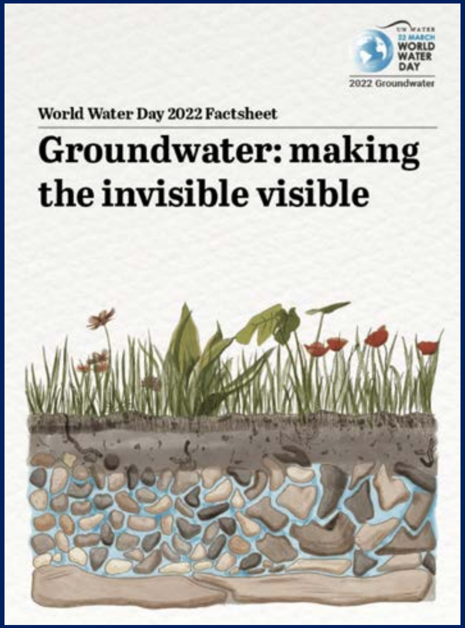
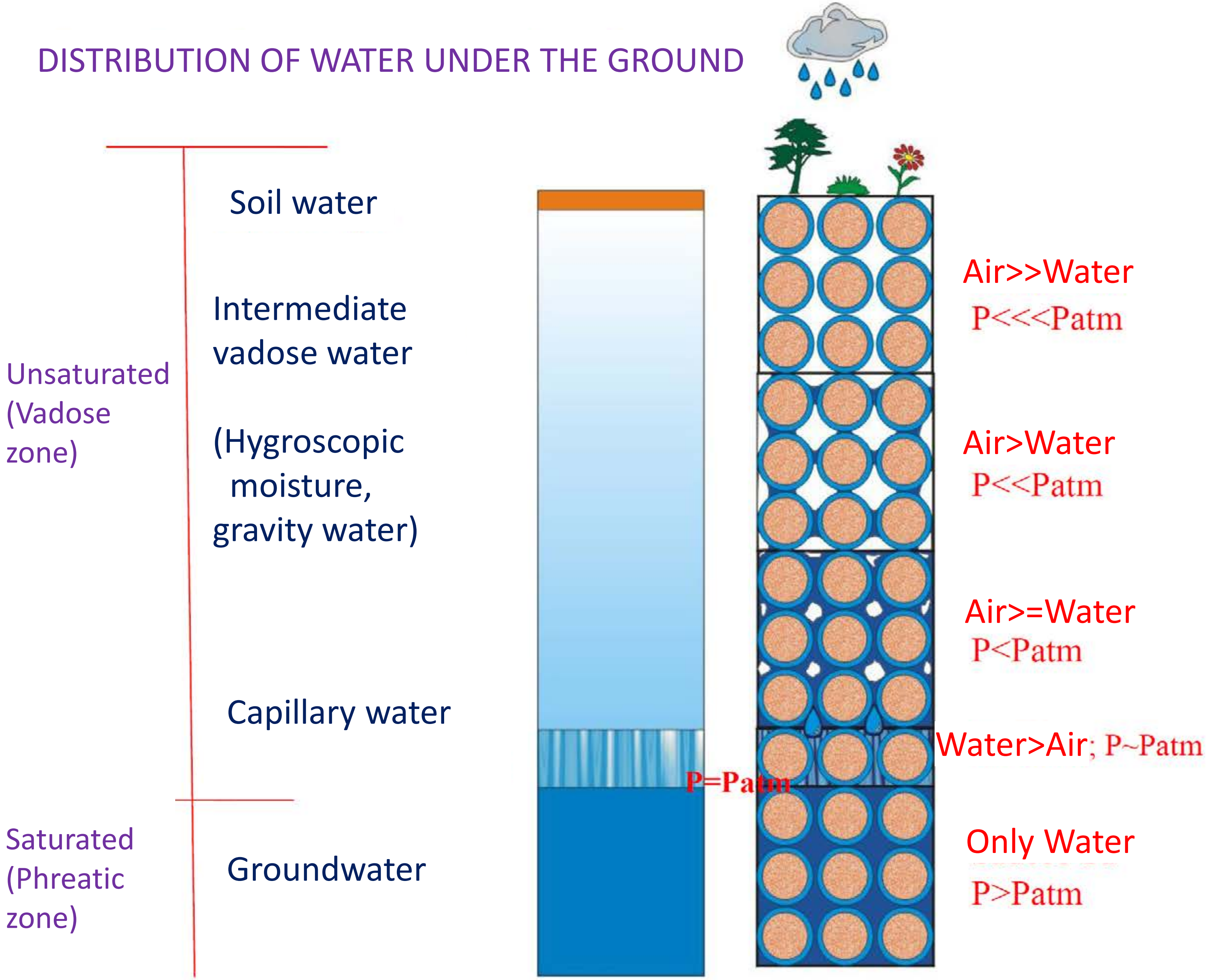


GEO335
HYDROGEOLOGY

DISTRIBUTION OF WATER UNDER THE GROUND



* Şekil Prof. Dr. Mehmet Ekmekçi (2002) sunumundan alınmıştır «Yeraltısuyu sistemlerinin tanımlanması: Yeraltısuyunun oluşumu ve dağılımı»

DISTRIBUTION OF WATER UNDER THE GROUND

Unsaturated (Vadose zone)

- Soil water
- Intermediate vadose water (Hygroscopic moisture, gravity water)
- Capillary water

Saturated (Phreatic zone)

- Groundwater

Hygroscopic moisture: A thin layer of water held tightly to soil particles by surface forces. (NOT AVAILABLE TO PLANTS)

Gravity water: moves through the soil by the force of gravity and drains. Gravitational water moves in the larger pores of the soil and drains quickly (NOT AVAILABLE TO PLANTS).

Capillary water: is the water that is held inside soil pores against gravity (AVAILABLE MOISTURE CONTENT).

Air>>Water
P<<<Patm

Air>Water
P<<Patm

Air>=Water
P<Patm

/ater>Air; P~Patm

Only Water
P>Patm

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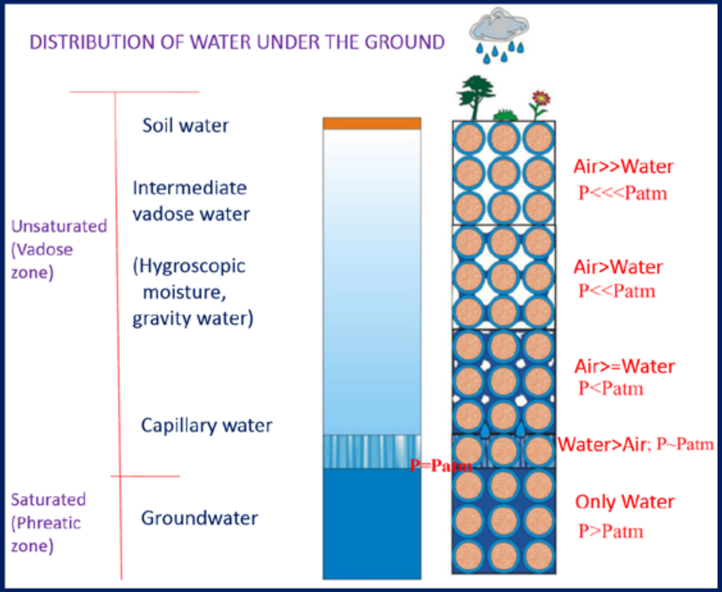
Evapotranspiration and Soil Moisture:

Field capacity (FC): is the moisture content above which water will freely drain out from soil by the gravity, i.e. the highest moisture content that can be retained in the soil pores against gravity pull (by capillary action).
Water above the field capacity is a loss (through percolation) as far as plant use is concerned.
It depends upon specific retention, evaporation depth and the unsaturated permeability characteristic curve of the soil.

Wilting point (WP): moisture content below which the plant will die and cannot be brought back to life even if water is added later to increase the moisture content.

Available moisture content= capillary water =FC- WP



Actual Evapotranspiration= AET = Amount of water that would be removed from the land surface by evaporation and transpiration. The amount of water that would be removed is limited with **SOIL MOISTURE!**

PET is the evaporation that would occur if there was always an adequate supply of water available to a fully vegetated surface. CONSUMPTIVE USE

METHODS FOR CALCULATING CONSUMPTIVE USE:

1) Thorntwaite 2) Blaney- Criddle

Potential evapotranspiration (PET) would occur if there was always an adequate water supply available to a fully vegetated surface.

Thornthwaite assumed that PET depends on meteorological conditions and not on vegetation (density and maturity is ignored).

What kind of information do we need for Thortntwaite PET calculations? Mean monthly air temperature, latitude, month (the last two determine average monthly sunlight)

1) Thorntwaite Equation

$Etp = 1.6\ (10\ t/I)^a$ in cm (we need to conver to mm's since ppt is given in mm's)

1- $i = (t/5)^{1.514}$

2- $I = \Sigma\ i$

3- $a = 6.75*10^{-7}*I^3 – 7.71*10^{-5}*I^2 + 1.79*10^{-2}*I + 0,492$

4- Etpc = Etp * Latitude correction factor

Thornthwaite Moisture Balance Table

Let's assume soil water reserve is 100 mm, the reserve in August 2015 was empty.

Months	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sum
Monthly average temperature (^{0}C)	18.70	13.20	7.58	2.85	0.92	3.19	5.84	10.76	15.40	21.23	23.89	22.21	
Temperature Index													
Potential Evapotranspiration Etp (mm)													
Latitude correction factor (38° 30')	1.030	0.970	0.855	0.835	0.865	0.845	1.030	1.100	1.215	1.225	1.245	1.165	
Corrected Etp (mm)													
Precipitation (mm)	17.00	43.60	52.45	96.76	109.23	53.27	51.34	36.33	30.98	29.30	19.20	11.20	550.66
Soil water reserve (mm)													
Actual Etr (mm)													
Water Surplus (mm)													
Water Deficit (mm)													

Good for finding annual values. No vegetation growth factor incorporated. Therefore, this method may overestimate during spring and early summer, underestimate during mid-summer.

Months	Sep-15	Oct-15	Nov-15	Dec-15	Jan-16	Feb-16	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16	Sum
Monthly average temperature (^{0}C)	18.70	13.20	7.58	2.85	0.92	3.19	5.84	10.76	15.40	21.23	23.89	22.21	
Temperature Index	7.37	4.35	1.88	0.43	0.08	0.51	1.27	3.19	5.49	8.93	10.68	9.56	53.71
Potential Evapotranspiration Etp (mm)	84.67	53.18	25.35	6.86	1.52	7.98	17.89	40.47	65.33	100.31	117.44	106.54	
Latitude correction factor (38° 30')	1.030	0.970	0.855	0.835	0.865	0.845	1.030	1.100	1.215	1.225	1.245	1.165	
Corrected Etp (mm)	87.213	51.580	21.673	5.731	1.311	6.739	18.430	44.519	79.378	122.882	146.215	124.123	
Precipitation (mm)	17.00	43.60	52.45	96.76	109.23	53.27	51.34	36.33	30.98	29.30	19.20	11.20	550.66
Soil water reserve (mm) 0													
Actual Etr (mm)													
Water Surplus (mm)													
Water Deficit (mm)													
a	0.104606	-0.22245	0.961474	0.492	1.335635								

Let's assume soil water reserve is 100 mm, the reserve in August 2015 was empty.

2) Blaney-Criddle Equation

$$PET = U = kF = \sum_{i=1}^{m} \frac{k_i t_i p_i}{100}$$

i = month of the year
U = consumptive use in inches per unit area
k = crop consumptive use coefficient
F = consumptive use factor = the sum of the monthly consumptive use factors for each month during the growing season

$$F = \frac{tp}{100}$$

t = mean monthly air temperature (°F)
p = % of annual daytime hours during each month of the year.

Table 5.3. P values: % daytime hours in the Blaney-Criddle formula

Month	Latitudes (in northern hemisphere)							
	24^0	26^0	28^0	30^0	32^0	34^0	36^0	38^0
January	7.58	7.49	7.40	7.30	7.20	7.10	6.99	6.87
February	7.17	7.12	7.07	7.03	6.06	6.91	6.86	6.76
March	8.40	8.40	8.39	8.38	8.37	8.36	8.35	8.34
April	8.60	8.64	9.68	8.72	8.75	8.80	8.85	8.90
May	9.30	9.38	9.46	9.53	9.63	9.72	9.81	9.92
June	9.20	9.30	9.38	9.49	9.60	9.70	9.83	9.95
July	9.41	9.49	9.58	9.67	9.77	9.88	9.99	10.10
August	9.05	9.10	9.16	9.22	9.28	9.33	9.40	9.47
September	8.31	8.31	8.32	8.34	8.34	8.36	8.36	8.38
October	8.09	8.06	8.02	7.99	7.93	7.90	7.85	7.80
November	7.43	7.36	7.27	7.19	7.11	7.02	6.92	6.82
December	7.46	7.35	7.27	7.14	7.05	6.92	6.79	6.66

https://www.chegg.com/homework-help/questions-and-answers/hint-must-use-equations-tables-solution-irrigation-drainage-civil-engineering-q43244889