



Desertification Model of Turkey (DMT)

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The DMT is a tool used for estimating land degradation, assessing desertification vulnerability and risk, preparing watershed scale risk maps, and monitoring desertification hot spots of the country.

The DMT has been designed to consist of [48 indicators and 37 sub-indicators under seven main criteria](#) defined by an expertise group and using the analytical hierarchy process.

Percentage distribution of desertification risk among watersheds was calculated in nine classes based on the [Desertification Risk Map of Turkey](#) and revised in accordance with field surveys carried out in 2016–2017 within the scope of the DMT Verification and Calibration Project.

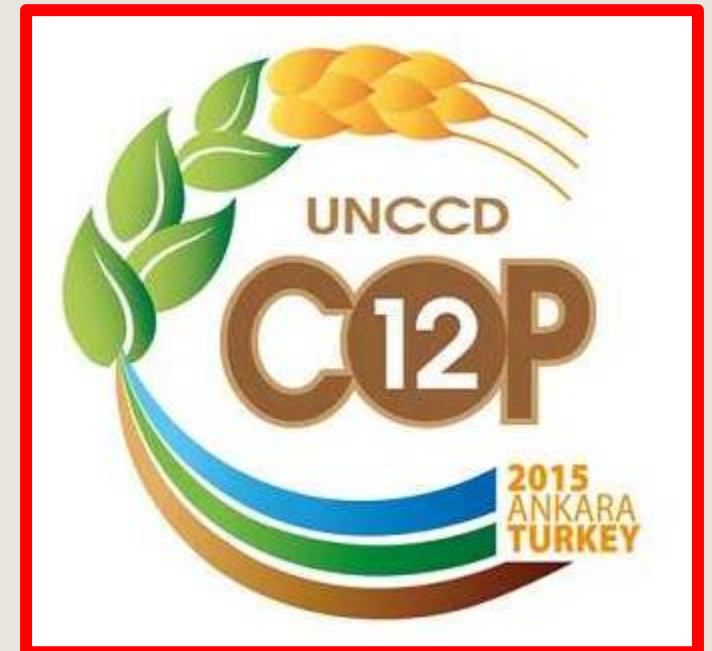


Turkey is located in the southeastern Europe and the western Mediterranean zones and benefits from a wide variety and variability of physical geographical and climatic characteristics.

As is the case with the majority of the Earth's ecosystems, land degradation is one of the most significant phenomena that exerts pressure on ecosystems in Turkey and progressively becomes more impactful on lands of arid and semiarid parts of the country.

Evaluation of land degradation vulnerability at national scale

With this fact thoroughly internalized, the Turkish Government has initiated a set of projects in order to evaluate land degradation vulnerability at national scale, having already set voluntary Land Degradation Neutrality (LDN; decision 3/12th Conference of the Parties [COP12], UNCCD, 2015a) targets to be implemented by 2030 and having launched the “[Ankara Initiative](#)” (decision COP12/29, UNCCD, 2015a) to support countries worldwide in need of assistance to formulate their LDN targets during the COP12 to the UNCCD in October 2015, Ankara, Turkey.



Land degradation neutrality

At this stage, it is of paramount importance to note that LDN is included in Sustainable Development Goal 15.3 (United Nations Sustainable Development Group, 2016) and scientifically conceptualized as a vital tool for enhancing the implementation of the UNCCD (Orr et al., 2017).

Sustainable Development Goal (SDG) target 15.3 states: “By 2030, combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods, and strive to achieve a land degradation-neutral world.”



Background

Preparation works for the Desertification Model of Turkey (DMT) not only comprised a comprehensive literature review on land degradation and desertification but also the examination and assessment of approximately 50 different models, projects, and programs within the framework of various criteria that include but are not limited to target and scope, methodology, sensitivity, required themes, data and indicators, representation level, scale, relevancy, and success rate (TÜBİTAK BİLGEM-YTE, 2015; CEM, 2017).

Mediterranean Desertification and Land Use ([MEDALUS](#)) (Kosmas et al., 1998; Kosmas, Ferrara, Briasouli, & Imeson, 1999; Kosmas, Kirkby, & Geeson, 1999; Kosmas, Poesen, & Briasouli, 1999)

Desertification Indicator System for Mediterranean Europe ([DIS4ME](#)) (Kosmas et al., 2014; Kosmas, Kirkby, & Geeson, 1999; Kosmas, Poesen, & Briasouli, 1999; Salvati, 2011).

Background

The MEDALUS project employs thematic indicators as well as environmentally sensitive areas index based on

- climate,
- soil quality,
- land use,
- vegetation cover, and
- management

to identify sensitive lands under risk of desertification.

Weighted layers produced by this model are mapped using geographical information systems (Geeson, Brandt, & Thornes, 2002).

Background

Within the scope of the DIS4ME project, approximately 150 desertification indicators for European countries were studied. These indicators were selected from countries prevalently affected by desertification, such as Portugal, Spain, Italy, and Greece.

Physical and ecological indicators consist of

- climate,
- water,
- surface runoff,
- soil,
- vegetation, and
- fire

Economic and social indicators include

- agriculture,
 - land management,
 - land use,
 - soil cultivation,
 - farming,
 - water use,
 - tourism, and
 - macroeconomic indicators
- (Desertlinks, 2004).

Criteria and indicators for Desertification Risk Model of Turkey

The DMT contains 48 indicators and 37 sub-indicators, grouped under seven main criteria (factors) identified and described by an expert group following the analytical hierarchy process (AHP) based on national features regarding land degradation and desertification.

Seven main criteria

- Climate,
- Soil,
- Water,
- Land cover and land use
- Topography and geomorphology
- Socio-economy
- Management

Criteria	Indicators	Sub-indicators
Climate	UNEP and United Nations Convention to Combat Desertification aridity index	
	Potential evapotranspiration and mean annual climatological water availability	
	Precipitation	Mean annual precipitation
		Precipitation type
	Drought	Standardized precipitation index
		Palmer drought severity index
	Rainfall variability	Interannual rainfall variability
		Rainfall seasonality index
		Precipitation intensity
	Aridity and precipitation trends	
	Interannual air temperature variability	
	Mean annual air temperature	
	Conrad's continentality index	
Wind	Wind speed	
	Number of days with gales	

Criteria	Indicators	Sub-indicators
Water	Availability of water resources	
	Aquifer condition	
	Efficient use of water	

Criteria	Indicators	Sub-indicators
Soil	Soil erosion risk	
	Soil depth	
	Soil texture	
	Soil organic matter content	
	Soil reaction (pH)	
	Soil parent material	
	Drainage	
	Salinity and alkalinity	
	Soil lime content	
	Soil pollution	

Criteria	Indicators	Sub-indicators
1. Land cover type	Vegetation cover ratio	
	Resilience	
	Resilience to drought	
	Soil erosion prevention	
2. Land use type	Agricultural lands	
	Rangelands	Rangeland grazing capacity and intensity, Rangeland quality, Biomass production of rangeland, Rangeland grazing period
	Other areas	Mines, quarries, dumping, and construction sites
		Industrial, commercial, and transportation areas
		Settlement areas, Sea waters, Wetlands in the main land, Inland waters, Wetlands originating from seas, Nonagricultural urban green spaces
	Shrub lands	Shrub use intensity
		Shrub use types
	Forest lands	Forest land-use intensity
Forest fires		

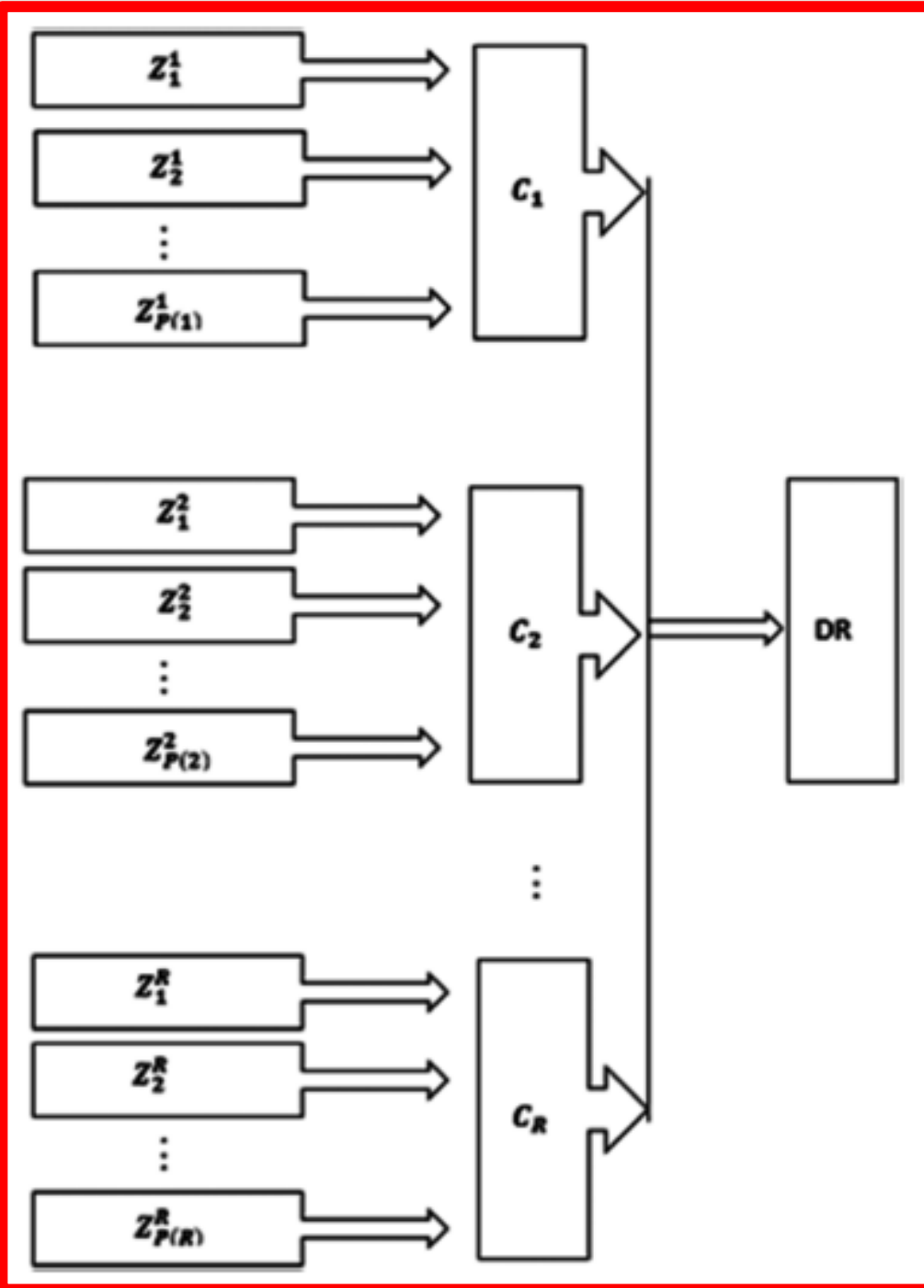
Criteria	Indicators	Sub-indicators
Topography and geomorphology	Main physiographic landform groups	
	Slope gradient	
	Slope formation	
	Slope exposure	
	Surface rocks	
	Hydrographic drainage density	

Criteria	Indicators	Sub-indicators
Socio-economy	Rural income and land distribution	
	Increasing agricultural costs–net operating income	
	Abandoned lands and invaded areas	
	Illegal employment and income levels in agriculture and forest villages	
	Public knowledge levels on desertification: education-publication services-awareness, sensitivity	
	Changes in economically significant natural species	
	Perception of civil authorities and local administrations of desertification	

Criteria	Indicators	Sub-indicators
Management	Watershed management policies	
	Rural development policies	
	National strategic plan and programs on combating desertification	
	Nationwide desertification measurement, monitoring and evaluation structures and the number of experts competent in the field of desertification	
	Policies on agricultural lands	
	Policies on rangelands	
	Policies on forest lands	
	Policies on protected sites	
	Policies on greenhouse gas emissions	
	Policies on mine-site rehabilitation	

Seven main criteria used for the desertification model in Turkey and their respective weights (TÜBİTAK BİLGEM-YTE, 2015)

No	Criteria	Weight (%)
1	Climate	35.6
2	Water	18.4
3	Soil	17.2
4	Land cover and land use	11.6
5	Topography and geomorphology	6.3
6	Socioeconomy	6.2
7	Management	4.7



Generation of desertification criteria index and risk maps

Desertification risk (DR) is calculated through linear combination of indicators and main criteria

$$DR = \sum_{r=1}^R w_r C_r \quad C_r = \sum_{p=1}^{P(r)} v_p Z_p^r$$

Where $C_r, r = 1, \dots, R$ criteria, and each criteria is represented with $Z_p^r, p = 1, \dots, P(r)$ indicators.

Category ranges and descriptions of desertification index for Turkey

Risk category	Descriptions	Class	Index value
Low	L1: Low	1	1.0–1.27
	L2: Moderate	2	1.28–1.34
	L3: High	3	1.35–1.40
Moderate	L1: Low	4	1.41–1.45
	L2: Moderate	5	1.46–1.48
	L3: High	6	1.49–1.54
High	L1: Low	7	1.55–1.60
	L2: Moderate	8	1.61–1.67
	L3: High	9	1.68–2.00

Verification and calibration approach

Verification procedure is based on testing desertification risk produced from the model against the desertification risk observed in the field. Tests include comparisons of the model and observed risks in terms of the frequency distribution, global averages, local (micro basin) averages, and the linear regression.

The first procedure is based on χ^2 testing of model and observed frequencies falling inside each risk class. The second procedure contains comparison of the averages for the model and observed risks over the whole basin, whereas the third procedure compares the averages associated with micro basins. The last procedure is to linearly regress the model risk onto the observed risk and derive a regression equation with linear correlation coefficient.

RESULTS: Desertification risk of Turkey

The country-specific DMT is envisioned and developed as a significant tool to estimate land degradation and desertification risk, generating watershed-level risk maps, and to dynamically monitor desertification and land degradation risk.

“Desertification Risk Map” of Turkey takes into account sources of specific statistical errors on a national level and is generated based on presently complete climate, soil, topography, and land cover datasets using the AHP method.

In this manner, the map entails a bio-geophysical quality.

RESULTS: Desertification risk of Turkey

Results of the Desertification Risk Map of Turkey calculations suggest that regarding desertification risk,

- 12.7% of lands in Turkey are in low risk group,
- 53.2% are in moderate, and
- 25.5% are in high risk group.

Areas classified as 'other' (2,250 m and above 'Ice Cap and Permanent Snow,' 'Rocky Structure,' and 'Sparsely Vegetated Areas') constitute 8.6% of lands in Turkey.

RESULTS: Desertification risk of Turkey

Among the nine distinct desertification risk category-level combinations combining three Desertification Risk Levels (low, moderate, and high), each divided into three more categories (low, moderate, and high), the moderate–high risk group combination, without a doubt, carries the highest level of sensitivity and vulnerability to desertification.

The percentage of lands in this risk group combination is 23.1% of all lands in Turkey.

Unless urgent and efficient measures are taken against land degradation and desertification in the lands under moderate–high risk groups, these lands will inevitably bear high desertification risk in near future.

Thank you

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