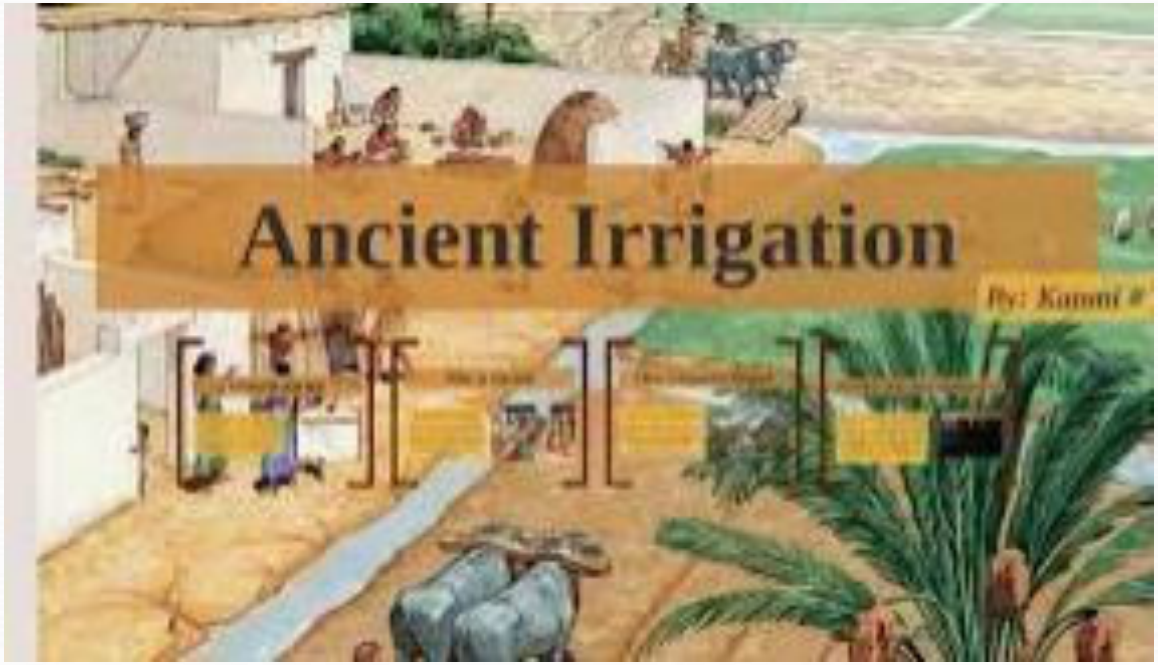
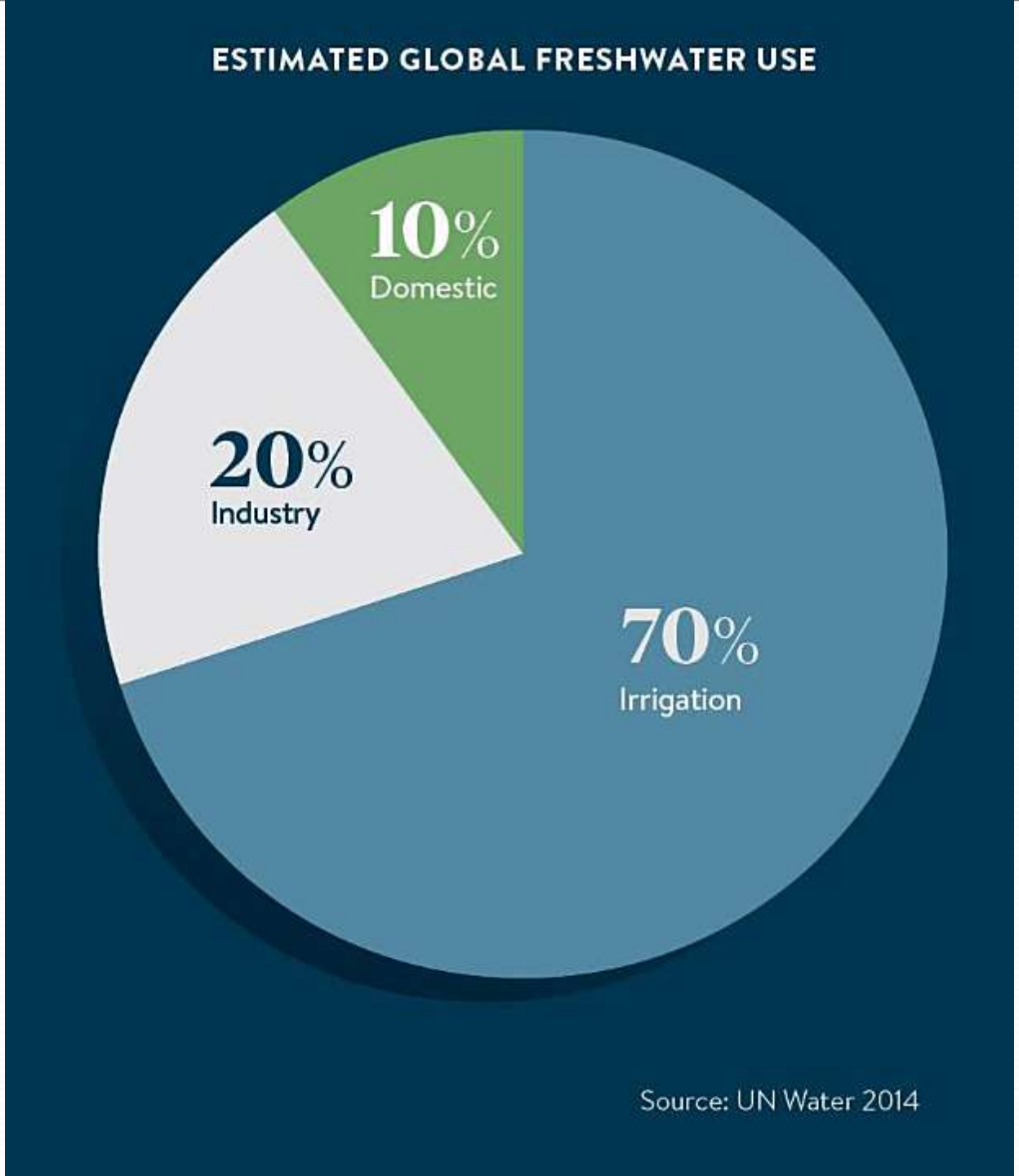
7. When and how much to irrigate
8. Irrigation efficiency

Illustrations and practical examples from Nickerie


Ancient Irrigation
By: Kammi P


ESTIMATED GLOBAL FRESHWATER USE
10%
Domestic
20%
Industry
70%
Irrigation
Source: UN Water 2014

IRRIGATION ENGINEERING

By Dr. K N Tiwari Dr. N S Raghuwanshi

What is irrigation?

Irrigation is defined as the practice of artificial application of water to land, in accordance to the crop water requirement throughout the crop growing period.

(K. Tiwari et al, Irrigation Engineering, 2014)

Other functions of irrigation

Besides meeting the crop water requirement, irrigation water is also provided for field preparation, distribution of fertilizers and pesticides, climate control, leaching of salts, etc.

The role of irrigation water

1. Extends soil biological and chemical activity during dry periods, creating longer and more optimal growing conditions for cultivated crops.
2. Irrigation water becomes the medium into which soil nutrients are dissolved and through which nutrients are made available for plant uptake.
3. Water molecules contained within the water-conducting vascular bundles and other tissues of plants provide physical support for the plant itself.
4. The loss of water through the process of evapotranspiration liberates heat from the plant, thereby regulating plant temperature.
5. By reducing stress on the plant, proper irrigation improves plants' resistance to pest and disease damage and improves crop quality.

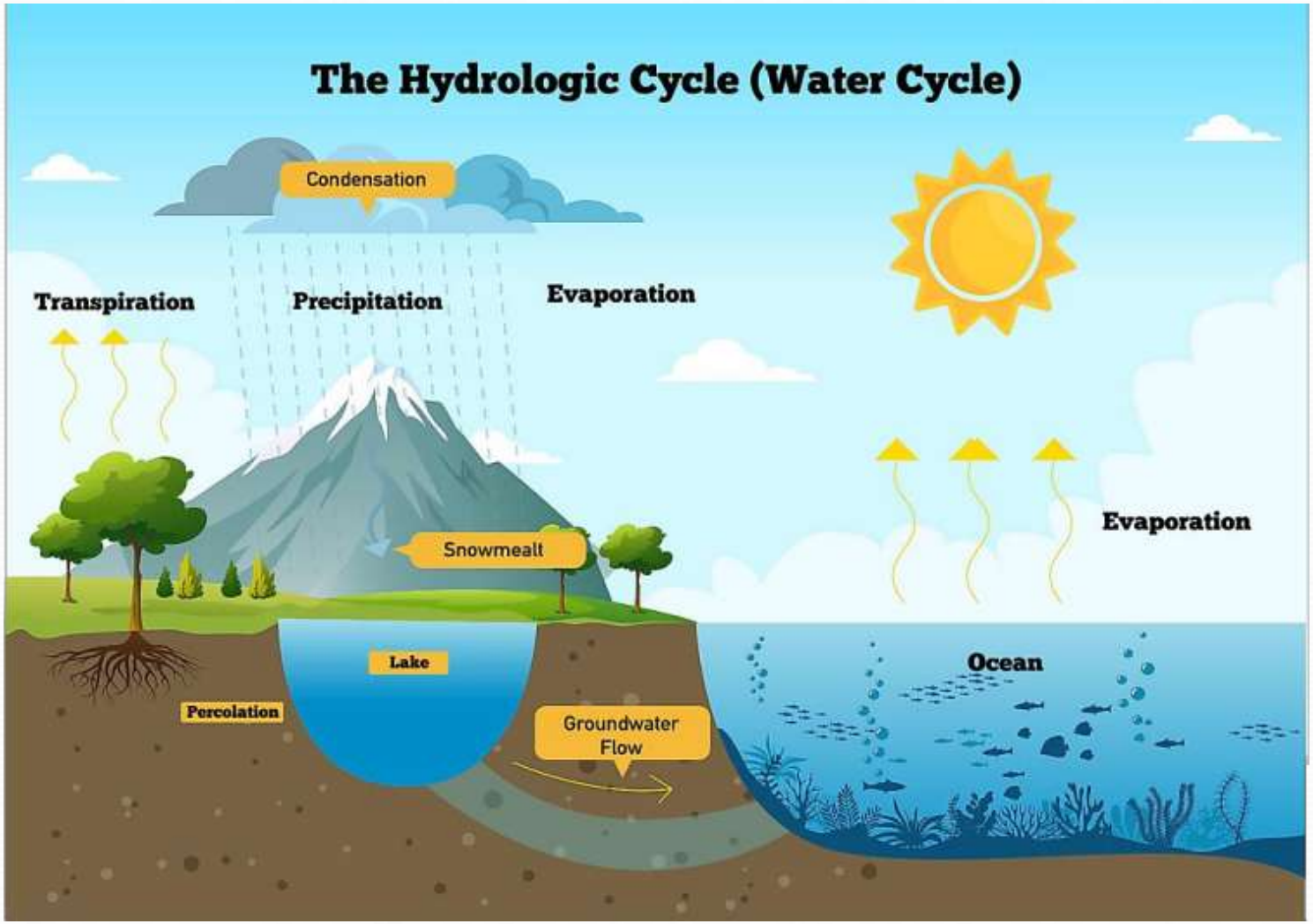
Advantages of irrigation

- Allows for higher yields and multiple cropping during a year *(on average, irrigated crop yields are 2.3 x those from rainfed grounds).*
- Reduces risk of crop failures caused by drougths.
- Increases agricultural productivity *(globally, 20% of cultivated land is irrigated, producing 40% of food).*
- Leads to more food products at lower food prices.
- Improves socioeconomic conditions of farmers.
- Provides better food security for the population.
- Contributes to welfare of the country.

Disadvantages of irrigation

- Excessive irrigation may cause decrease in crop yield.
- Excessive irrigation may cause leaching of chemicals, pesticides, nitrates to surface water and groundwater.
- Excessive groundwater pumping may cause decrease in groundwater levels, which may damage the aquifer structure and increases the risk of land subsidence.
- Poorly maintained irrigation systems are inefficient and expensive.
- Negative impact of irrigation on environment (environmental implications of large-scale irrigation?).

Sources of irrigation water



Source: WorldAtlas

Where does irrigation water come from?

- Natural sources: rainwater, rivers, lakes, streams, ponds, springs, etc.
- Manmade sources: dams, wells, pumps, canals, etc.

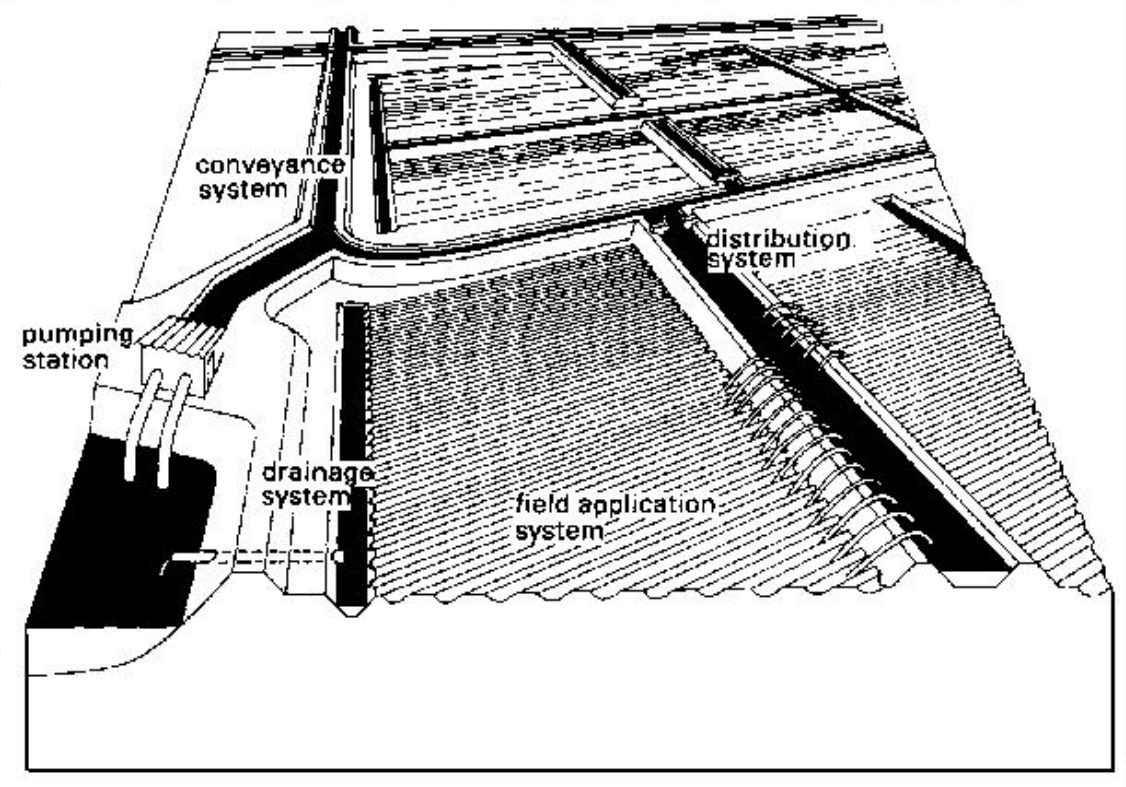
Important factors to consider are quantity, quality, and reliability of irrigation water.

Simplest form of irrigation?

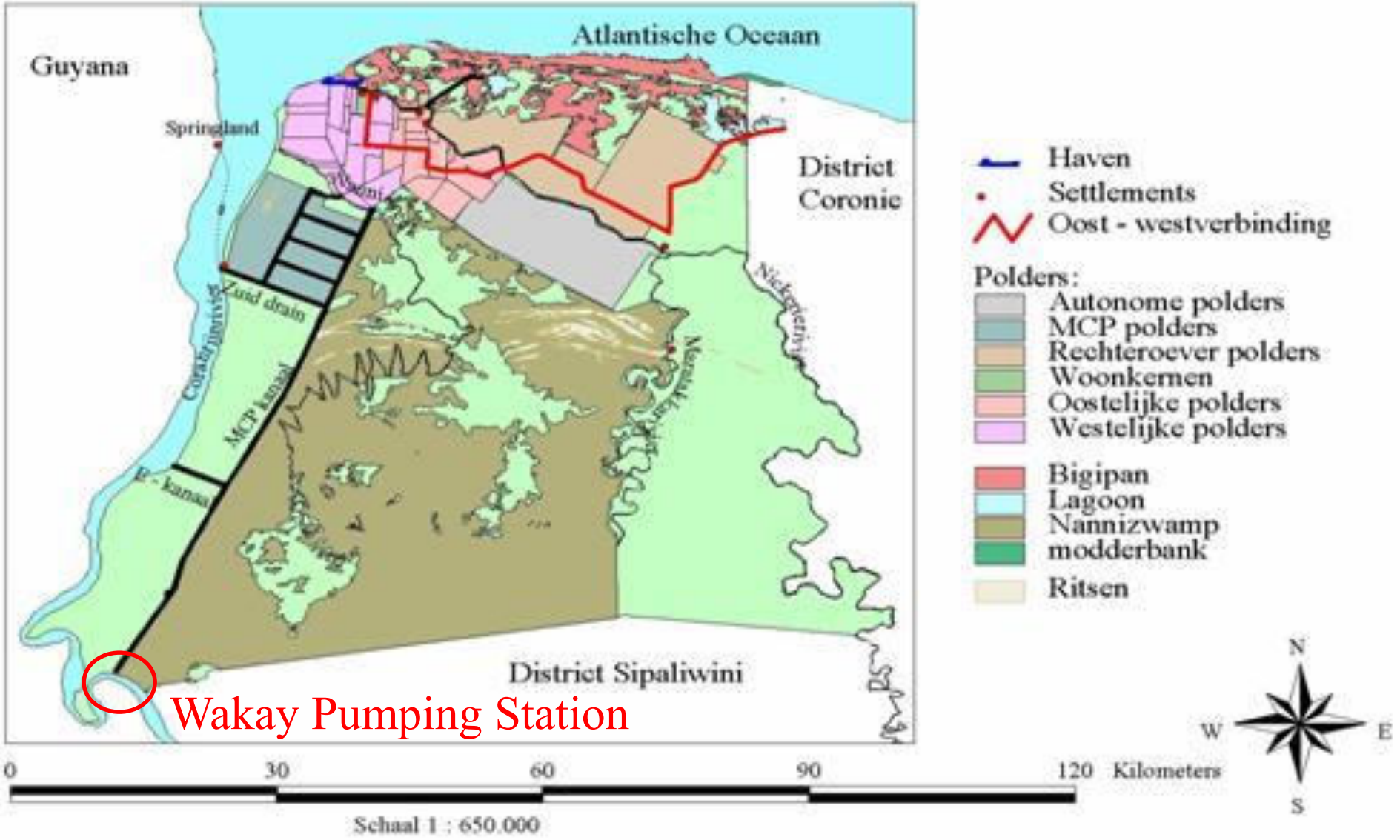
Simplest form of irrigation

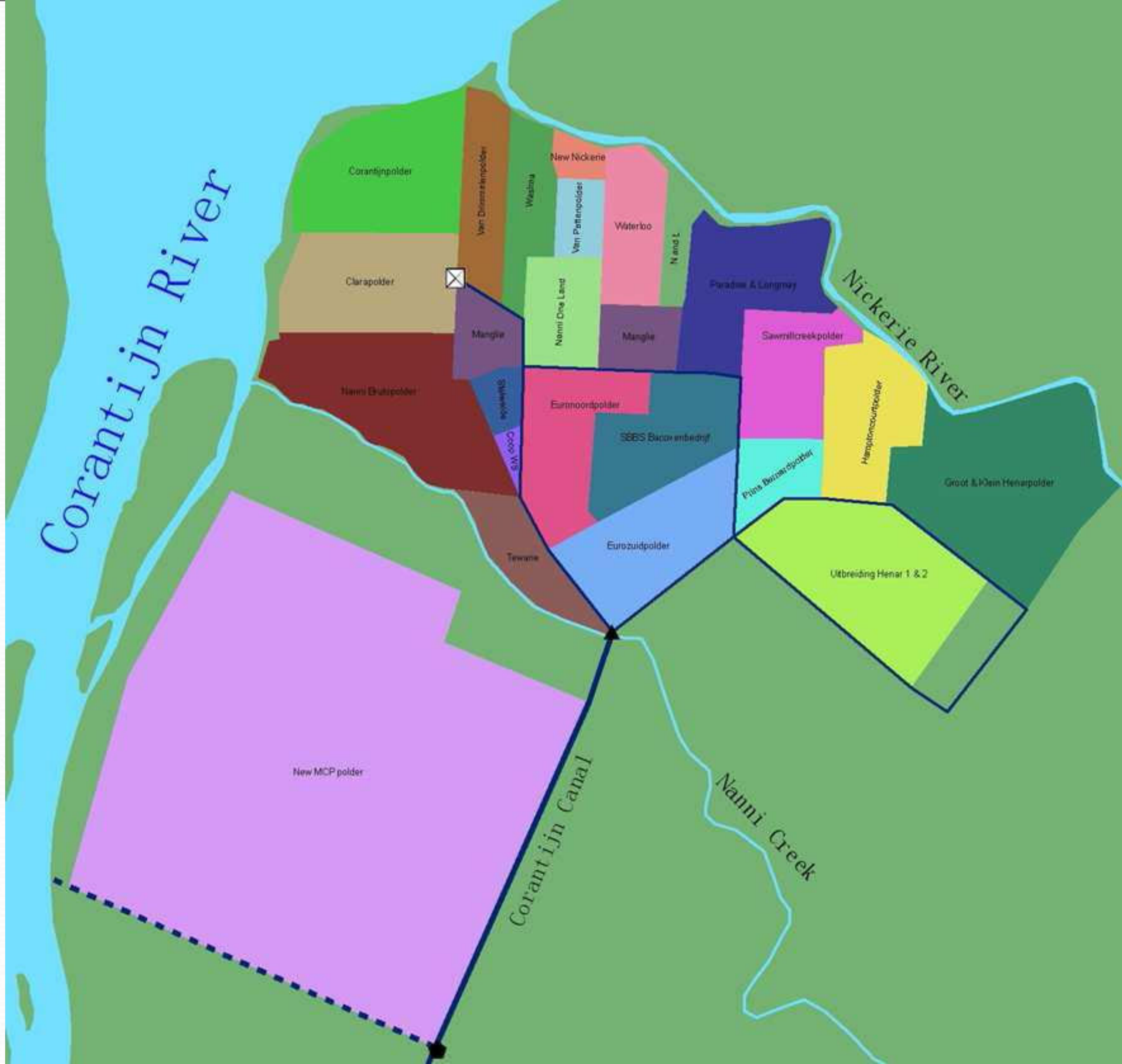
Irrigation systems

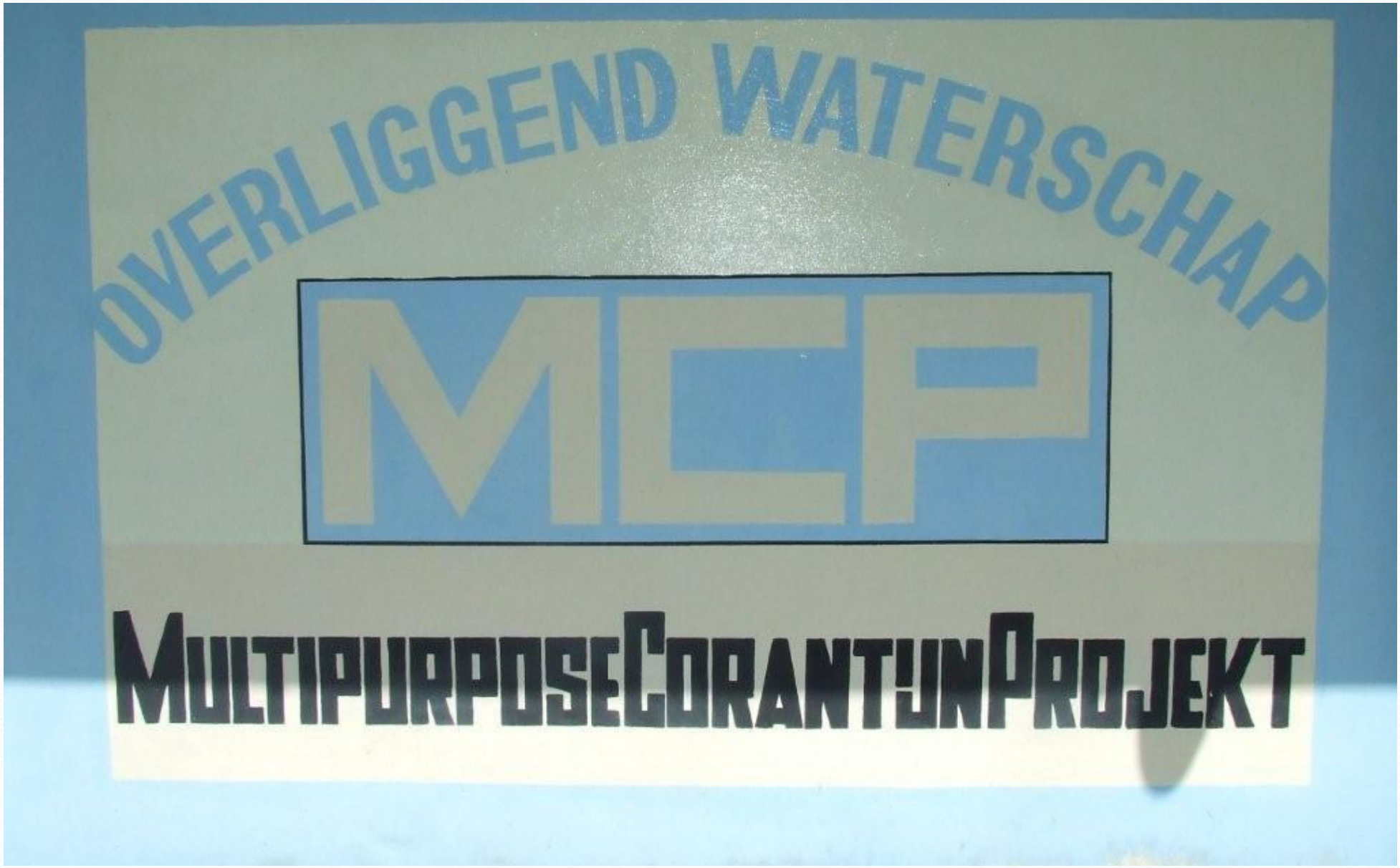
An irrigation system consists of an intake structure or pumping station, a conveyance system, a distribution system, a field application system, and a drainage system.



An overview of the district Nickerie

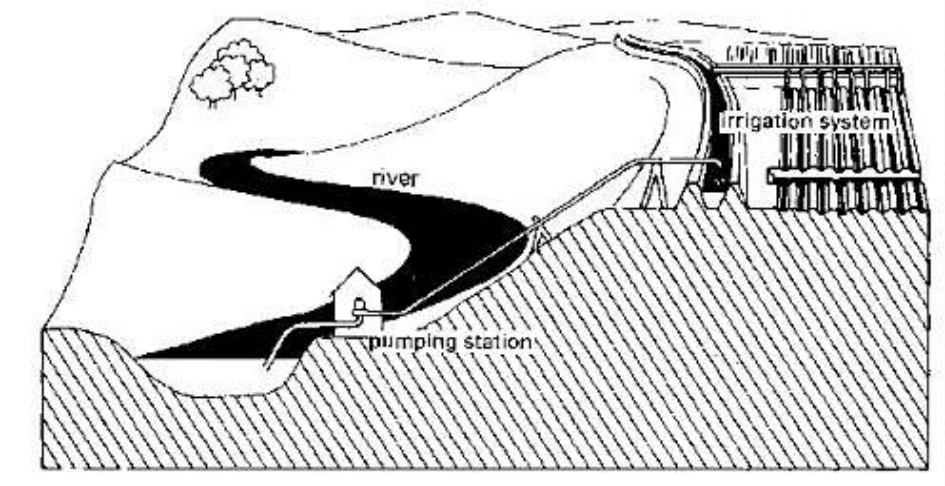


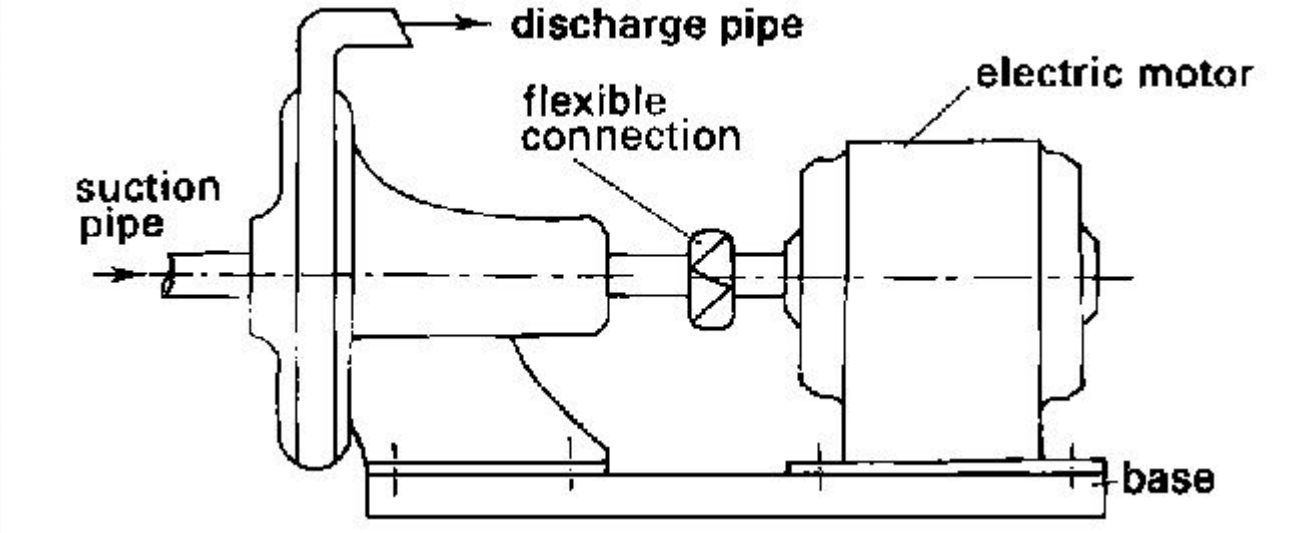

Corantijn River
Nickerie River
Corantijnpolder
Van Drimmelenpolder
New Nickerie
Van Pattenpolder
Waterloo
N and L
Clarapolder
Manglie
Nanni One Land
Manglie
Paradise & Longmay
Sawmillcreekpolder
Hamptoncourtpolder
Euronoordpolder
Coco WS
Groot & Klein Henarpolder
Eurozuidpolder
Uitbreiding Henar 1 & 2
New MCP polder
Corantijn Canal
Nanni Creek


OVERLIGGEND WATERSCHAP
MCP
MULTIPURPOSECORANTIJNPROJEKT


OW
MCP

Pumping station





Wakay pumping station

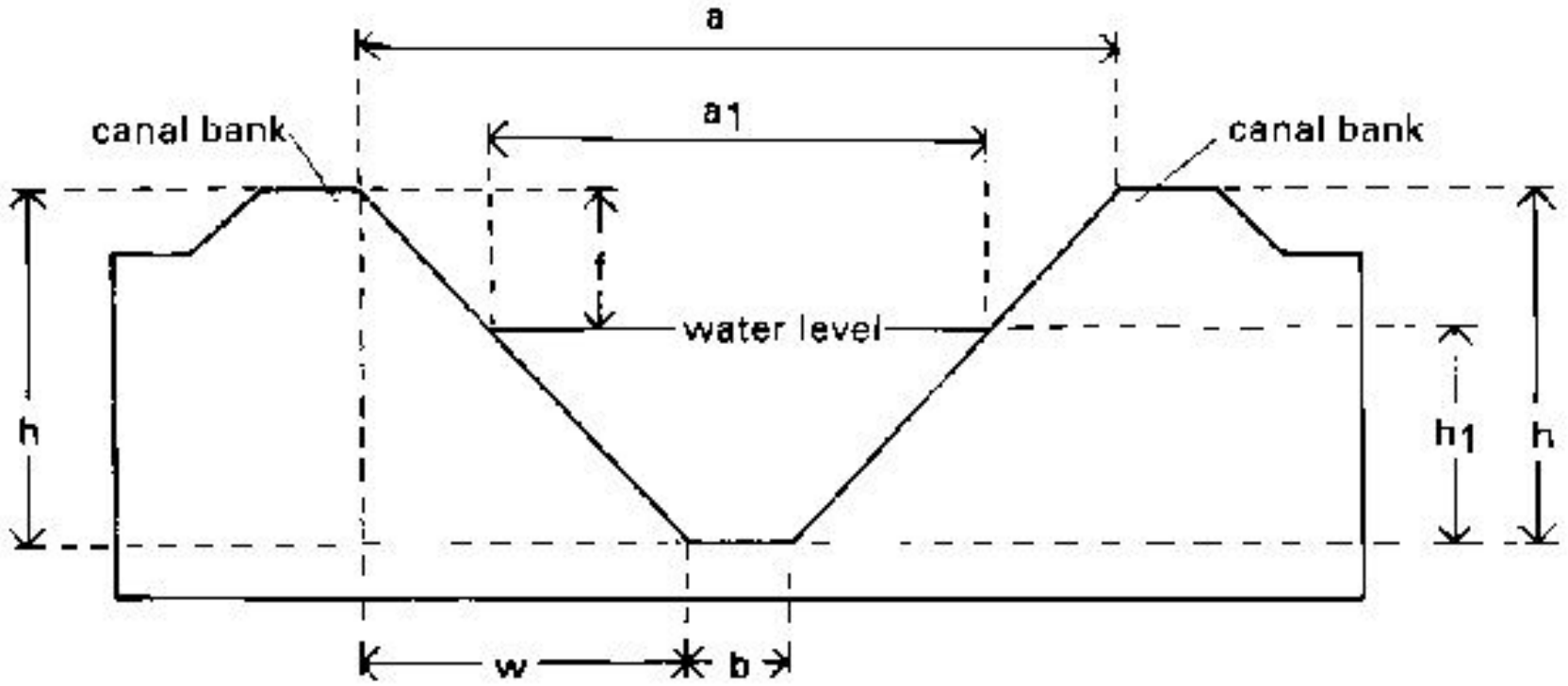
Delivers water to appr. 15,000 ha of rice polders

Four water pumps at Wakay

capacity 4 x 7,5 m^3/sec = 30 m^3/sec

(SWM drinking water station Van Hattemweg 1,100 m^3 /hour)

Canals



a = top width of the canal
a_1 = top width of the water level
h = height of the canal
h_1 = heigth or depth of the water in the canal
b = bottom width of the canal
h:w = side slope of the canal
f = free board (= $h-h_1$)

Canals

Corantijn Canal in Nickerie (66 km length, 40-50 m width)

Canals

Excessive vegetation growth in the Corantijn Canal in Nickerie

Canals

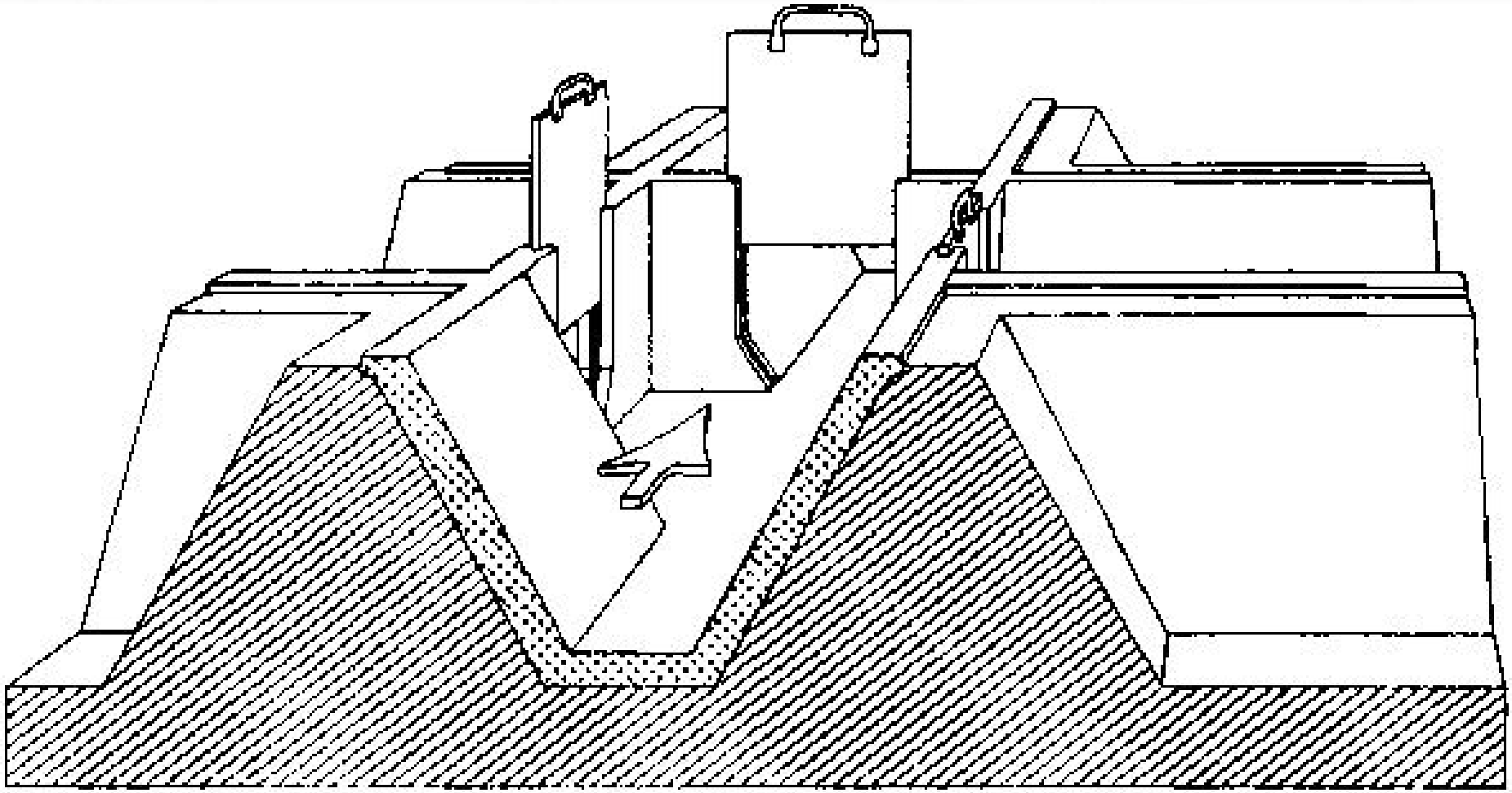
Cleaning of the canal banks of the Corantijn Canal in Nickerie

Canal structures

Piece of the canal bank of the Corantijn Canal washed away

Canal structures

Division box with three gates

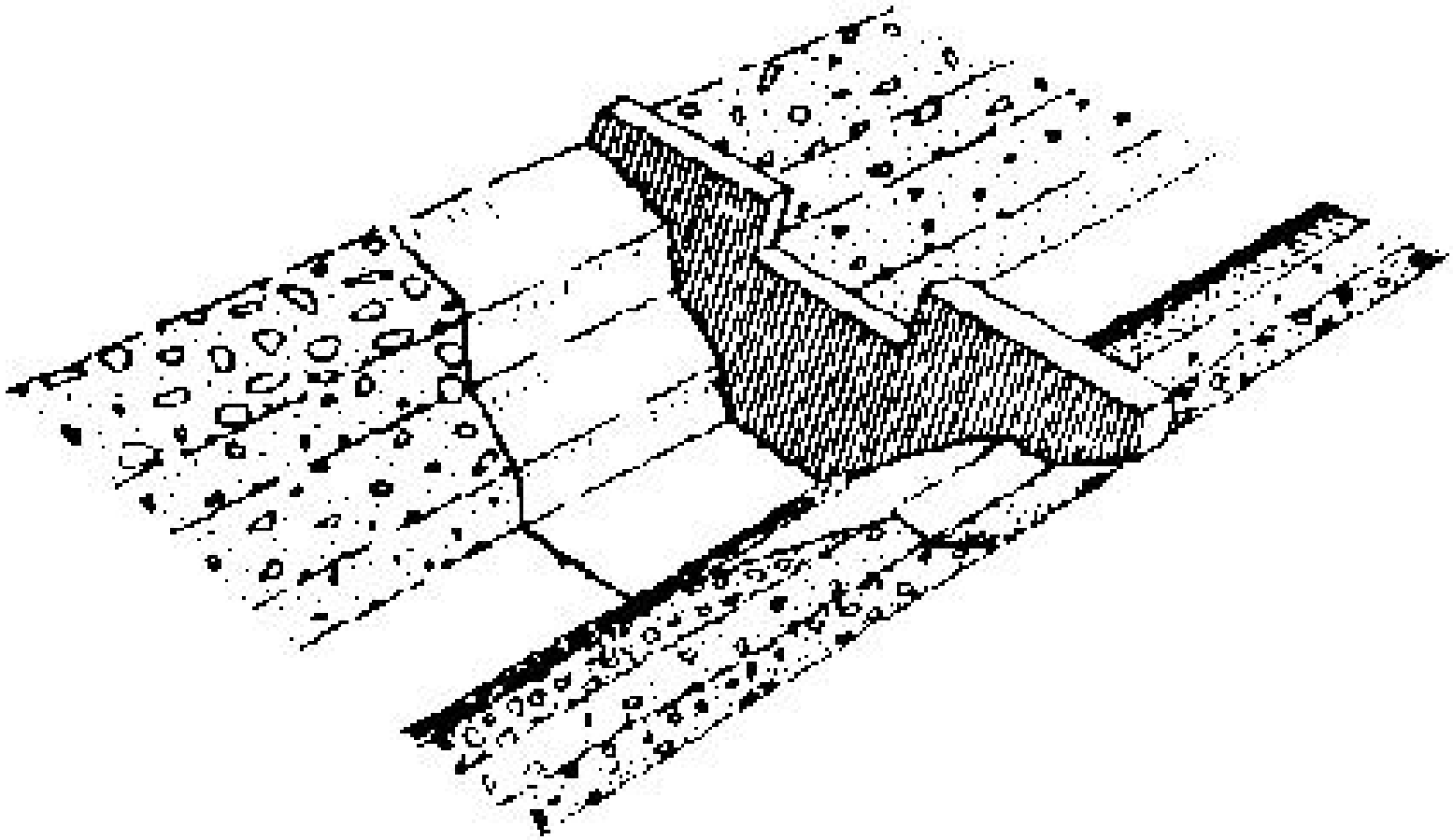


Canal structures

Clara Pompgemaal in Clara Polder, Nickerie

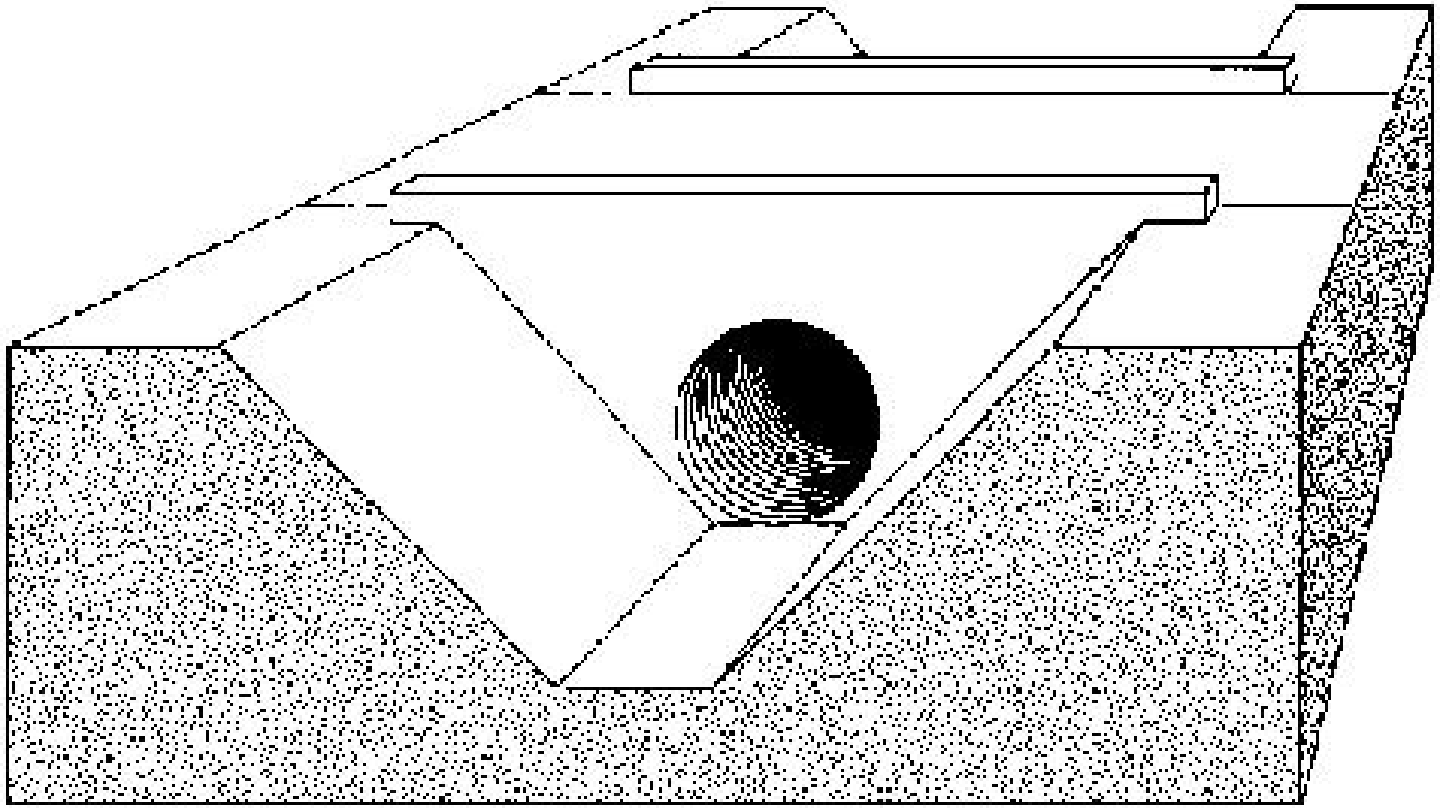
Canal structures

Concrete check



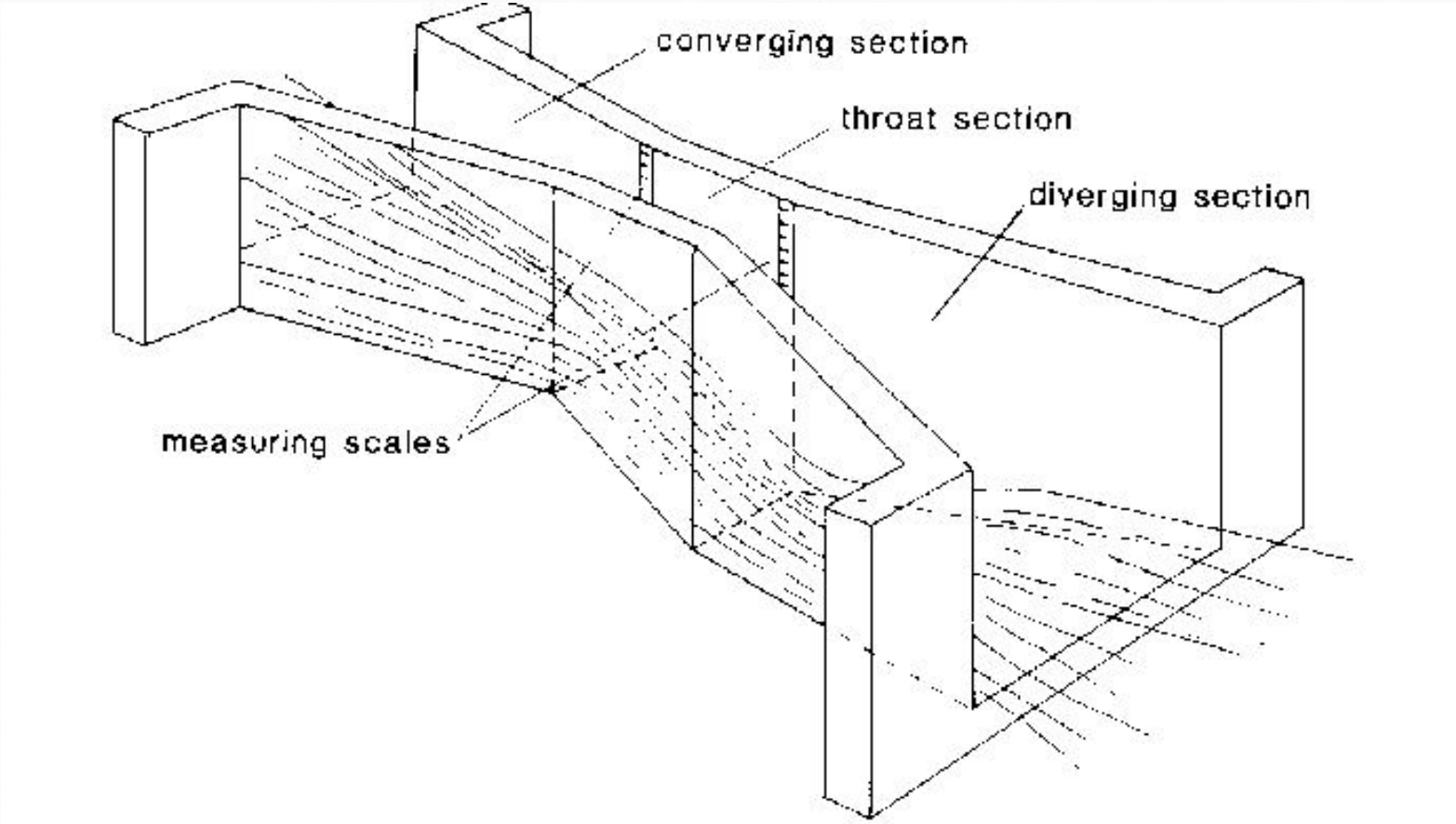
Canal structures

Culvert



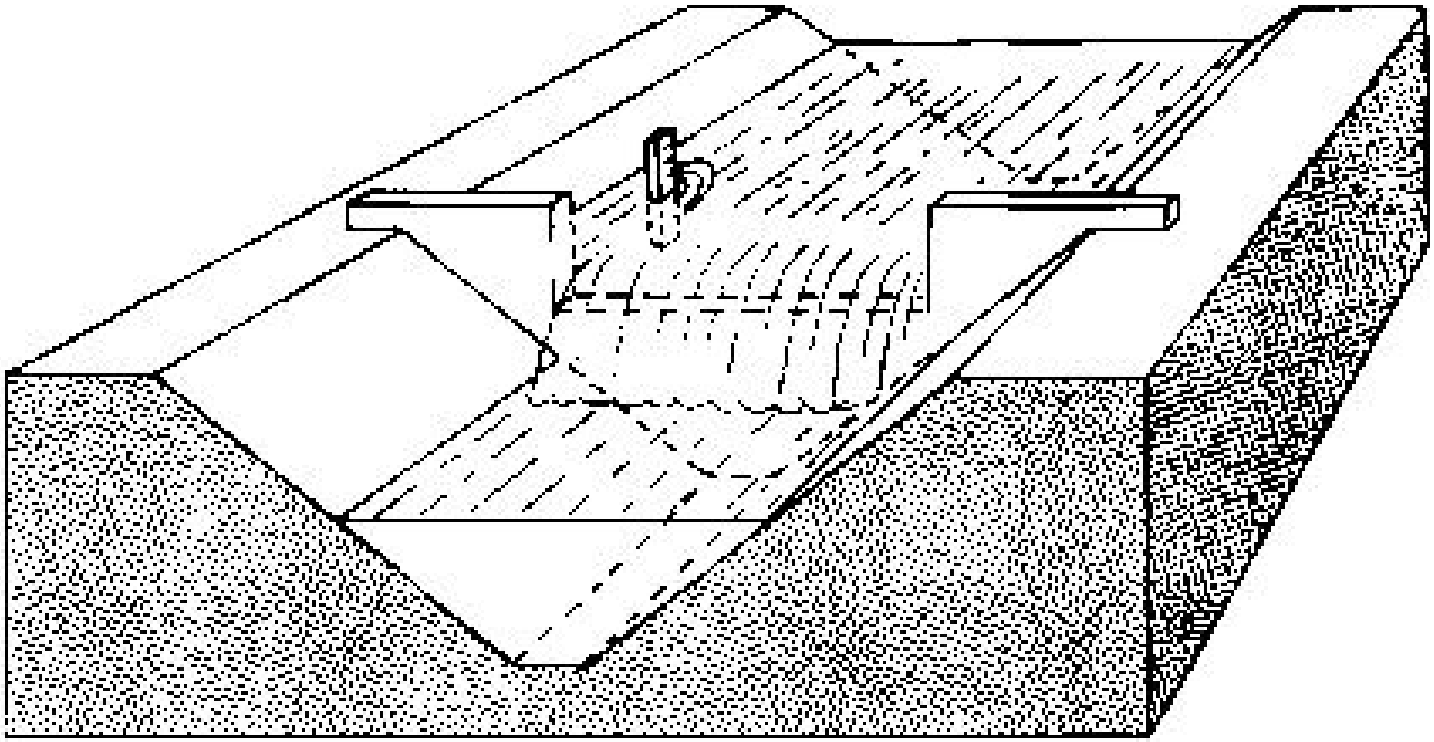
Canal structures

Flume



Canal structures

Weir



Canal structures

Weir in the Corantijn Canal

Canal structures

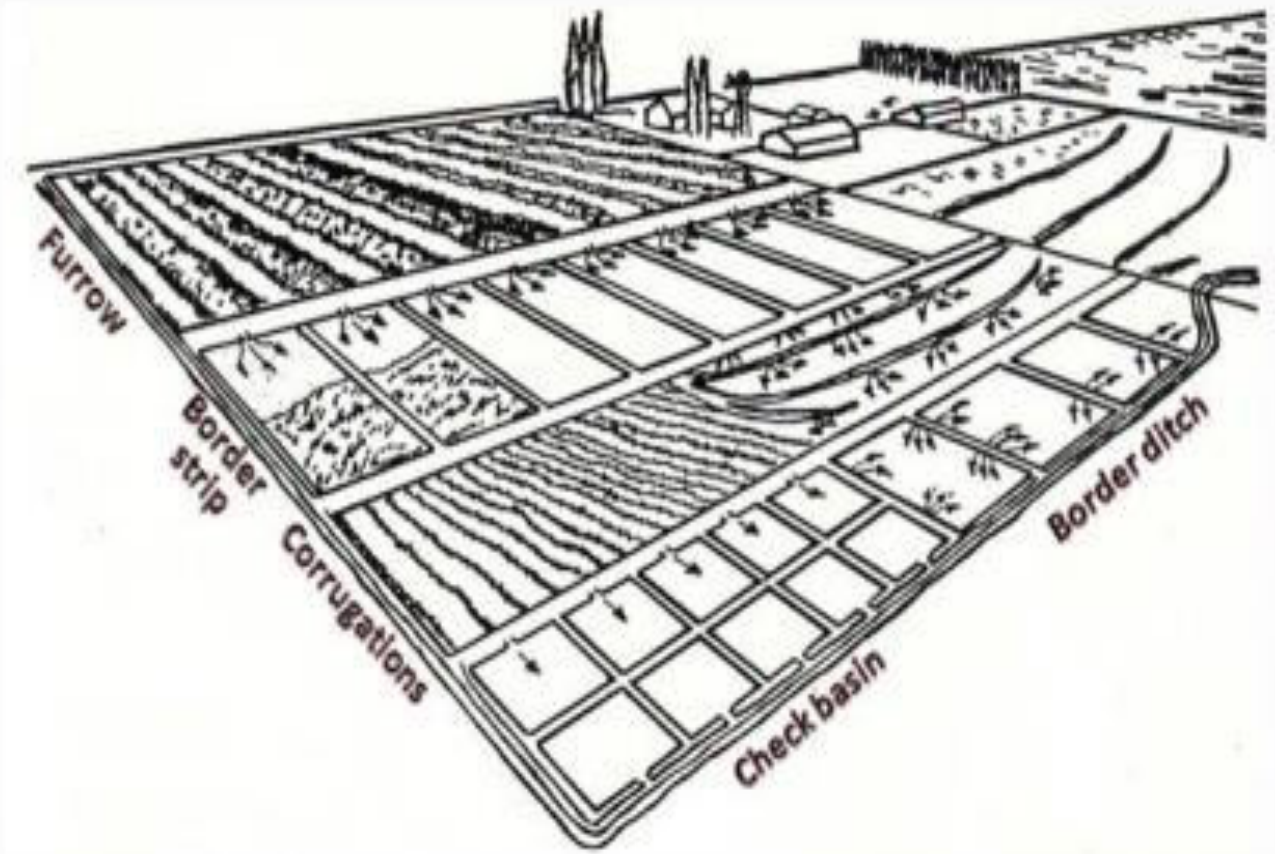
Van Wouw inlet, conveying water from Corantijn Canal to the western rice polders

Irrigating the fields

- Surface irrigation (globally 80% of all irrigated land)
- Sprinkler irrigation
- Drip irrigation

Surface irrigation methods

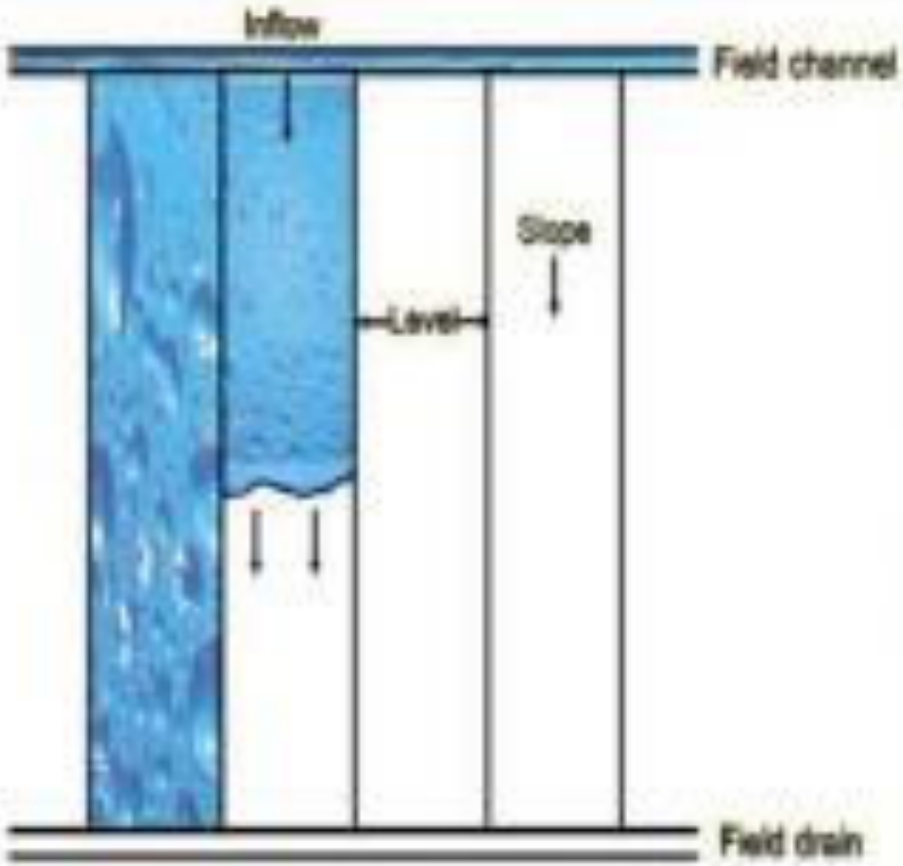
- Uncontrolled flooding
- Basins
- Border strips
- Furrows



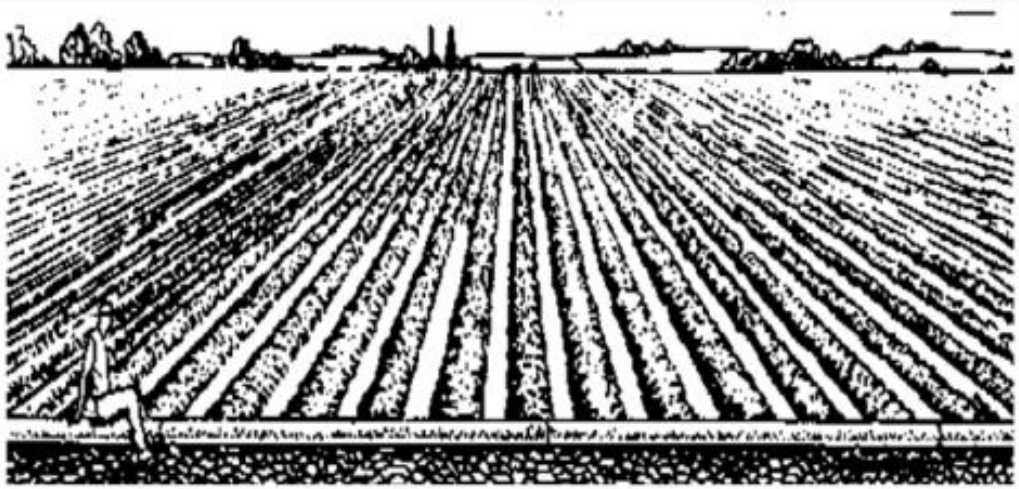
Uncontrolled flooding

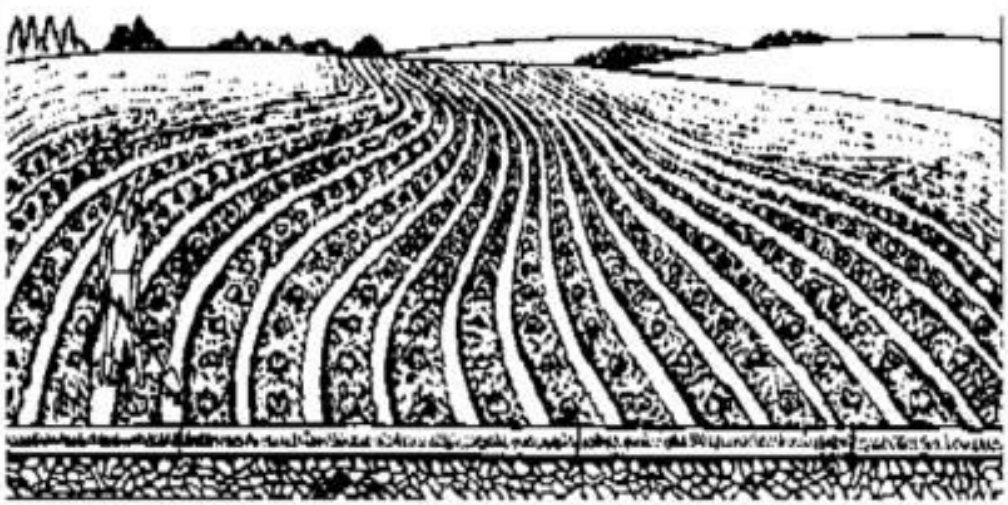
Basins

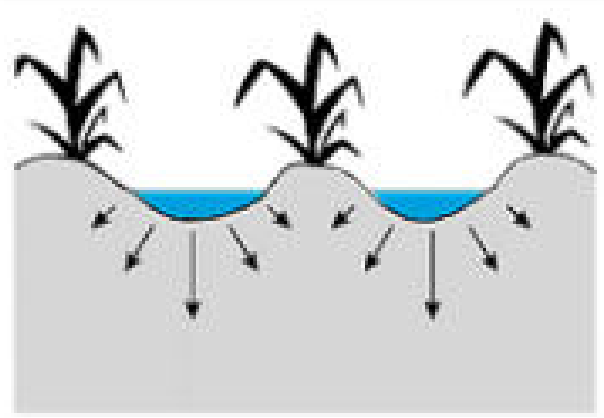
Border strips



Furrow irrigation







Furrow irrigation

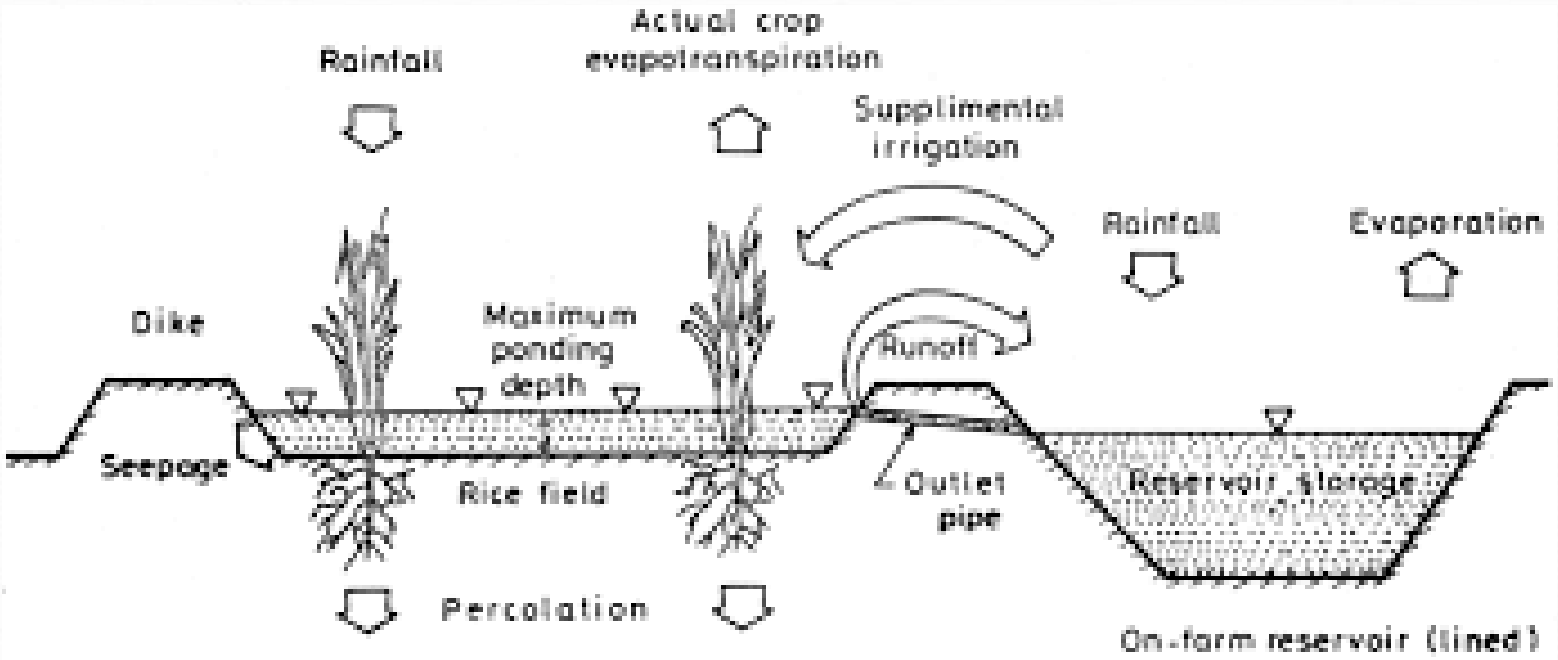
Sprinkler irrigation

Drip irrigation

When to irrigate?

- Strong relationship between soil moisture, plant stress, crop productivity, and water requirement.
- Water sensitive stages during crop development.
- General signs of water needs.
- The ‘feel’ approach (qualitative/experience).
- Water balance approach (quantitative/scientific).

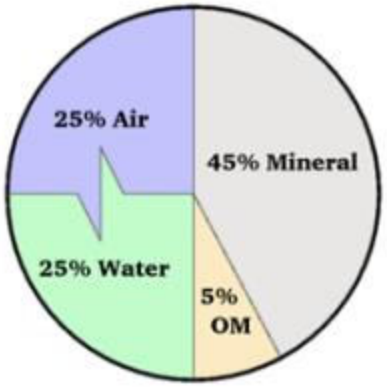
Water balance

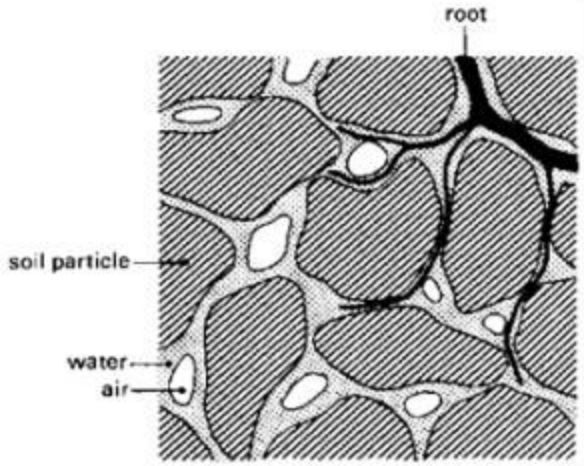


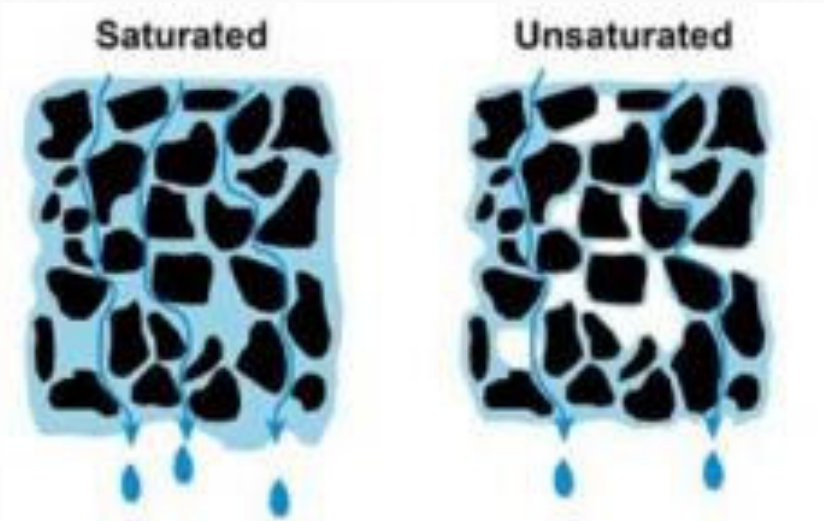
The water balance equation for a catchment is P = Q + AET + GW + DS, with all terms expressed in mm/year, where P is Precipitation, Q is Runoff, AET is actual evapotranspiration, GW is exchange with groundwater aquifer and DS is change in soil storage.

Soil and water

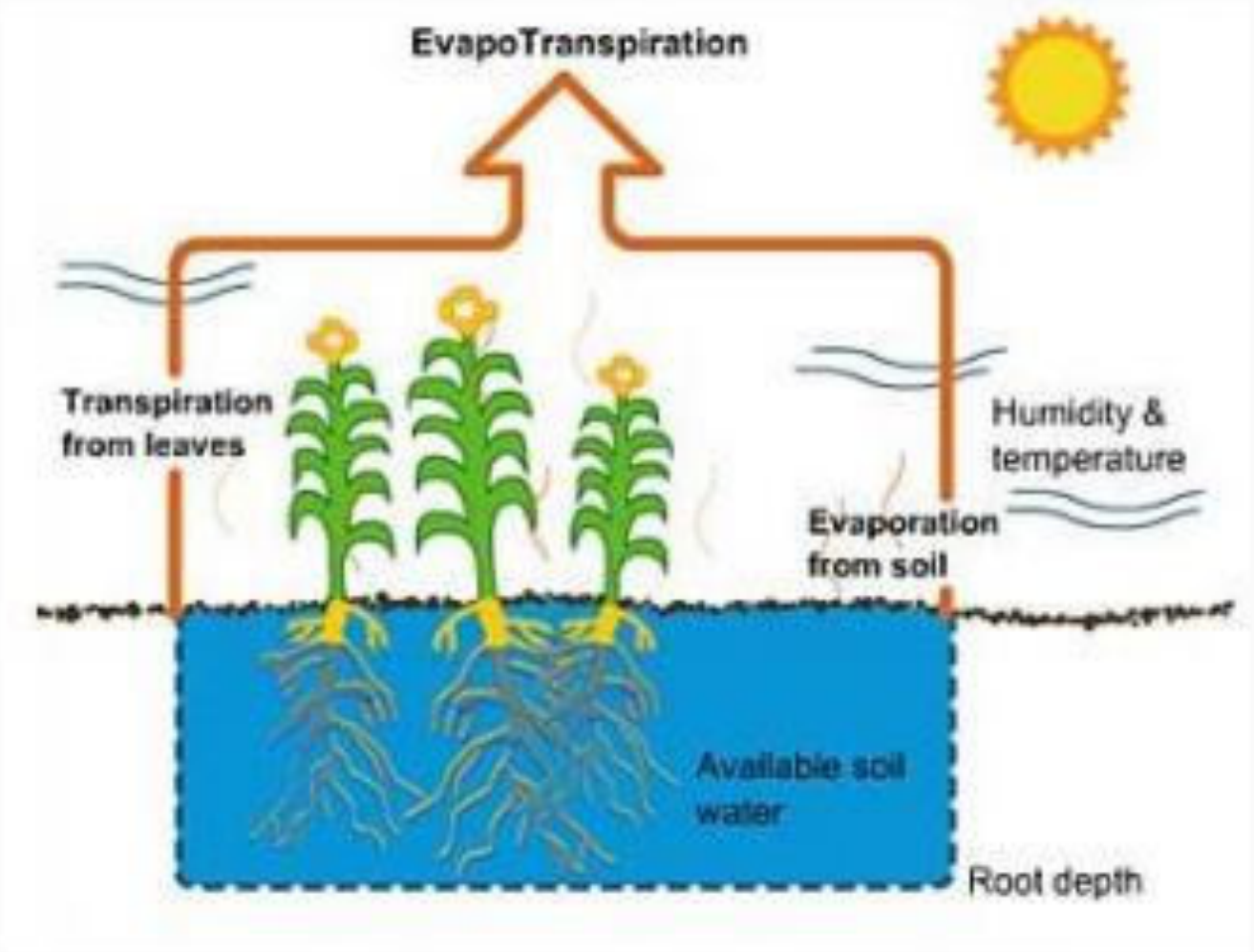
- Sandy soils drain rapidly.
- Clay soils drain slowly and hold water tightly.
- Soil improved with organic material maintain good drainage and moisture retention.



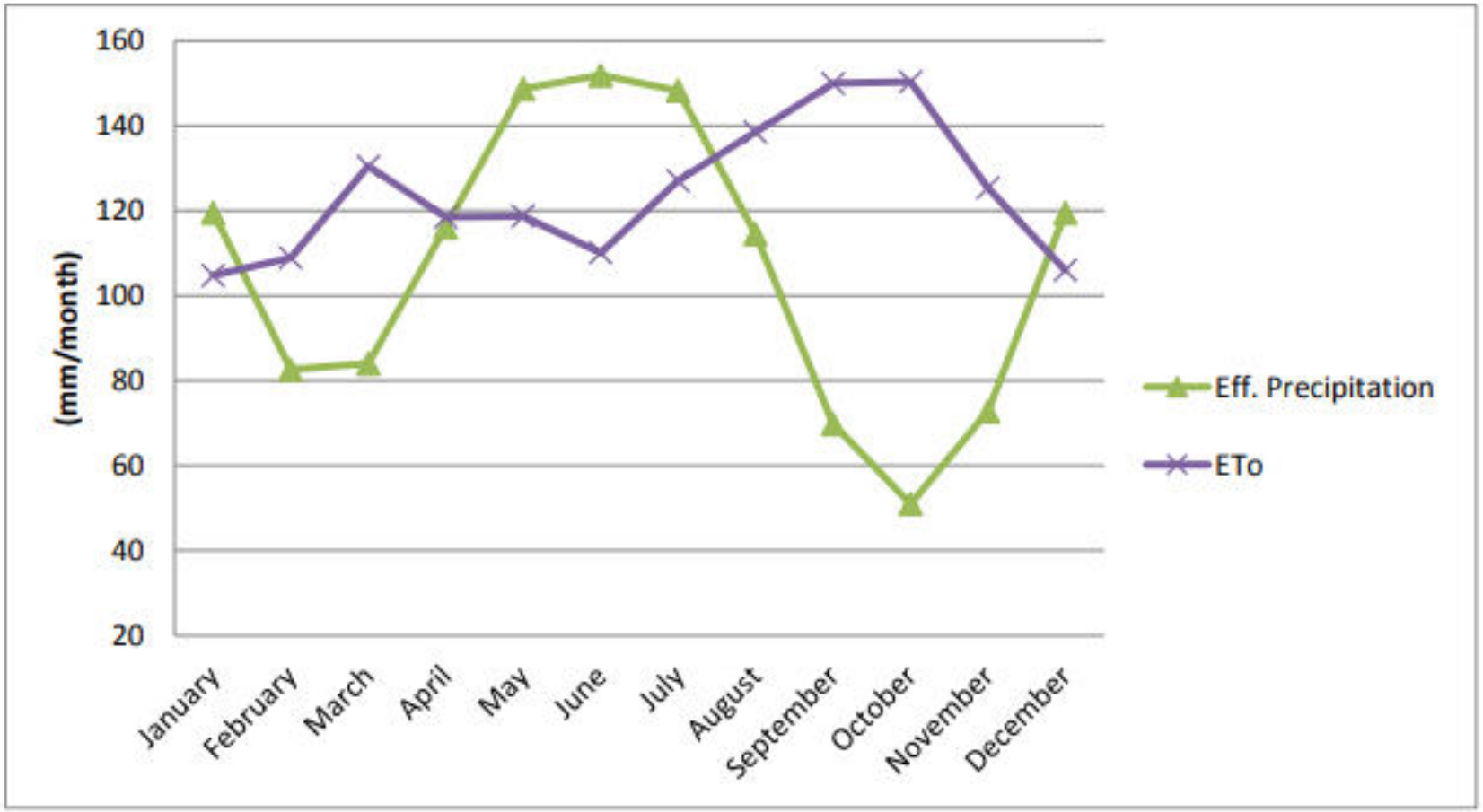




Evapotranspiration



Average precipitation and evapotranspiration in Nickerie



Source: FAO 2013

Crop water requirement

CWR is the total quantity of water required by a crop in a given period of time for its normal growth under specific field conditions at a given place.

Crop	Water requirement (mm)	Crop	Water requirement (mm)
Rice	1200	Tomato	600 – 800
Wheat	450 – 650	Potato	500 – 700
Sorghum	450 – 650	Pea	350 – 500
Maize	500 – 800	Onion	350 – 550
Sugarcane	1500 – 2500	Chillies	400 – 600
Sugarbeet	550 – 750	Cabbage	380 – 500
Groundnut	500 – 700	Banana	1200 – 2200
Cotton	700 – 1300	Citrus	900 – 1200
Soybean	450 – 700	Grapes	700 – 1200
Tobacco	400 – 600	Mango	1000 – 1200
Beans	300 – 500	Turmeric	1200 – 1400

Irrigation efficiency

- Irrigation efficiency is the ratio of total irrigation water used to total irrigation water supplied.
  - Water conveyance efficiency
  - Field application efficiency
  - Water use efficiency
- Irrigation efficiency is a critical measure of irrigation performance.
- Maintenance is an important efficiency factor!
- Attention for irrigation efficiency improves the sustainable use of declining freswater resources.

Irrigation efficiency

Irrigation methods	Field application efficiency
Surface irrigation (border, furrow, basin)	60%
Sprinkler irrigation	75%
Drip irrigation	90%

With sufficient irrigation water rice grows happily in Nickerie

And a happy irrigation manager …

Thank you

Question and Answers

Discussions