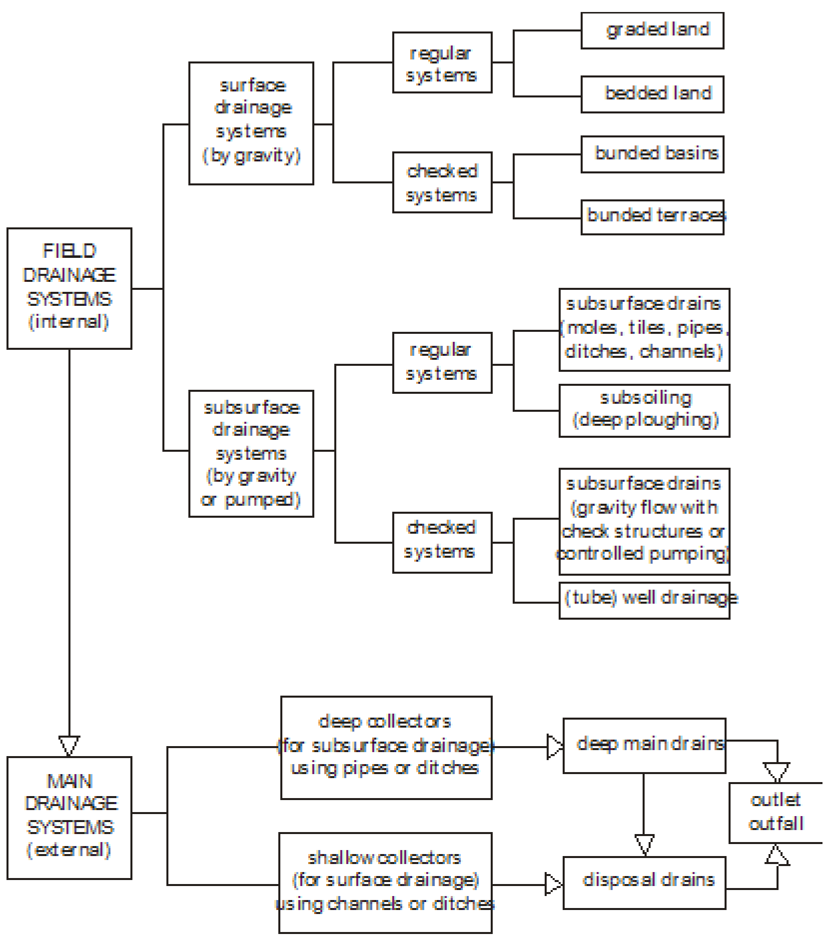
Subsurface drainage

On website https://www.waterlog.info/

Agricultural subsurface drainage is the practice of lowering the water table (phreatic level) in the soil of agricultural land by a drainage system with the objective to promote crop production, a subject of drainage research

Introduction and classification



The figure shows a classification of drainage systems divided in systems at field level (*internal drainage*) and at project level (*external drainage*).

The function of the internal system is to control the water table and the external system serves to receive (collect) the water from the internal system and transport it to the *outlet*.

The internal systems are distinguished in *surface* drainage systems to control the water level on top of the soil, and *subsurface* drainage systems to control the water level inside the soil.
Both systems can be differentiated in *regular* systems (relief systems) which function permanently when drainable water is present, and *controlled* systems which evacuate water temporarily, only when desired, to conserve water.

Contents

Purpose

The *purpose* of subsurface drainage is to increase the depth of the water table (Figure 1) so that there will be no more negative interference of the shallow water table with ploughing and other soil operations as wel as with crop production (Figure 2).

Drainage is practiced in agricultural land that originally were too wet or that had water levels in the soil that were too high too permit a profitable agriculture.

Moreover, drainage can be instrumental in soil salinity control to reduce the soil salinity.

The development of *drainage criteria* is necessary to establish drainage objectives for the design and operation of the drainage system with respect to an *optimal* level of the phreatic surface.

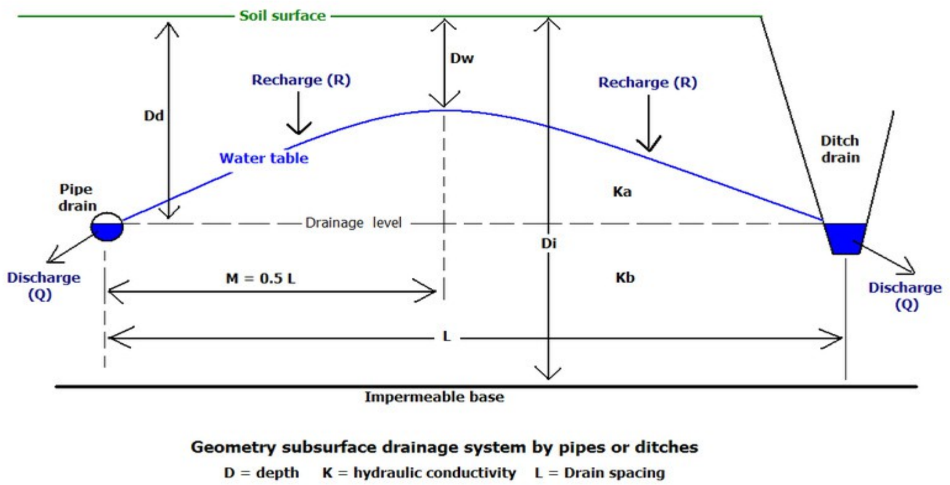


Figure 1. Drainage parameters for the control of the water table

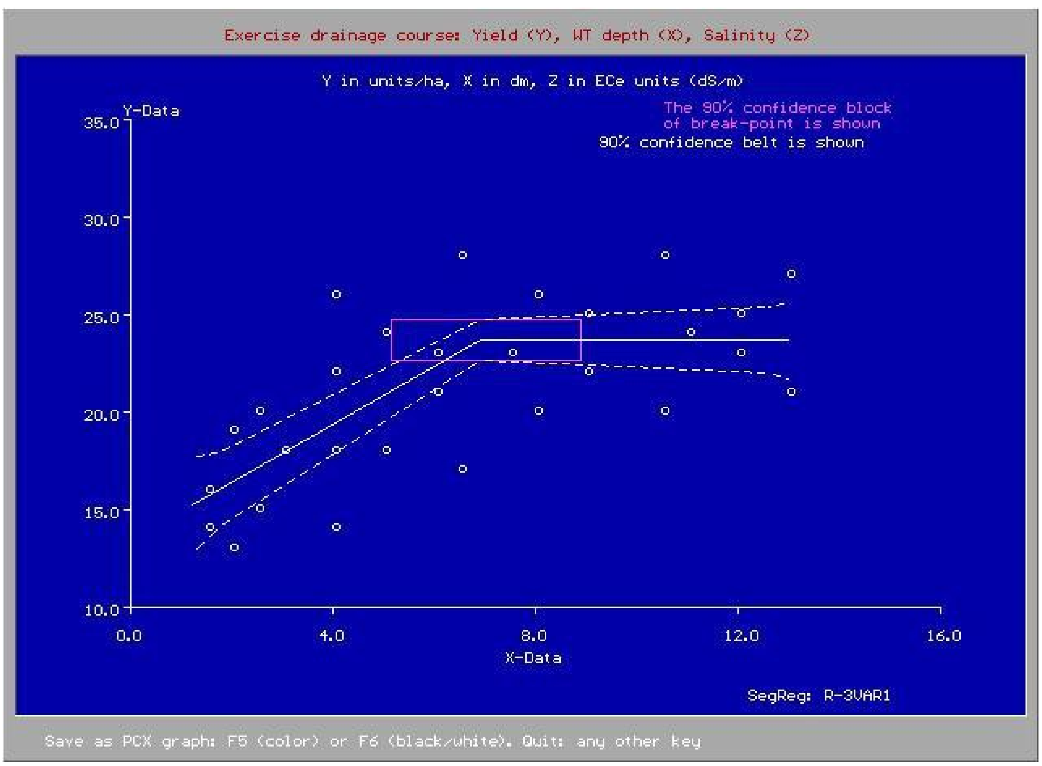


Figure 2. Crop yield and seasonal average depth of the water table (X in dm). When the water table is shallower than 7 dm, the yield decline.

This figure was made with the computer program SegReg for segmeneted regression

Optimization

The optimization of the depth of the water table is related to the benefits and costs of the drainage system (Figure 3).

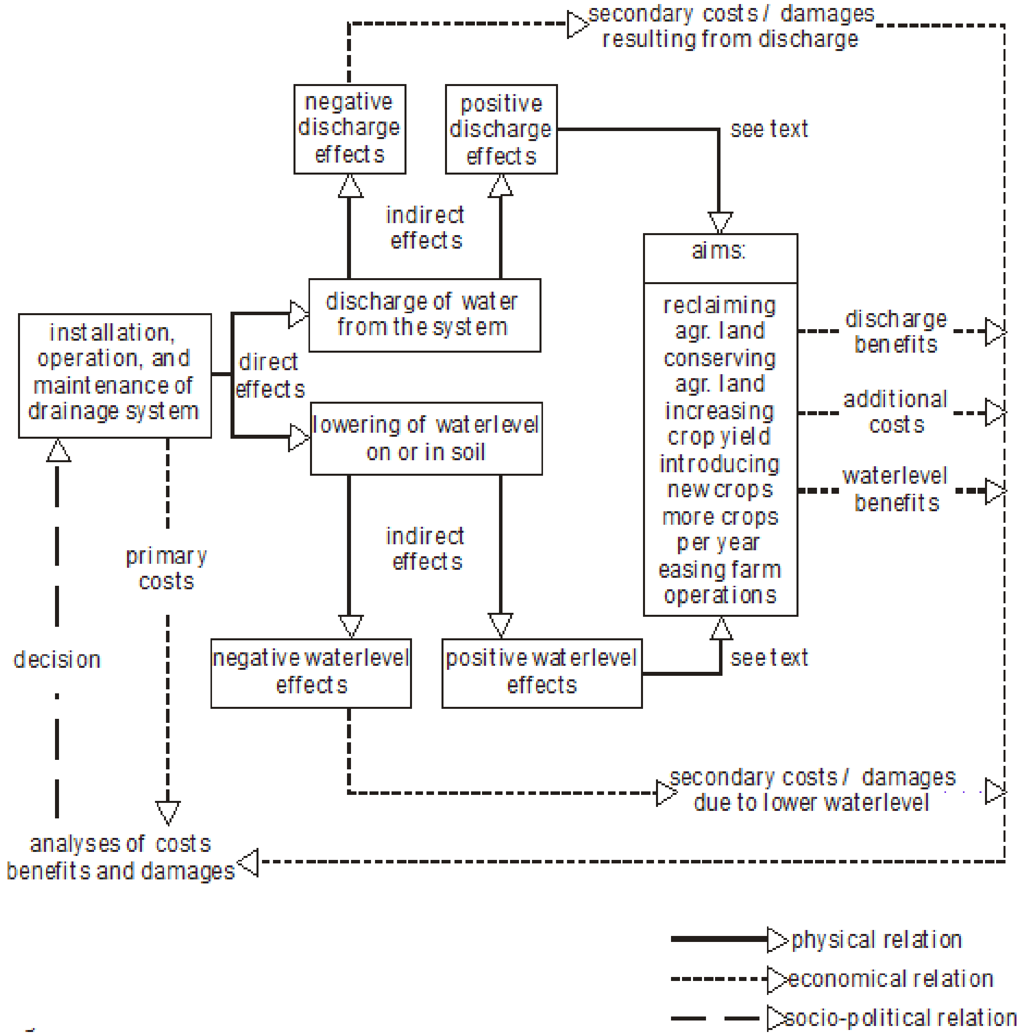


Figure 3. Positive and negative effects of subsurface drainage on the agriculture

The shallower the permissible depth of the water table the lower is the cost of the system to install to guarantee this depth. Nevertheless, the lowering of the water table, that originally was too shallow, implies secondary effects that need also to be taken into account.

Similarly, the mitigation of the environmental impacts should be included to achieve sustainable drainage

The table shows an example of the effect of the drain depth on various irrigation and drainage parameters, simulated with the computer program (software) SaltMod.

Table 1. Example of effects of drain depth

Drain depth (D_d, m), soil salinity (C_r, dS/m), field Irrigation efficiency of the group A crops (FaA, -), field irrigation sufficiency of the group A crops (JsA, -), seasonal average depth of the water table (D_w, m), and quantity of drainage water (G_d, mm per season).

Drain Depth	1st season (summer)				
D_d	C_r	FaA	JsA	D_w	G_d
0.6	2.7	0.84	0.99	0.37	105
0.8	2.5	0.83	0.98	0.55	112
1.0	2.4	0.82	0.97	0.74	117
1.2	2.2	0.81	0.96	0.93	122
1.4	2.1	0.80	0.95	1.12	127
	2nd season (winter)				
0.6	2.8	0.86	0.97	0.55	31
0.8	2.7	0.84	0.95	0.74	37
1.0	2.5	0.82	0.93	0.94	45
1.2	2.3	0.81	0.92	1.12	54
1.4	2.2	0.80	0.91	1.31	57

History

Historically, subsurface drainage of agricultural land started with the excavation of open ditches that were relatively shallow and that received the surface surface runoff (overland flow) as well as the discharge of the groundwater. The drains functioned both as *surface* and *subsurface* drainage.

By the end of the 19th century and at the beginning of the 20th, the ditches were considered inconvenient because they hampered the mechanized agricultural operations, and the ditches were replaced by tile drains (fired ceramic pipes), each tile about 30 cm long.

Since 1960 the flexible plastic drainpipes came into use. The were made of polyethylene (PE) or polyvinyl chloride (PVC), corrugated, perforated and of unlimited length so that they could be intalled in one go by drainage machines. The pipes could be pre-wrapped with filter materila synthetic fiber or geotextile that prevent the entry of soil particle into the pipe drains.

In that way, drainage was developed into a powerful industry. At the same, agriculture navigated towards maximization of the production which lead to the large scale installation of drainage systems

Environment

As a result of the large developments, many modern drainage projects wer overdesigned while the negative environmental impacts remained unattended.

Amongst the persons concerned about the enviroment, agricultural land drainage did not get a good reputation, sometimes justified and sometimes not, especially when land drainage was confused with the more ample activity of reclamation of wetlands.

Today, in some countries, the industrial development has been reverted somewhat. Moreover, systems of *controlled* drainage were introduced as iluustrated in figure 4.

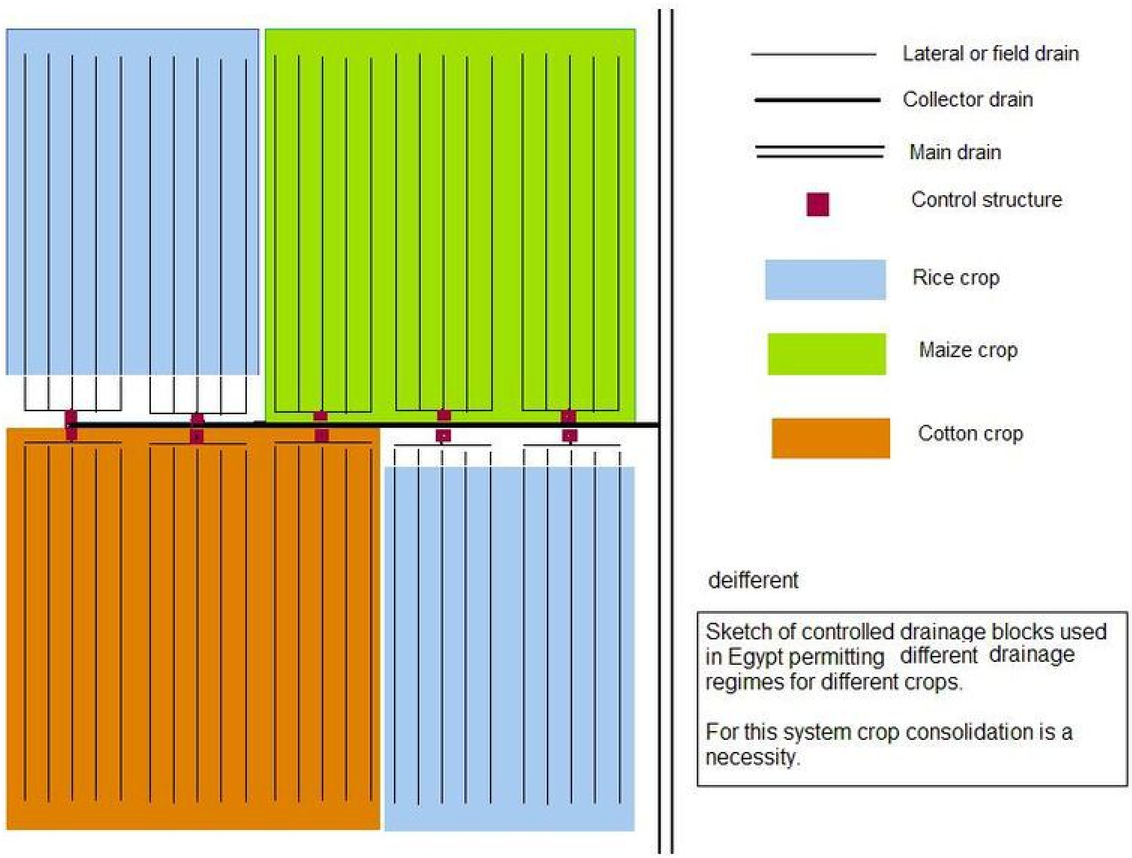


Figure 4. Contolled drainage

Design

The design of drainage systems with regard to location, depth, and spacing between drains are done with drainage equations using parameters like required depth of the water table, the depth of the soil, the hydraulic conductivity, and the drain discharge'.

The discharge is dtermined from a water balance.

The calculations can be made with a cpmuter program (software) like EnDrain.

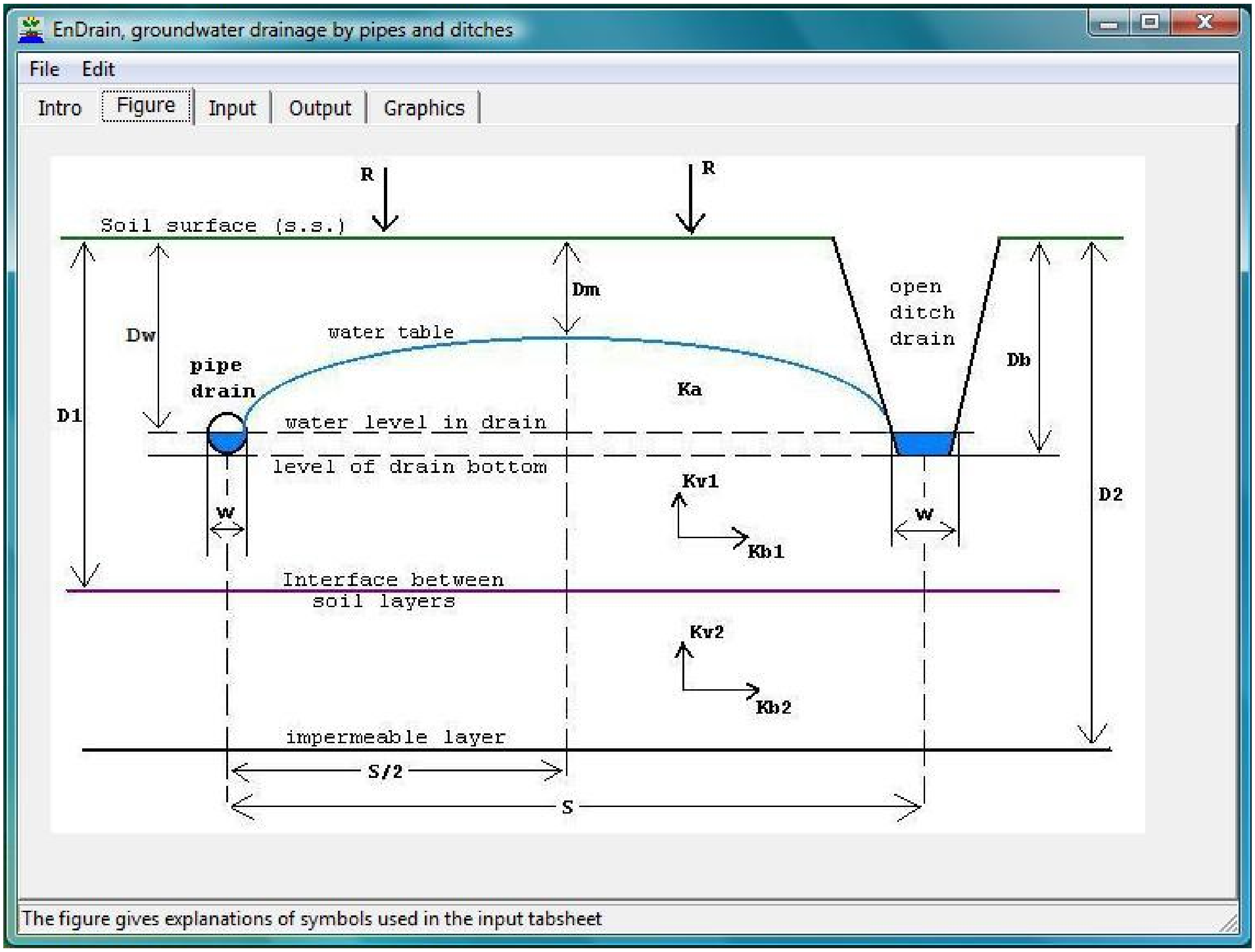


Figure 5. Sketch of drainage parameters used in EnDrain

Drainage by wells

Subsurface drainage can also be done by means of drainage by pumped wells . Such a system is also called *vertical* drainage in contrast with *horizontal* drainage with ditches and pipes.

In the valley of the Indus river in Pakistan, many drainage wells have been used. Although the results were not always very successful, the feasibility of this technique in areas with deep and permeable aquifers is not negligible..

For the design of a well drainage system the computer program (software) WellDrain can be used.

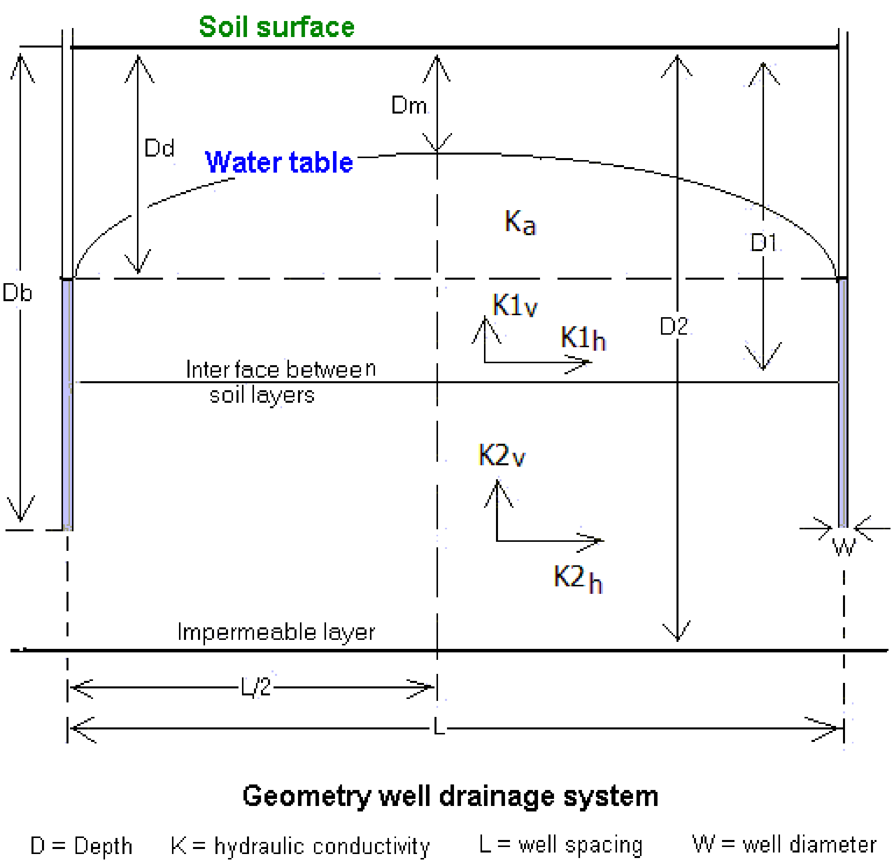


Figure 6. Geometry of a pumped well drainage system.

Galery of images

Technical aspects of agricultural land drainage

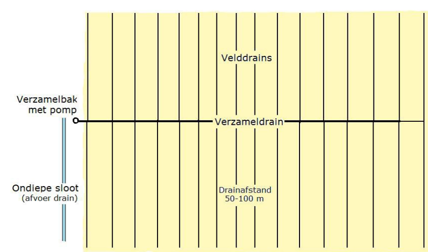
Outlet of an old tile drain

Open collector drain

Antique windmilss evacuating the drainage water from the interior polders to the river between levees

Pumping stattion elevating the drainage water for evacuation

Drainage machine burrying plastic drainpipes.



Map of a controlled drainage system in India.

Photo 1 Tractor-drawn rotary-blade ditcher at work. (By courtesy of Impex International, Spartanburg, South Carolina, USA)

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