

Groundwater Vulnerability Analysis of Tirnavos Basin, Central Greece: An Application of RIVA Method

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Table S1. Correlation between annual precipitation (mm/y), P values and vulnerability classes.

P (mm/y)	P Value	Vulnerability Class	Vulnerability Characterization
<200 or >1600	0	I	Very Low (VL)
200–400 or 1400–1600	1	II	Low (L)
400–600 or 1200–1400	2.5	III	Medium (M)
600–800 or 1000–1200	3.5	IV	High (H)
800–1000	5	V	Very High (VH)

Table S2. Correlation between rainfall intensity (mm/d), In values and vulnerability classes.

Rain intensity (mm/day)	In Value	Vulnerability class	Vulnerability Characterization
<5	0.0	I	Very Low (VL)
5–10	0.4	II	Low (L)
>10–15	1.0	III	Medium (M)
>15–20	1.4	IV	High (H)
>20	2.0	V	Very High (VH)

Table S3. Correlation between irrigation dose, In values and vulnerability class.

Irrigation dose	In Values	Vulnerability Class	Vulnerability Characterization
Non irrigated area or deficiently irrigated (lower than suggested)	0	I – II	Very Low (VL) – Low (L)
Nominal irrigation (suggested according to local experts or agronomists)	1	III	Medium (M)
Excessive irrigation (greater than suggested)	3	IV – V	High (H) – Very High (VH)

Table S4. Classification of topographic slope (s) and correlation with vulnerability classes.

Topographic Slope	Vulnerability Classes	s Values
$\leq 3^\circ$	V	10
$>3^\circ$ – 6°	IV	7
$>6^\circ$ – 12°	III	5
$>12^\circ$ – 25°	II	2
$> 25^\circ$	I	0

Table S5. Categorization of vegetation according to CORINE land use classification (EEA, 2020).

Vegetation	CORINE Category
Low vegetation	2.1 Arable land
	2.2 Permanent crops
	2.3 Pastures
	2.4 Heterogeneous agricultural areas
	3.2 Scrub and/or herbaceous vegetation associations
High vegetation	3.1 Forests
Bare land or sparse vegetation	3.3 Open areas with little or no vegetation

Table S6. Calculation of F values according to soil (s) and vegetation (v) parameters and link with vulnerability classes.

		Slope (s)				
		≤3°	3°–6°	> 6°–12°	> 12°–25°	>25°
Vegetation	High vegetation	5 (V)	5 (V)	5 (V)	3.5 (IV)	2.5 (III)
	Low vegetation	5 (V)	5 (V)	3.5 (IV)	2.5 (III)	1 (II)
	Bare land or sparse vegetation	5 (V)	3.5 (IV)	2.5 (III)	1 (II)	0 (I)

Table S7. Calculation of S values for the soils and correlation with the vulnerability class (USDA, 1999).

Soil type	Texture	Permeability	Vulnerability Class	S Value
A1	Sand	Very High	V	5
A2	Loamy sand, sandy loam	High	IV	3.5
B	Silt loam, loam, silt	Medium	III	2.5
C	Sandy clay loam	Low	II	1
D	Clay loam, silty clay loam, sandy clay, silty clay, clay	Very low	I	0

Table S8. Calculation of S values for consolidated geological formations and correlation with permeability and the vulnerability class (Lewis et al., 2006).

Geological Formation	Affecting Factor ¹	Intensity of Affecting Factor ²	Permeability	S Value	Vulnerability Class
Limestone	a–b	(VL–L, M, H–VH)	(L, M, H)	(2.5, 3.5, 5)	(III, IV, V)
Sandstone	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5, 3.5)	(II, III, IV)
Mudstone/shale	b	(VL–L, M, H–VH)	(L, M, H)	(0, 1)	(I, II)
Granite	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5)	(II, III)
Gneiss	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5)	(II, III)
Dolostone	a–b	(VL–L, M, H–VH)	(L, M, H)	(2.5, 3.5, 5)	(III, IV, V)
Schist	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5)	(II, III)
Marble	a–b	(VL–L, M, H–VH)	(VL, L, M, H)	(1, 2.5, 3.5, 5)	(II, III, IV, V)
Basalt	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5, 3.5)	(II, III, IV)
Ophiolite	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5, 3.5)	(II, III, IV)
Marl	b	(VL–L, M, H–VH)	(L, M, H)	(1, 2.5)	(II, III)
All	c	(VL–L, M, H–VH)			

¹ Indicative but not limited to (a) karstification, (b) fracturing, (c) intercalations with low permeability horizons. ² V.L.: very low, L: low, M: medium, H: high, V.H.: very high

Table S9. Classification of layer reference values (ly) for representative geological formations.

Layer reference Value (ly)	Geological Formation
5000	Claystone, siltstone, mudstone, shale, slate
1000	Marl, granite, gneiss, schist, basalt, ophiolite, flysch, sandstone, marble, quartzite
500	Alluvial deposits with high clayey content, marly limestones
100	Limestone, dolostone, conglomerates, breccias, turf and other organic rich formations, alluvial deposits with average clayey content, volcanic tuffs
10	Sand
1	Gravel, colluvium, debris, weathered zones, crust, mylonitized formations

Table S10. “f” factor values according to the assessed fracturing or karstification degree.

Fracturing or Karstification Degree	f
Negligible or none or N/A	1
Low	0.5
Medium	0.1
High	0.01

Table S11. Protective cover (pc) values and corresponding vulnerability characterization and V factor values.

pc Value	V Factor	Vulnerability Class	Vulnerability Characterization
<250	10	V	Very High (VH)
250–1000	7	IV	High (H)
1000–5000	5	III	Medium (M)
5000–15,000	2	II	Low (L)
>15,000	0	I	Very low (VL)

Table S12. The suggested link between hydraulic conductivity and A factor values, corresponding to specific vulnerability class.

Hydraulic Conductivity (cm/s)	A Values	Vulnerability Class
$<10^{-7}$	0	I
10^{-7} – 10^{-5}	2	II
$>10^{-57}$ – 10^{-3}	5	III
$>10^{-37}$ – 10^{-1}	7	IV
$>10^{-1}$	10	V