

PROGRAM GEO –GeoAV ver.1 per Windows

Theoretical basis

In the following paragraphs will be illustrated two methods to estimate the vulnerability index of an aquifer: DRASTIC and SINTACS. They're parametric methods based on the sum of seven partial indexes, multiplied by just as many weights. The vulnerability index measures the hazard of groundwater contamination by surface pollution sources and it's useful to elaborate groundwater vulnerability maps.

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D.R.A.S.T.I.C. (Aller et al., 1987)

It's based on the following scheme:

Parameters	Range	Rating	Weight Normal condition	Weight Pesticide
Water table depth (m) (D)	0.0-1.5	10	5	5
	1.5-4.5	9		
	4.5-9.0	7		
	9.0-15.0	5		
	15.0-22.5	3		
	22.5-30.0	2		
	>30.0	1		
Net recharge (mm) (R)	0-50	1	4	4
	50-100	3		
	100-175	6		
	175-250	8		
	>250	9		
Aquifer media (A)	Massive shale	2	3	3
	Metamorphic/igneous	3		
	Weathered met./igneous	4		
	Bedded sandstone	6		
	Limestone	6		
	Shale sequences	6		
	Massive sandstone	6		
	Massive limestone	6		
	Sand and gravel	8		
	Basalt	9		
Karst limestone	10			
Soil media (S)	Soil thin or absent	10	2	5
	Gravel	10		
	Sand	9		
	Peat	8		
	Shrinking and/or aggregated clay	7		
	Sandy loam	4		
	Loam	5		
	Silty loam	5		
	Clay loam	4		
	Muck	3		
	Non-shrinking and non-aggregated clay	2		
Topography (T) %	0-2	10	1	3
	2-6	9		
	6-12	5		
	12-18	3		
	>18	1		
Impact of vadose zone (I)	Silt/clay	1	5	4
	Shale	3		
	Limestone	6		
	Sandstone	6		
	Bedded limestone, Sandstone, shale	6		
	Sand and gravel with significant silt and clay	6		
	Metamorphic/igneous	4		
	Sand and gravel	8		
	Basalt	9		
	Karst limestone	10		

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Hydraulic conductivity (C) (m/s)	5×10^{-7} - 5×10^{-6}	1	3	2
	5×10^{-5} - 1.5×10^{-4}	2		
	1.5×10^{-4} - 3.5×10^{-4}	4		
	3.5×10^{-4} - 5.0×10^{-4}	6		
	5.0×10^{-4} - 1.0×10^{-3}	8		
	$> 1.0 \times 10^{-3}$	10		

The net recharge of the aquifer can be estimated through the following expression:

$$\text{Net Recharge} = (P - E) \times ci$$

where:

P = average precipitation on an annual basis;

E = average evapotranspiration on an annual basis;

ci = coefficient of infiltration; it usually varies from 0 (impervious surface) to 0.5 (pervious surface)

In case of confined aquifer, the rating relative to the Impact of vadose zone has to be imposed equal to 1

The DRASTIC Index is computed using the following expression:

$$Di = Dr \times Dw + Rr \times Rw + Ar \times Aw + Sr \times Sw + Tr \times Tw + Ir \times Iw + Cr \times Cw$$

where:

r = rating;

w = weight

D, R, A, S, T, I and C = DRASTIC parameters.

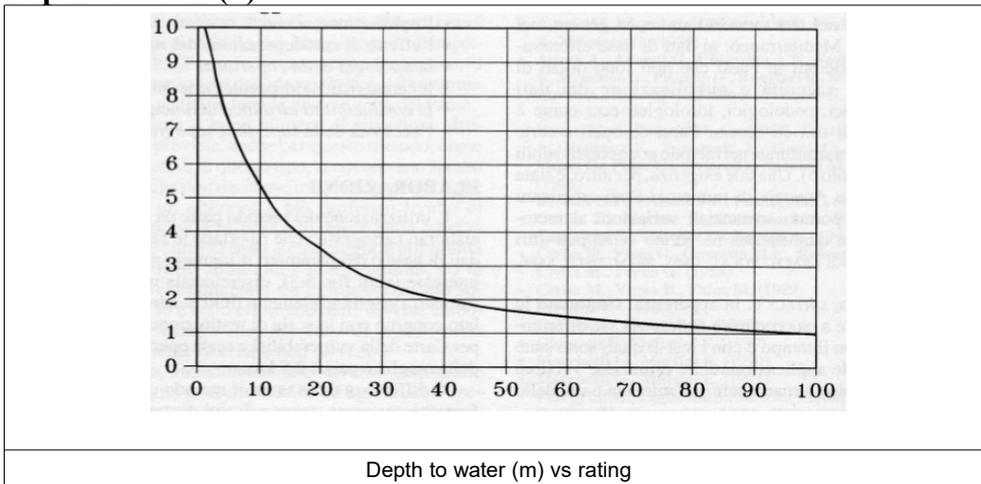
The vulnerability degree of the aquifer is given by the following table.

Interval	Vulnerability degree
< 47	Very low
47 – 101	Low
101 - 155	Medium
155 - 209	High
> 209	Very high

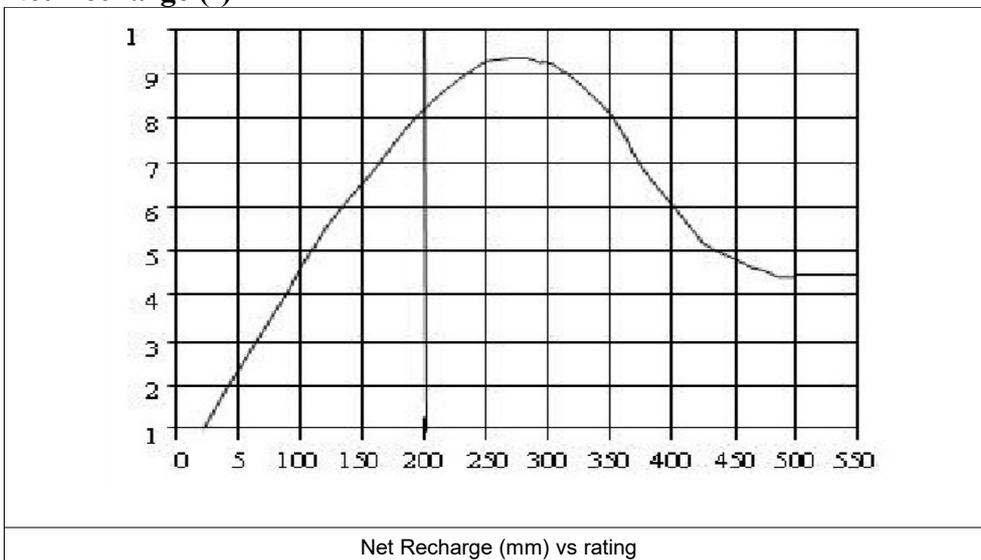
S.I.N.T.A.C.S. (Civita and De Maio., 1997)

It's based on the following parameters.

Depth to water (S)



Net Recharge (I)



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The net recharge of the aquifer can be estimated through the following expression:

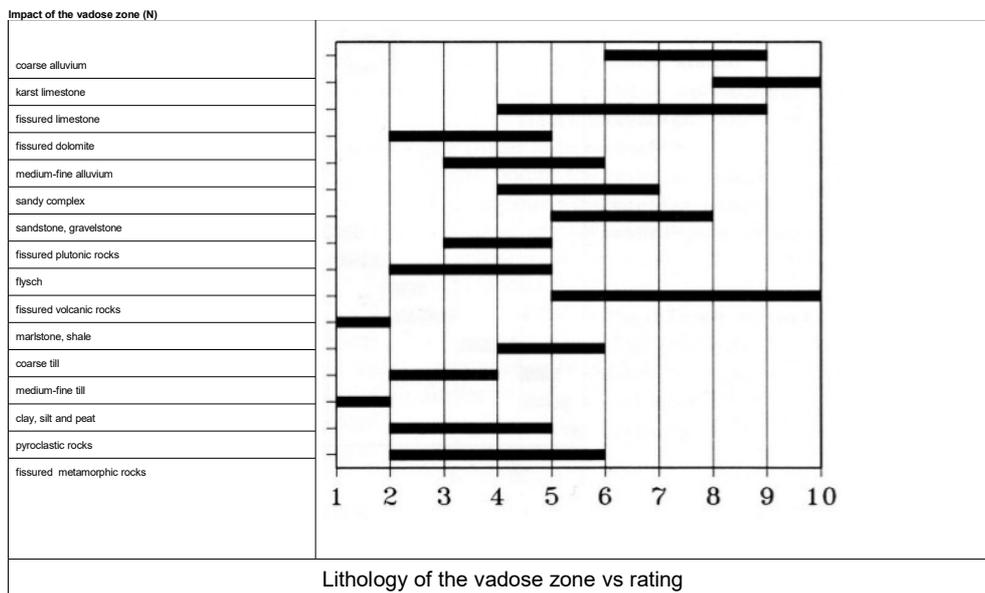
$$\text{Net Recharge} = (P - E) \times c_i$$

where:

P = average precipitation on an annual basis;

E = average evapotranspiration on an annual basis;

c_i = coefficient of infiltration; it usually varies from 0 (impervious surface) to 0.5 (pervious surface)



In case of more lithologies along the examined vertical inside the vadose zone, the ratings of every single lithology have to be summed in the following way:

$$N = \sum_{j=1}^n h_j P_j / \sum_{j=1}^n h_j$$

where:

N = total rating;

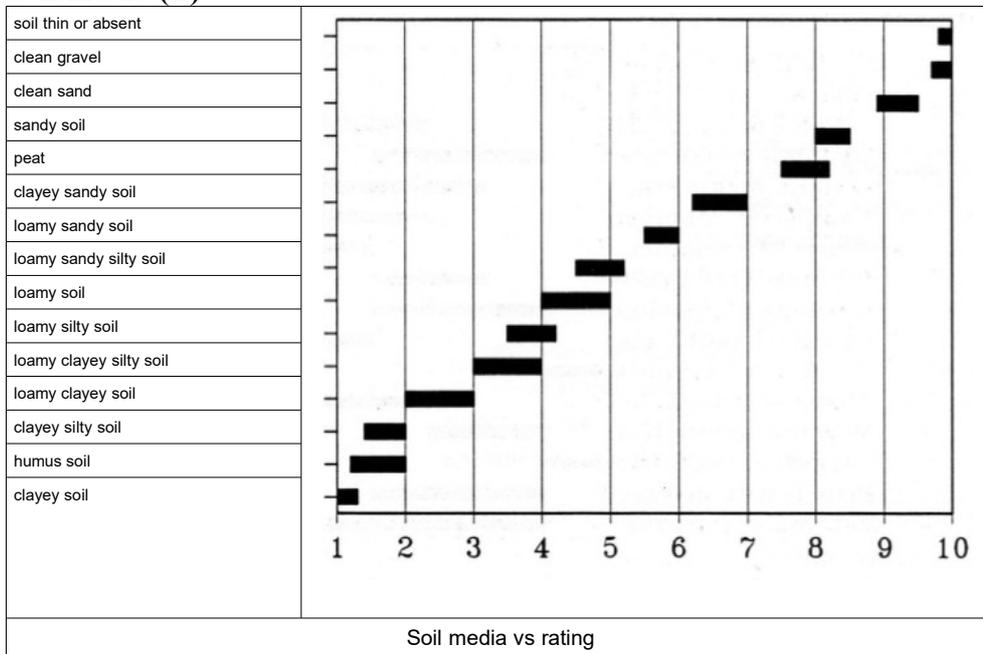
P = partial rating;

h = thickness of the layer.

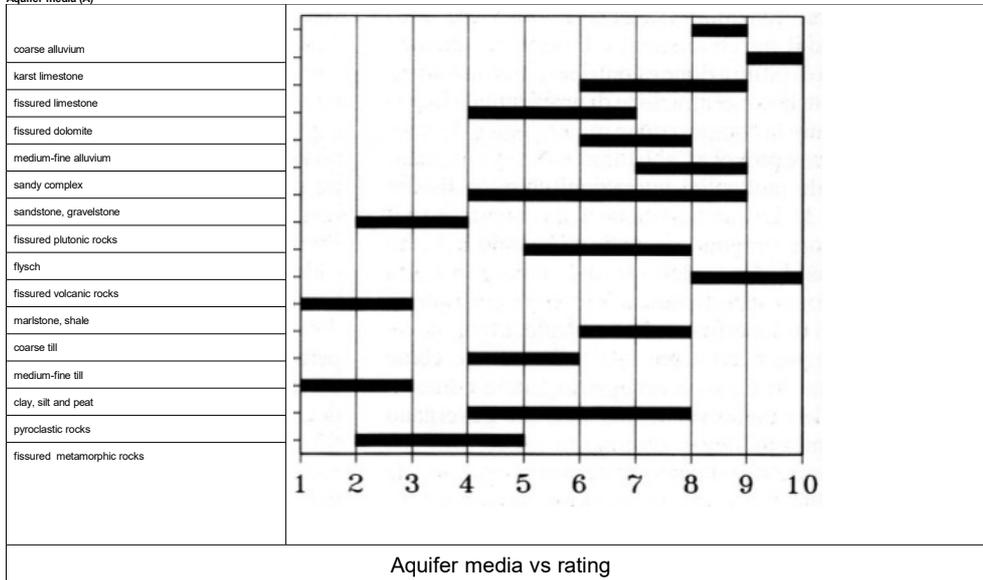
In case of confined aquifer, the rating relative to the Impact of vadose zone has to be imposed equal to 1.

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Soil media (T)

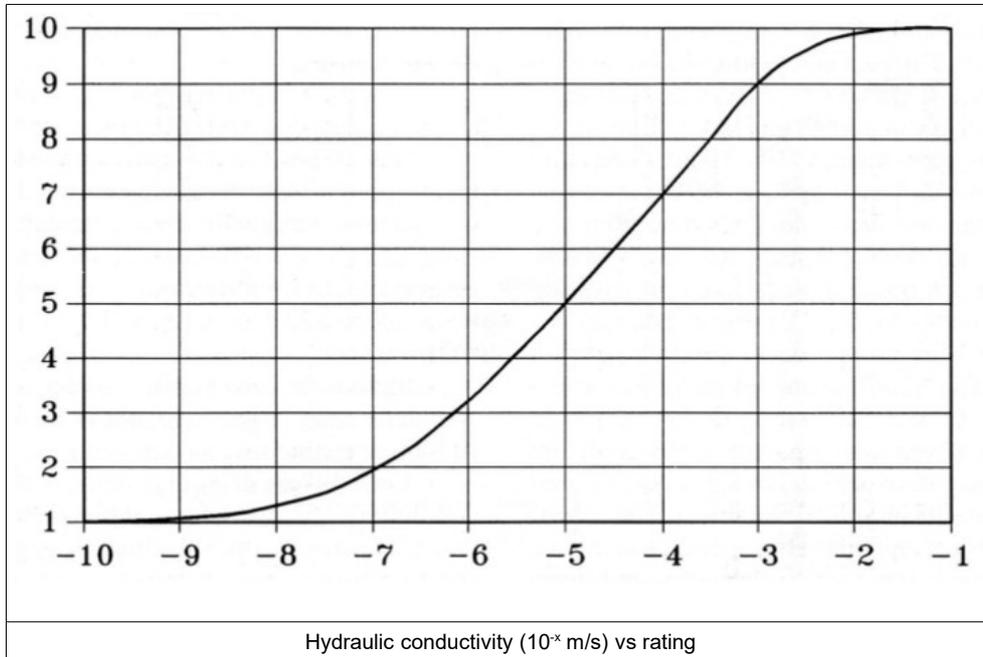


Aquifer media (A)

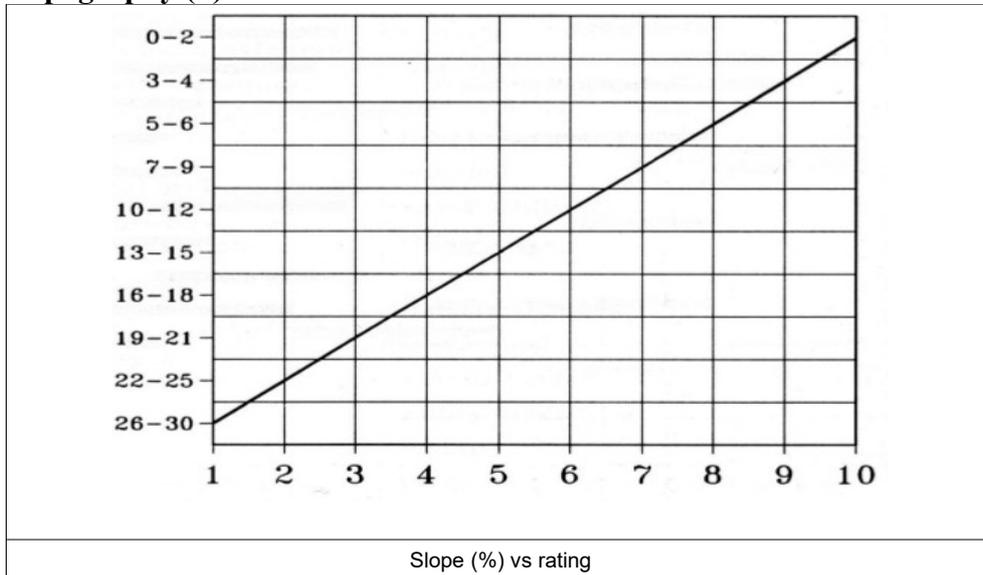


Hydraulic conductivity (C)

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Topography (S)



Weights.

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The method considers several sets of weights. The difference between normal and significant impacts concerns the land use (normal or intensive).

Parameters	Normal impact	Significant impact	Drainage from surface water body	Karts	Fissured rocks
S	5	5	4	2	3
I	4	5	4	5	3
N	5	4	4	1	3
T	4	5	2	3	4
A	3	3	5	5	4
C	3	2	5	5	5
S	2	2	2	5	4

The SINTACS Index is computed using the following expression:

$$I = S_r \times S_w + I_r \times I_w + N_r \times N_w + T_r \times T_w + A_r \times A_w + C_r \times C_w + S_r \times S_w$$

where:

r = rating;

w = weight

S, I, N, T, A, C and S = SINTACS parameters.

The vulnerability degree of the aquifer is given by the following scheme.

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