

# Dynamic Erosion Model and Monitoring System (DEMIS) at the National Scale in Turkey

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Soil erosion is one of the most important means that threatens the sustainable use of soil resources in the catchments of Turkey (FAO and ITPS, 2015). Also, varying with climate, soil, topography and land cover and management, sediment amounts transported into water reservoirs by different erosion processes cause harmful consequences for energy and agricultural water use in the semi-arid ecosystems of Anatolia in Turkey. Therefore, a nationwide evaluation of erosion risk became a pressing priority for natural resource managers and soil erosion scientists to have to contain this threat, and a RUSLE model based project was initiated by the General Directorate of Combating Desertification and Erosion (ÇEM) under the Ministry of Agriculture and Forestry (MAF).

# Dynamic Erosion Model and Monitoring System (DEMIS) at the National Scale in Turkey

$$A = R \times K \times LS \times C \times P$$

A = Average Annual Soil Loss (tonne/hectare/year)

R = Rainfall-Runoff Erosivity Factor

LS = Slope Length and Steepness Factor

K = Soil Erodibility Factor

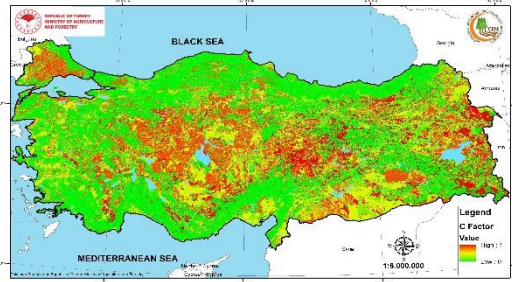
C = Cover Management Factor

P = Support Practice Factor

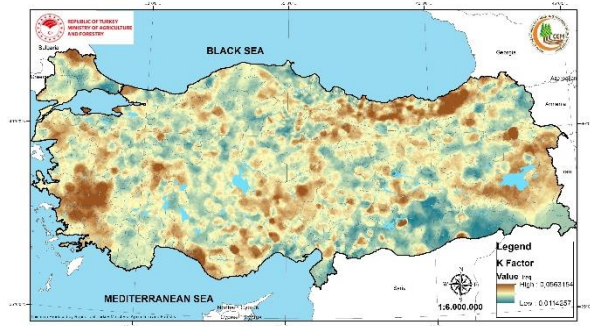
**RUSLE**

(Revised Universal Soil Loss  
Equation)

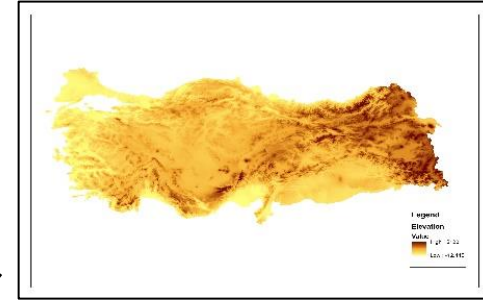
$$A = R \times K \times LS \times C \times P$$



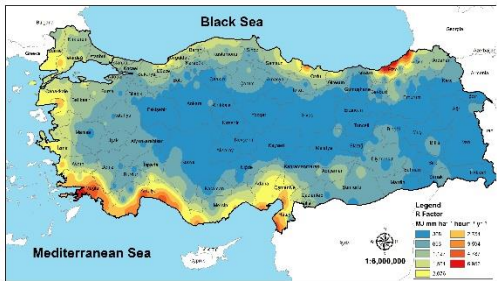
**C = Cover Management Factor**



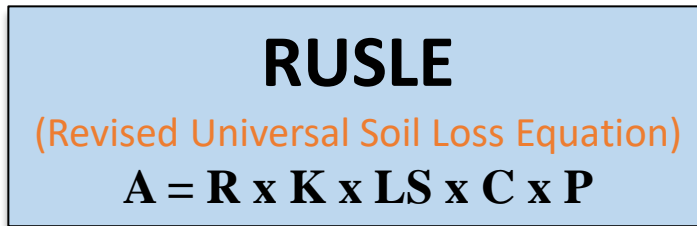
**K = Soil Erodibility Factor**



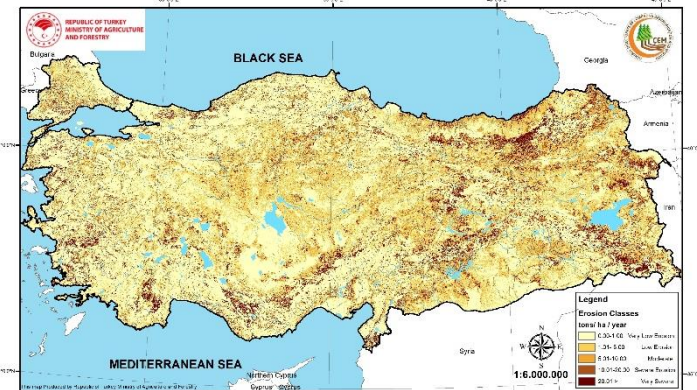
**LS = Slope Length and Steepness Factor**



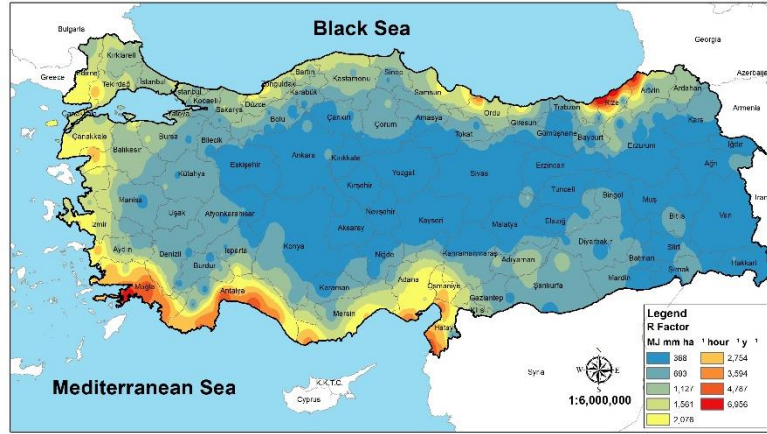
**R = Rainfall-Runoff Erosivity Factor**



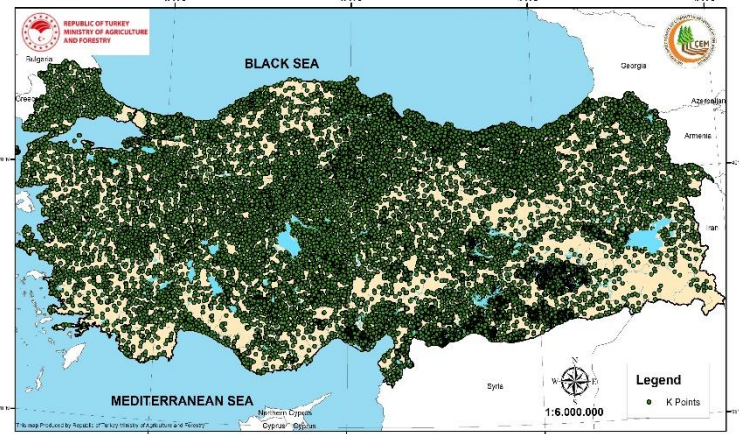
**P = Support Practice Factor**



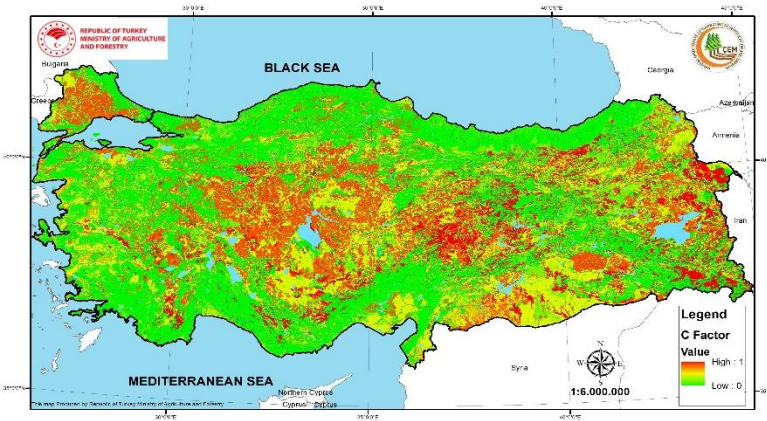
**A = Average Annual Soil Loss (tonne / hectare / year)**



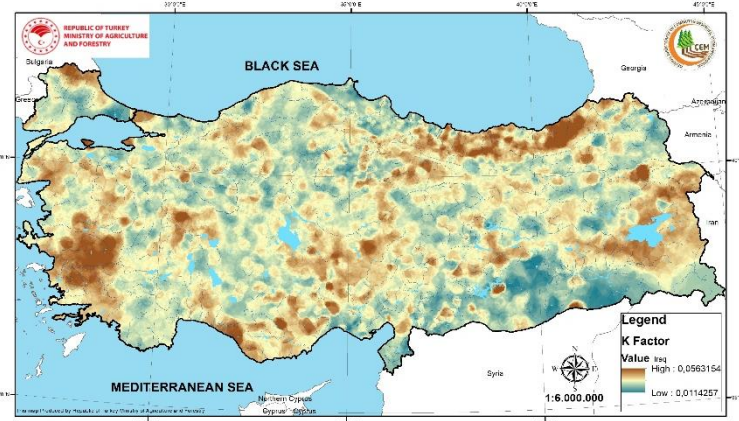
R Factor Map



K Factor Points



C Factor Map



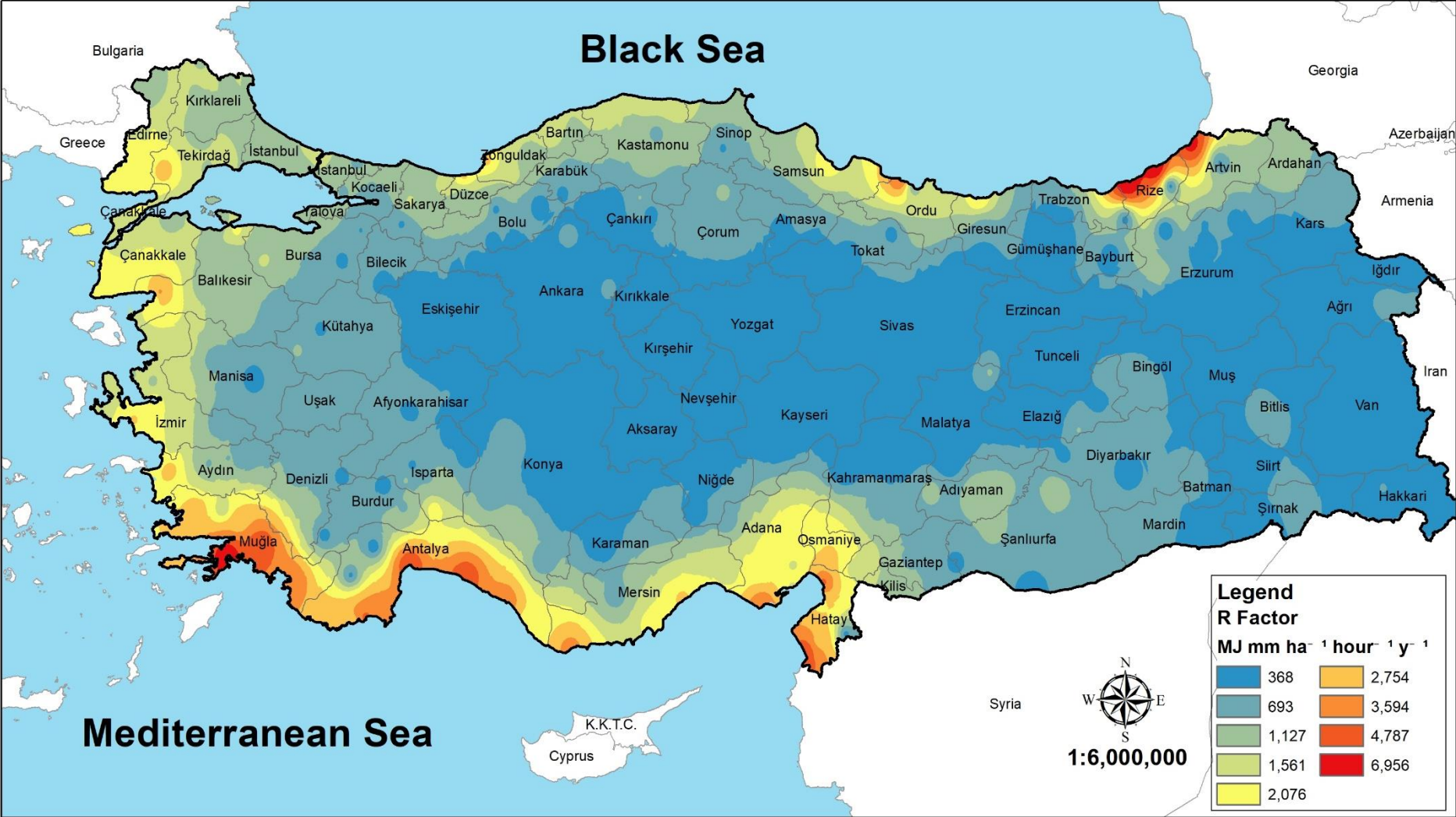
K Factor Map



## Rainfall-Runoff Erosivity Factor (RUSLE-R)

DEMIS uses an existing map of R-factor of Turkey, which is layered by using 357 minute-data of the Automatic Meteorological Observation Station and calculated as a result of the annual total energy of rainstorm ( $E$ ,  $\text{MJ ha}^{-1}\text{y}^{-1}$ ) and the maximum 30-min intensity ( $I_{30}$ ,  $\text{mm h}^{-1}$ ) ( $E \times I_{30}$ ) (Wischmeier and Smith 1978; Foster et al. 1981; Renard et al. 1997; Erpul et. al., 2016; Panagos et. al., 2017)

# Rainfall-Runoff Erosivity Factor (RUSLE-R)

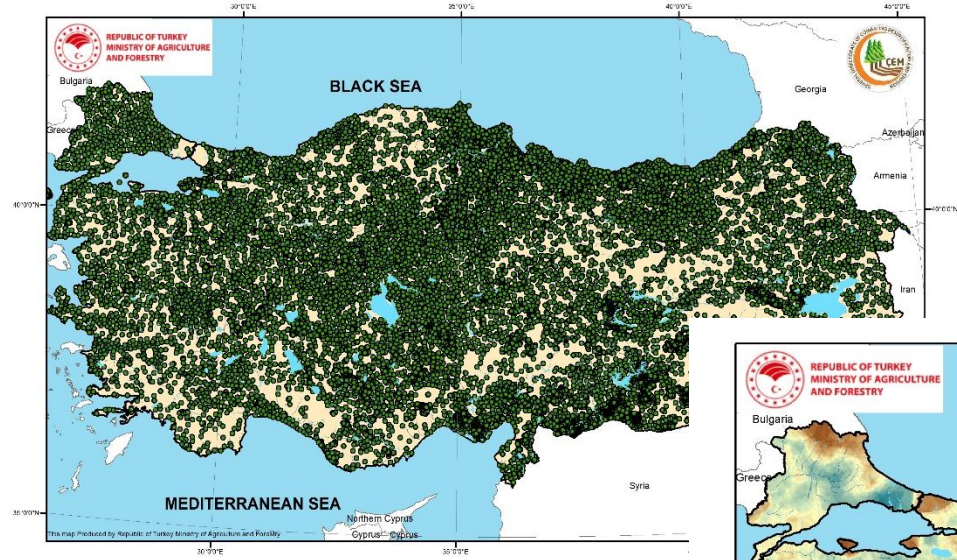


## **Soil Erodibility Factor (RUSLE-K)**

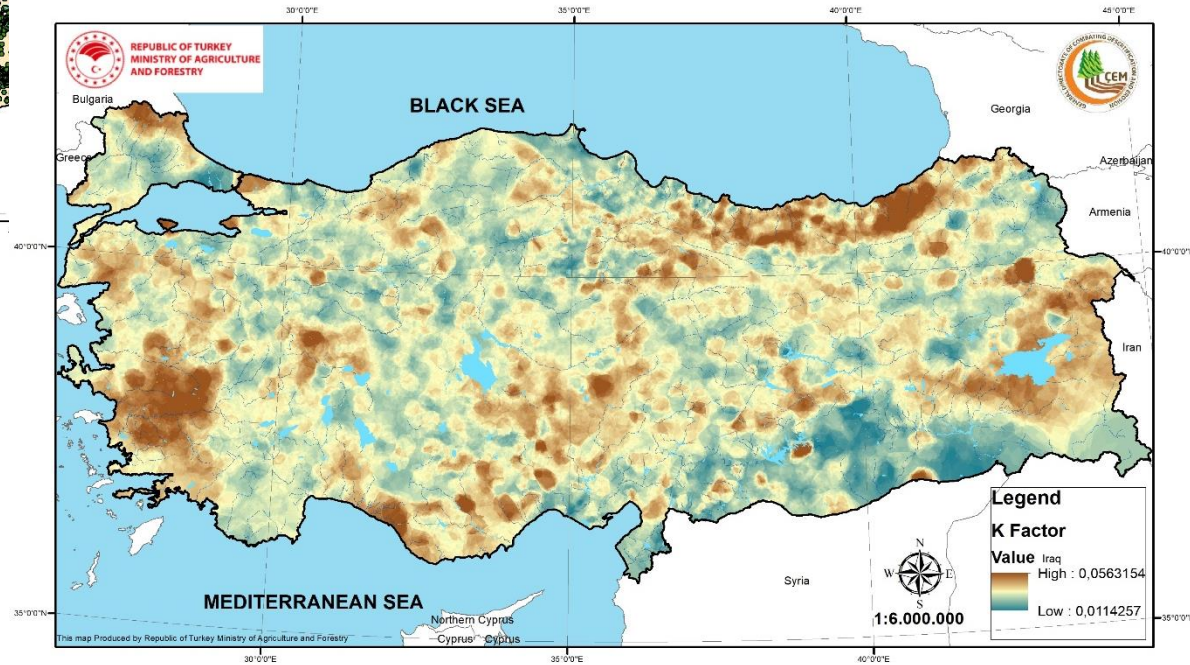
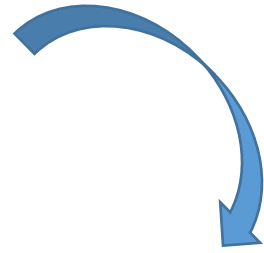
DEMIS computes soil erodibility factor from 23 thousands of geo-referenced soil samples distributed over Turkey. Dependent upon presence of germane soil parameters required to estimate erodibility, the equations of nomograph (Wischmeier et al., 1971), Torri et al. ((1997, 2002) and Römken et a. (1986, 1997) were utilized to assess K factor after regression analyses to express best possible relations among three different K values.



# Soil Erodibility Factor (RUSLE-K)



K Factor Points



K Factor Map

## Slope Length and Steepness Factor (RUSLE-LS)

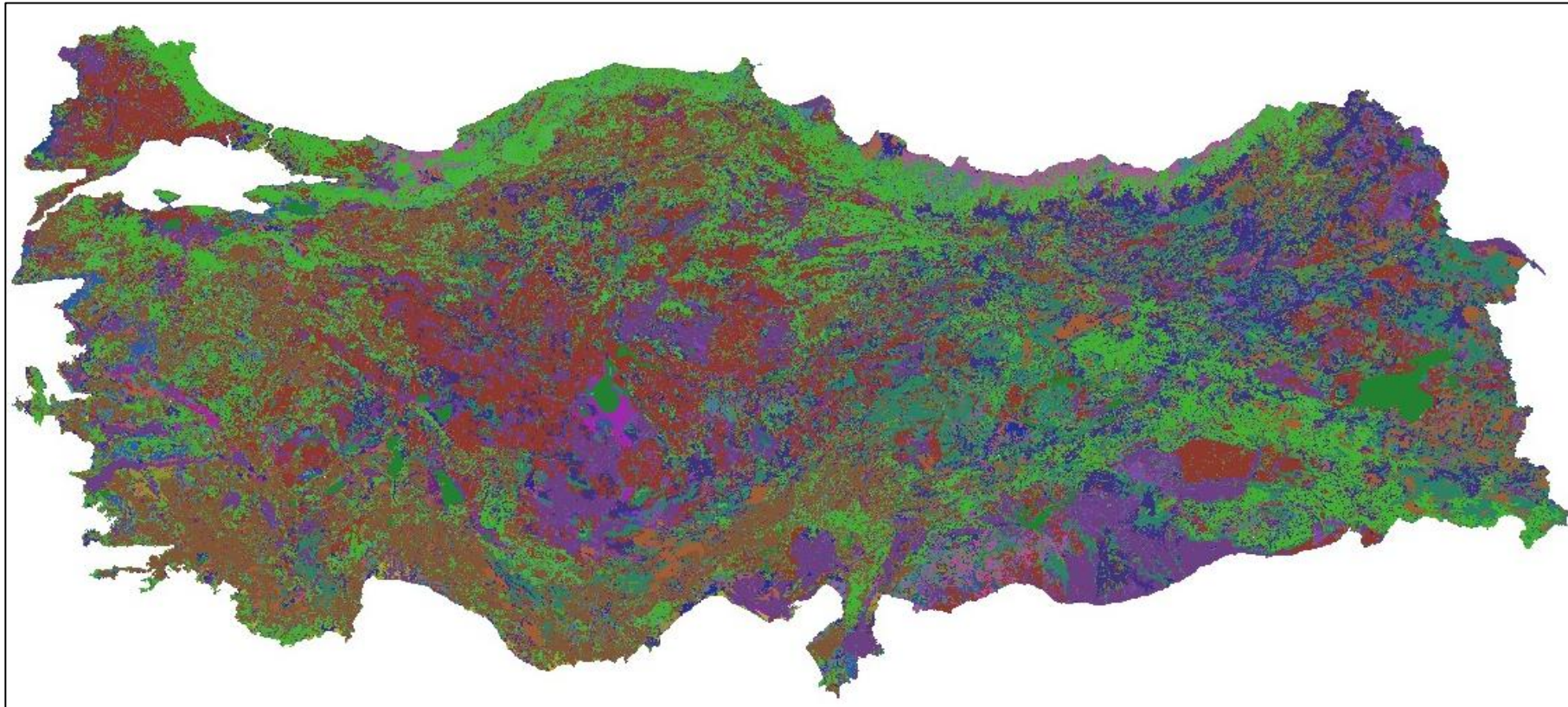
The topographic factor of DEMIS is interactively calculated by slope length factor (L) and steepness factor (S) along with flow accumulation (Moore and Bruch 1986a, b; Ogawa et al. 1997) (Eq. 2).

$$LS = \left( \frac{x\eta}{22,13} \right)^{0,4} \left( \frac{\sin \theta}{0,0896} \right)^{1,3} \quad [2]$$

Where  $\chi$  is the flow accumulation and is obtained from DEM using a GIS accumulation algorithm, which employs the watershed delineation tool of Arc view 10.2 (Lee, 2004),  $\eta$  is the cell size, and  $\theta$  is the slope steepness in degrees.

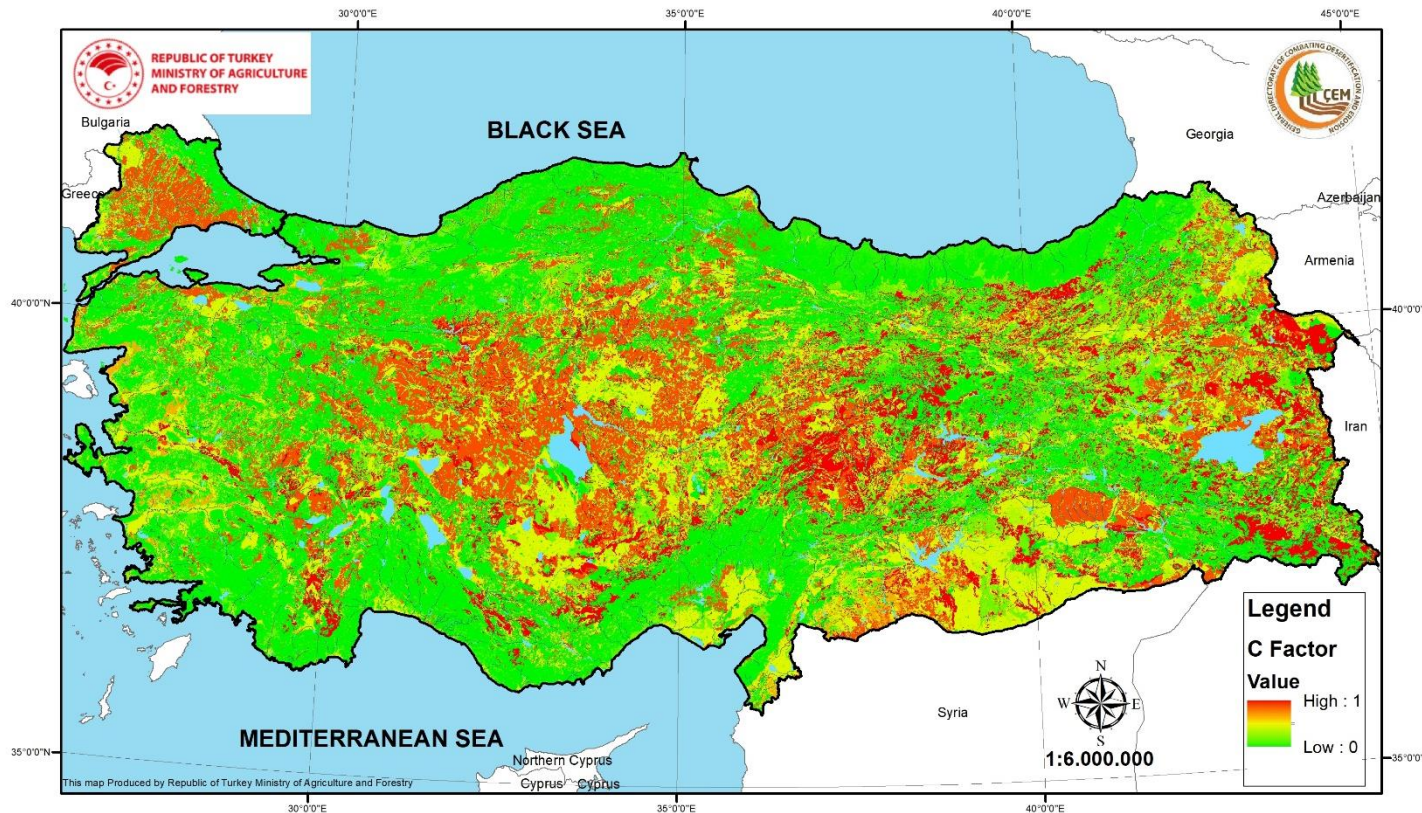
## LULC (Land Use/Cover) Map and Classes

DEMIS consumes 44 classes of CORINE land cover (CORINE 2012) as a base map for the RUSLE-C together with correspondent values determined by Panagos et al. (2015). Furthermore, additional adaptive corrections were performed combinatorially using the National Forest Map of Turkey given semi-arid specificities of forest types and vegetative covers.



# Cover Management Factor (RUSLE-C)

RUSLE-C is obtained by Combination of National Forest Map and CORINE 2012. C factor values were taken for each class from Panagos et al. (2015) and values are adapted to land and climatic conditions of Turkey.

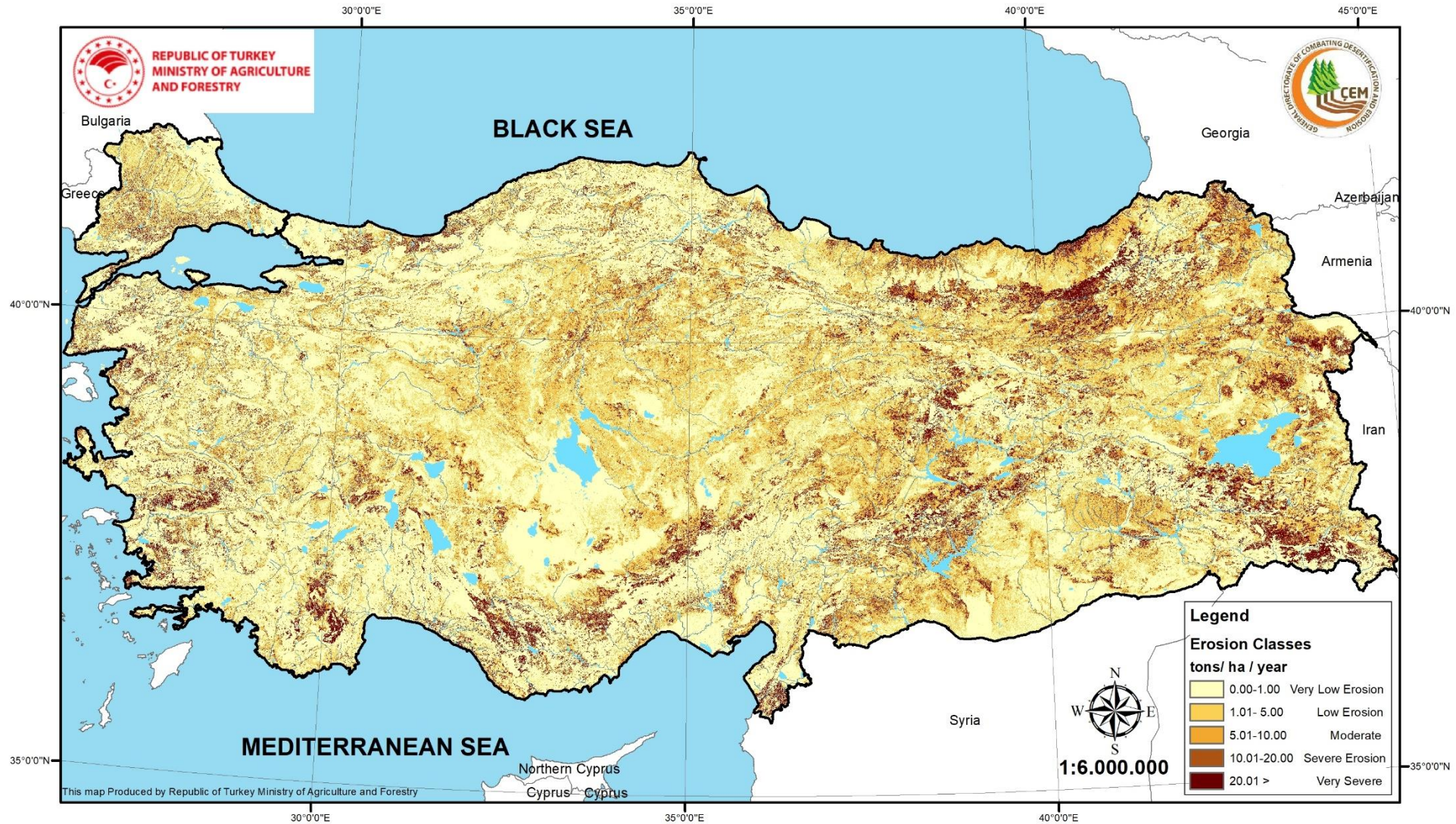


# Results and Discussion

	Soil Loss (%)					Amount of Erosion	Erosion in Grassland Areas	Erosion in Forest	Erosion in Agricultural Areas	Erosion in Other Areas
	0 - 1	1 - 5	5 - 10	10 - 20	20 - +					
Basin Name	Very Low	Low	Moderate	Severe	Very Severe	tone year <sup>-1</sup>	tone year <sup>-1</sup>	tone year <sup>-1</sup>	tone year <sup>-1</sup>	tone year <sup>-1</sup>
Akarçay	60,58	20,95	8,58	5,22	4,67	4.803.394,68	2.942.856,75	124.601,12	1.618.646,32	117.290,49
Antalya	75,39	11,58	4,08	3,33	5,61	15.373.556,15	7.477.986,04	1.377.224,64	6.004.857,62	513.487,85
Aras	41,15	28,03	12,11	9,13	9,58	29.456.085,13	22.172.090,87	96.944,12	6.902.238,86	284.811,28
Asi	65,03	12,95	5,14	5,39	11,49	10.800.877,22	1.629.480,14	508.110,55	8.457.453,27	205.833,26
Batı Akdeniz	67,50	16,26	3,79	3,36	9,10	28.721.544,25	11.111.828,06	1.749.919,22	9.263.244,73	6.596.552,24
Batı Karadeniz	76,41	9,26	4,98	4,91	4,44	15.151.093,02	1.404.945,89	1.960.229,64	11.414.555,68	371.361,81
Burdur	70,12	15,19	5,89	3,97	4,83	3.644.525,70	2.156.494,65	223.751,97	1.203.910,01	60.369,07
Büyük Menderes	69,29	12,03	5,91	5,10	7,66	25.437.415,87	5.411.148,72	1.194.831,04	16.905.950,49	1.925.485,62
Ceyhan	60,86	18,27	7,85	6,76	6,26	15.429.686,09	6.716.129,21	800.240,95	7.631.105,98	282.209,95
Çoruh	43,57	18,19	9,64	8,84	19,75	52.848.848,78	45.180.341,26	872.526,46	6.402.981,79	392.999,27
Dicle-Fırat	52,75	22,37	9,56	6,98	8,34	159.832.719,65	121.178.327,61	3.331.647,99	32.938.556,44	2.384.187,61
Doğu Akdeniz	67,54	9,57	4,73	5,47	12,69	33.237.078,42	20.393.209,54	1.280.821,83	10.602.448,75	960.598,30
Doğu Karadeniz	42,01	25,66	12,75	10,15	9,42	26.517.468,22	12.761.467,04	1.923.627,55	11.827.101,39	5.272,24
Gediz	69,01	10,25	7,89	6,89	5,97	11.468.942,37	2.159.779,27	759.949,48	8.219.961,29	329.252,33
Kızılırmak	53,92	27,66	9,15	5,56	3,71	45.496.277,22	18.530.132,50	1.893.783,67	24.477.144,26	595.216,79
Konya Kapalı	70,86	17,43	5,23	3,24	3,23	23.211.147,68	14.616.611,82	570.592,76	7.100.886,66	923.056,44
Kuzey Ege	67,57	7,58	6,19	7,01	11,65	13.388.428,93	1.550.819,34	490.945,48	10.103.043,97	1.243.620,14
Küçük Menderes	68,17	11,02	5,42	5,80	9,60	7.576.292,14	1.530.695,79	366.066,31	5.011.660,34	667.869,70
Marmara	78,70	5,73	4,26	4,76	6,54	15.637.948,72	685.647,19	1.279.196,51	12.552.037,20	1.121.067,82
Meriç Ergene	58,38	18,40	9,41	7,68	6,13	10.337.920,51	680.343,82	292.100,90	9.092.113,68	273.362,11
Sakarya	63,02	22,67	7,54	4,39	2,38	26.524.638,92	9.156.326,71	2.044.084,88	14.576.100,21	748.127,12
Seyhan	67,98	14,30	5,83	5,14	6,74	18.174.922,94	12.415.406,76	745.757,01	4.425.382,13	588.377,04
Susurluk	72,64	11,20	7,48	5,79	2,89	10.821.938,74	888.545,87	1.306.496,82	7.985.891,62	641.004,43
Van Gölü	56,28	20,30	9,04	7,56	6,81	13.229.460,68	10.050.573,16	18.218,52	2.525.045,51	635.623,49
Yeşilirmak	58,72	21,53	9,10	5,97	4,69	25.086.331,57	11.814.405,41	1.600.355,85	11.372.018,29	299.552,02
<b>TOTAL</b>	<b>60,28</b>	<b>19,13</b>	<b>7,93</b>	<b>5,97</b>	<b>6,70</b>	<b>642.208.543,60</b>	<b>344.615.593,42</b>	<b>26.812.025,27</b>	<b>248.614.336,49</b>	<b>22.166.588,42</b>

Table 1: National statistics of DEMIS sorted out by 25 River Basins on soil erosion severity and soil loss rates (tone year<sup>-1</sup>) of different land use types

# Results and Discussion



## Conclusions

Maps of the predicted soil losses together with soil erosion risk classes at different scales ranging from small watersheds up to big river basins in Turkey have been produced by using the RUSLE methodology after a Dynamic Erosion Model and Monitoring System (DEMIS) was set up. It continuously generates temporal and spatial statistics on when and where human-induced erosion rates alarmingly threaten soil resources.

Given the fact that soil erosion is a threat causing significant loss of ecosystem services and biodiversity and critical indicator for land degradation under the changing semi-arid climate in Turkey, DEMIS as a supportive prediction tool and system would have a high potentiality and provide opportunities for decision makers and policy developers not only to minimize soil erosion aimed at by for Sustainable Soil Management (SSM) but also to ensure sustainability of land resources by hierarchically avoiding, reducing and reversing land degradation.

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