



# Agricultural Drought Strategy

## - ADS -

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# Desertification, Land Degradation and Drought

Land degradation refers to any diminishment of biodiversity and ecosystem functioning that negatively impacts the provisioning of ecosystem services and ultimately impedes poverty eradication and sustainable development.

Land degradation is caused by human activities and natural processes and is being exacerbated by the adverse impacts of climate change.

In addition to unsustainable agricultural and livestock management practices, other sectoral activities contribute to land degradation thereby reducing socio-ecological resilience and food/water security.

When degradation occurs in arid, semi-arid and dry sub-humid areas where productivity is constrained by water availability, it is called desertification.

# Background of drought in Turkey

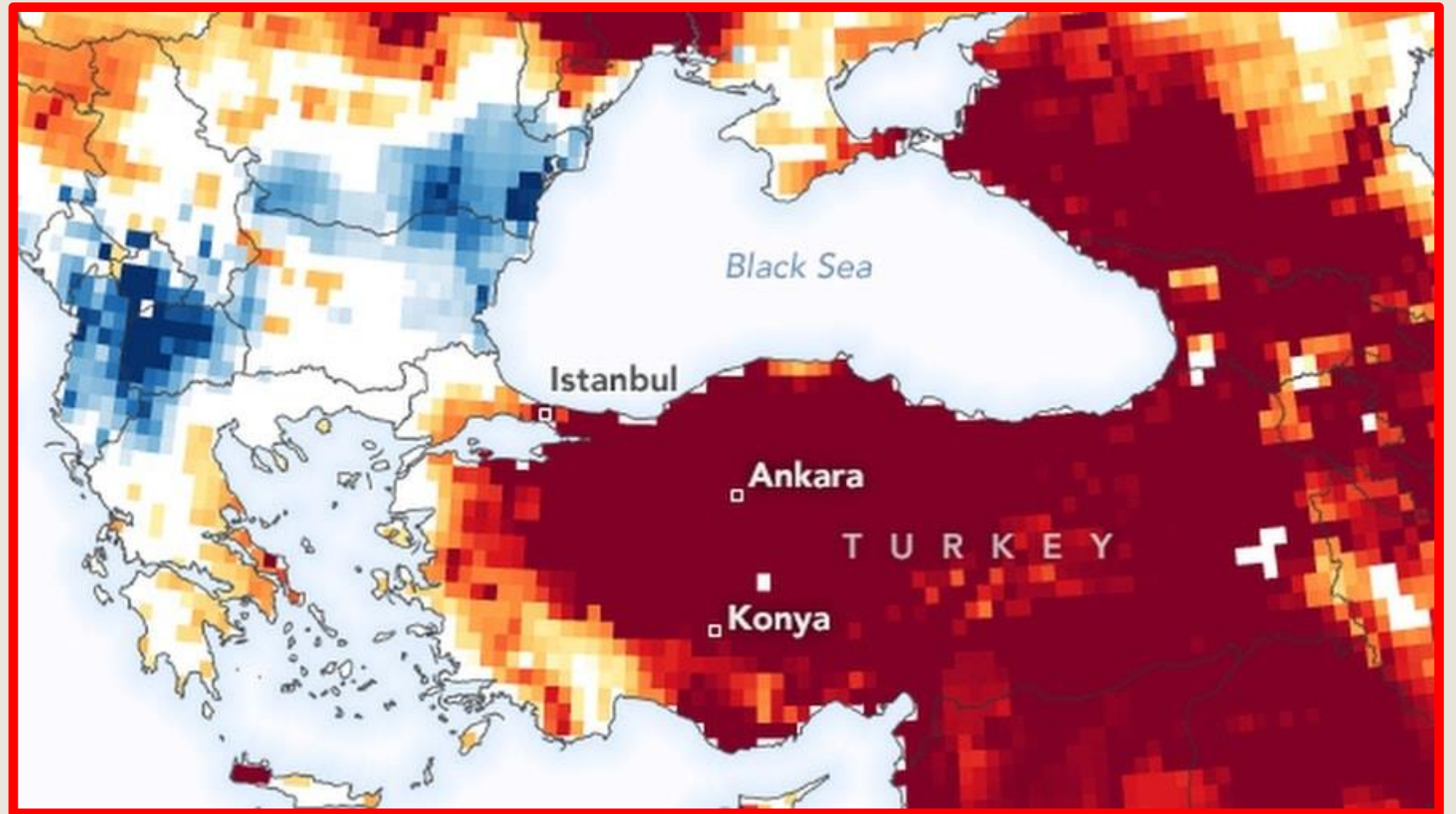
In 2012 the IPCC concluded that there is *medium confidence* that since the 1950s in particular southern Europe has experienced a trend toward more intense and longer droughts.



NASA says recent drought in Turkey and eastern Mediterranean worst in 900 years (2016)

# Background

Drought is common in Turkey, especially in the south and center of the country, with 2021 being the driest in 2 decades.



Forecasts report that drought events occur more frequently due to climate change. Most water loss is due to poor irrigation.

## Background

Sinkholes wide enough to swallow a bus dot the drought-stricken breadbasket of the Turkish plains, worrying farmers as they spread and creep closer to residential homes.

The sinkholes in Konya are scattered across the local landscape



# Drought frequency

Since Turkey is located **in the Mediterranean macroclimate region in the sub-tropical zone**, great rainfall variations can be seen between the years.

This causes regional and widespread droughts in various intensities.

Thus, drought is one of the main problems for Turkey.

On the most parts of the Central Anatolia Region along with Mediterranean which have around 650 mm of annual average rainfall, recurrence period of drought conditions is more than 1 in 4 years.

# Background of drought in Turkey

Spatial and temporal analyses of drought hazards in Turkey have not yet been completed but, for instance, intensive drought periods in 1804, 1876 and 1928 caused the loss of crops and animals and the migration of farmers to other areas.

In particular, drought in 1876 caused the loss of more than 200,000 people because of famine and disease epidemics.

Lake Akgol in eastern Turkey's Van Province on June 7. Typically home to thousands of birds, the lake dried up this summer (2021).



# Drought Symptoms

- (i) **Meteorological Drought:** the precipitation of a region below the average for a longer than normal period. Causes of the meteorological drought are high temperatures, low humidity in the atmosphere, increases in wind and evaporation, apart from the lack of precipitation.
- (ii) **Hydrological Drought:** It is defined as the decrease in surface and underground water resources due to long-term lack of precipitation. Even after the meteorological drought has ended, hydrological drought can continue to exist.
- (iii) **Agricultural Drought:** the decrease in the amount of water being used in the plant root zone in the soil and precipitation, plant water consumption and soil properties are defined as the main factors determining agricultural drought.
- (iv) **Socio-economic drought:** an approach that deals with the economic, social and environmental effects of drought in an integrated manner.



# Meteorological Drought

Under any circumstances, meteorological measurements are the first indicators of drought.

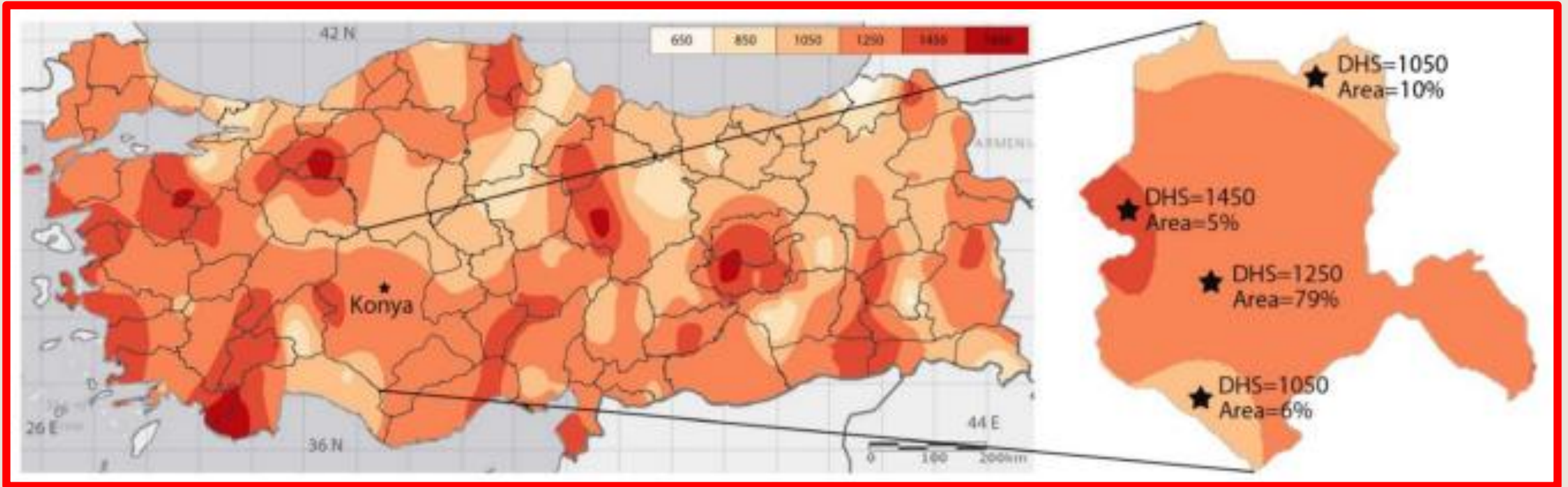
Contrary to the general perception, Turkey is not a country rich in water resources; most of the country is situated in a semi-arid region.

It is evidence-based that Turkey is exposed to effects of climate change and accordingly drought hazards rather frequently.

Water Resources	Average Annual Rainfall (mm)	Water Amount (billion m <sup>3</sup> / year)	Gross water Potential (billion m <sup>3</sup> / year)	Technically and Economically Available Water Potential (billion m <sup>3</sup> / year)
<b>Surface water</b>			193	98
domestic	646	501	186	95
overseas			7	3
<b>Groundwater</b>			41	14
<b>Total</b>				112

# Drought frequency

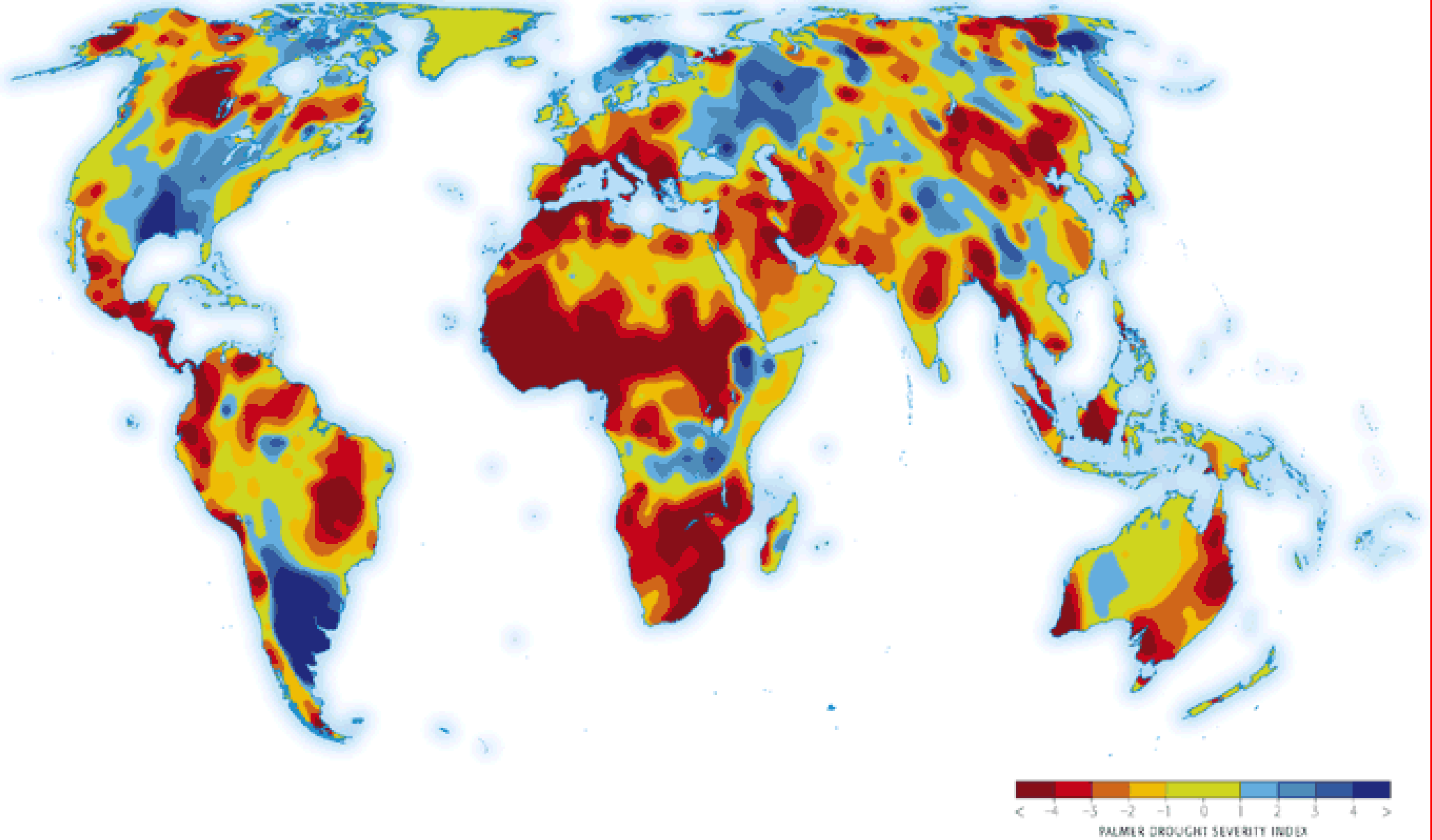
Drought Hazard Index (DHI) is derived based on the probability of drought occurrences using Standardized Precipitation Index (SPI)



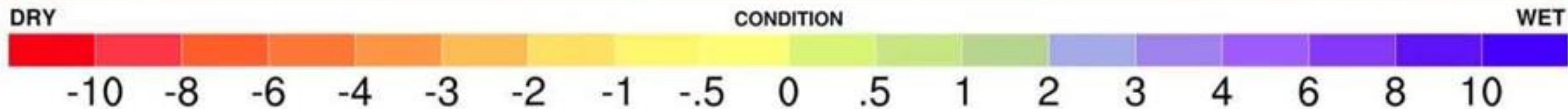
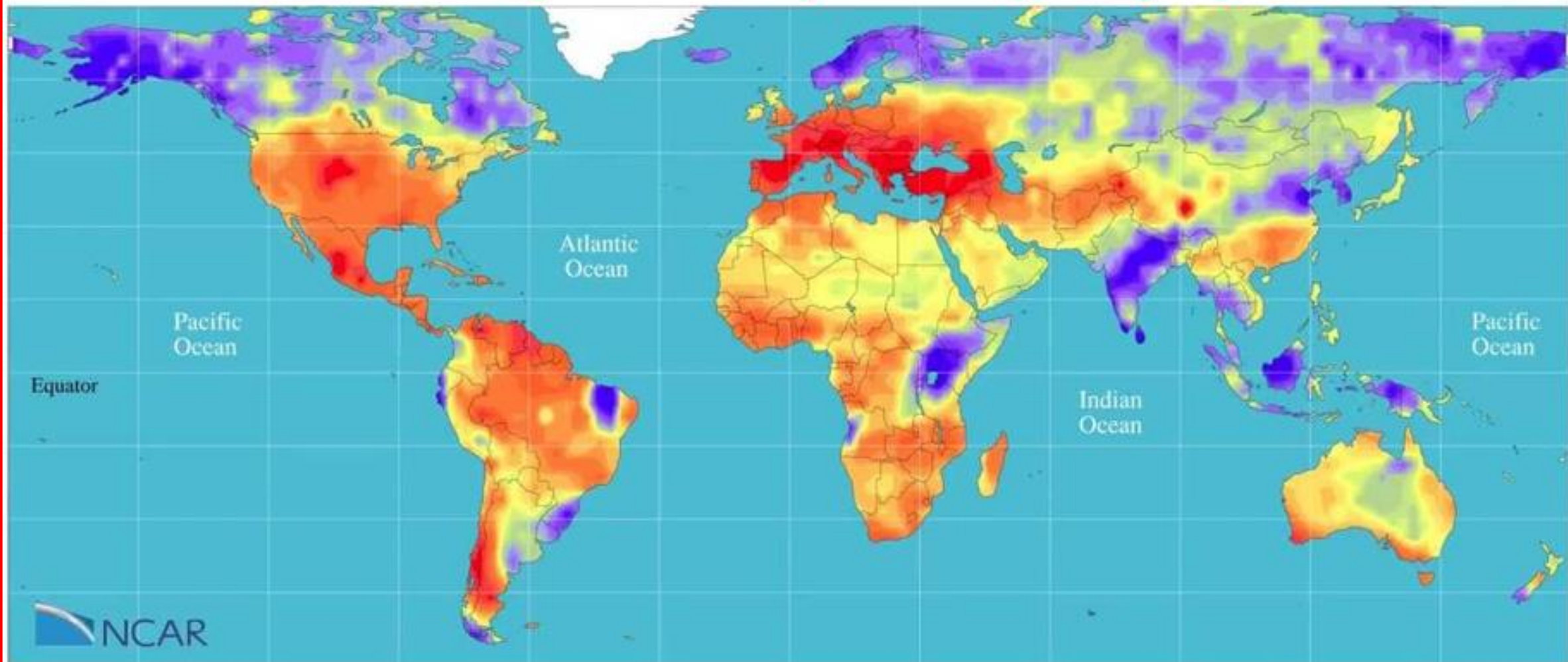
Drought hazard assessment contour maps and sample illustration DHS and corresponding areas of Konya for DHI calculation. Cumulative sum of DHS values between 1971 and 2010 can be directly related to drought hazard.

# Palmer Drought Severity Index (PDSI) by 2009

GLOBAL PATTERN OF DROUGHT, AS MEASURED BY THE PALMER DROUGHT SEVERITY INDEX



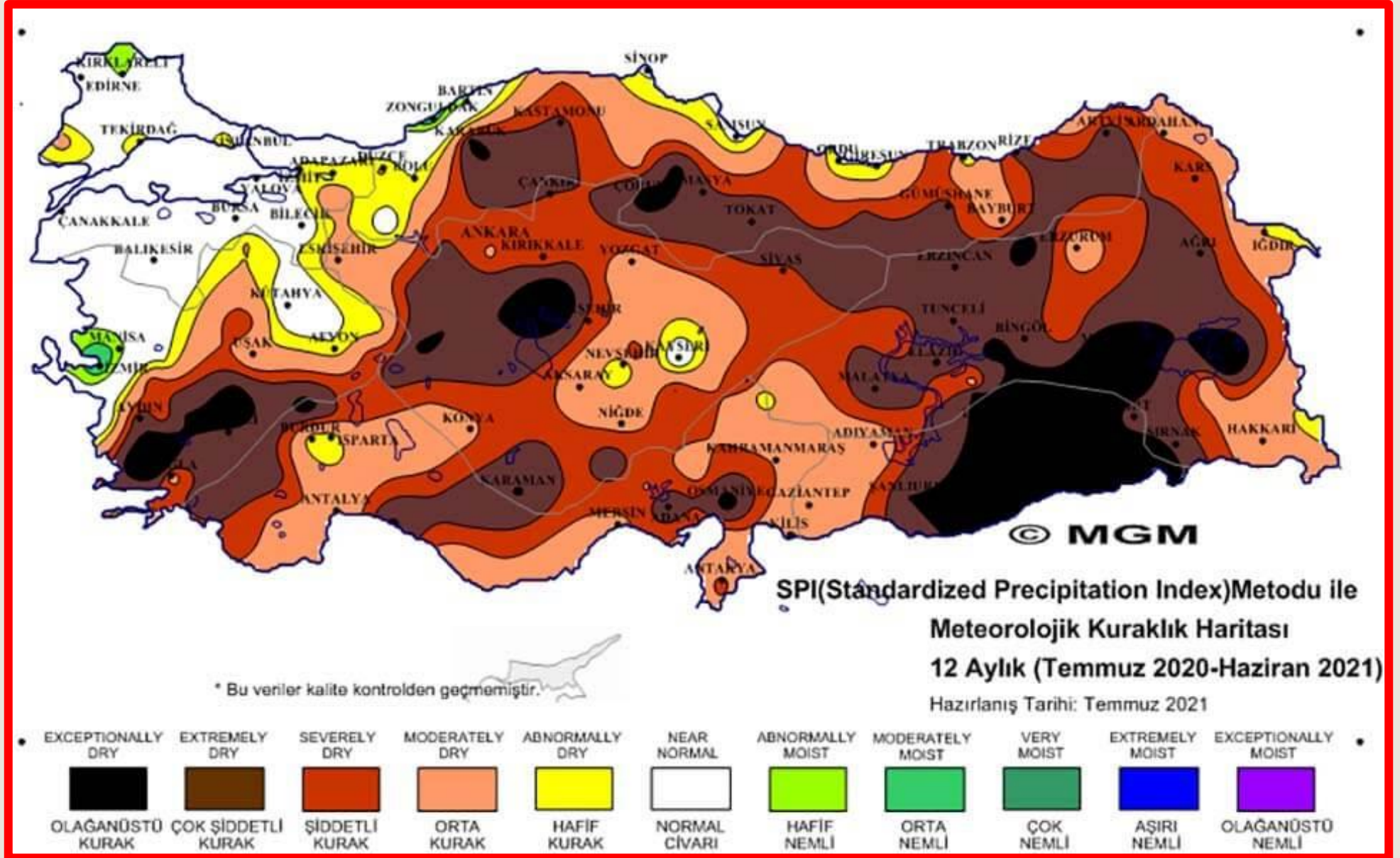
# Palmer Drought Severity Index (PDSI) by 2099



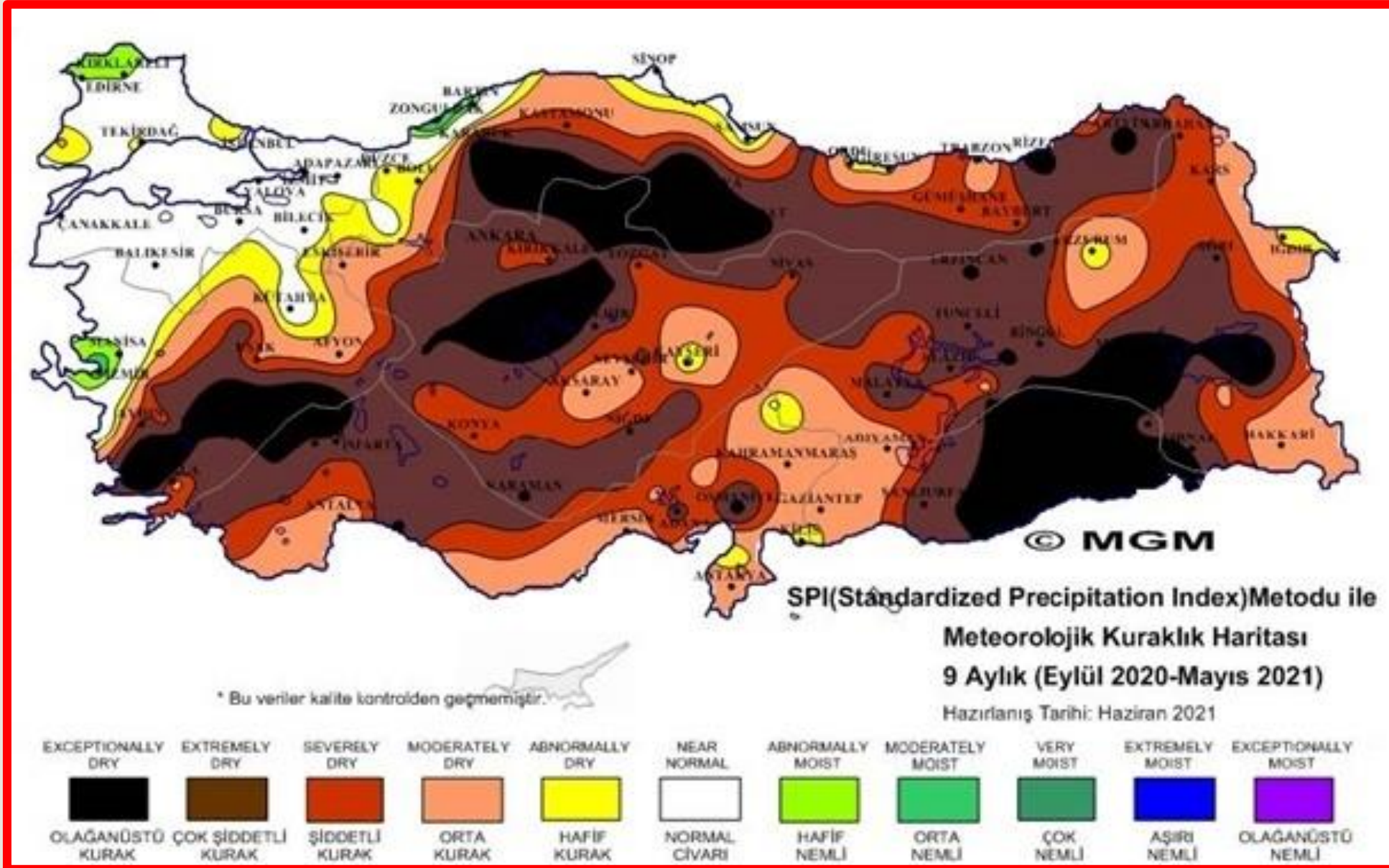
# Konya Basın

Annual precipitation below 400 mm extends over a large area of the Central Anatolia, especially over the Konya sub-region

Most vulnerable regions: Central Anatolia and Southeastern Anatolia



# Most vulnerable regions: Central Anatolia and Southeastern Anatolia



# Hydrological Drought

Hydrological drought refers to deficiencies in surface and subsurface water supplies.

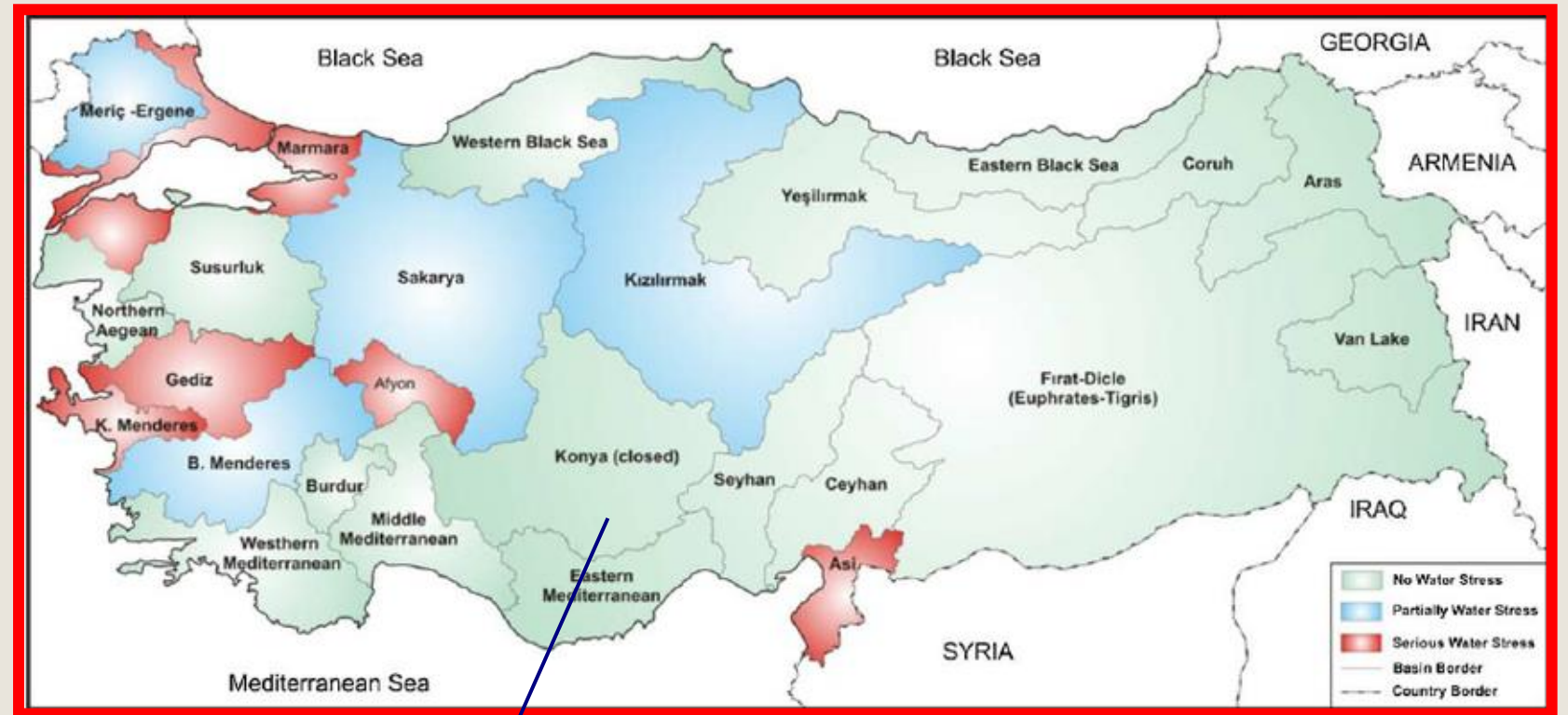
It is measured as streamflow, and as lake, reservoir and ground water levels.

There is a time lag between lack of rain and less water in streams, rivers, lakes and reservoirs, so hydrological measurements are not the earliest indicators of drought.

When precipitation is reduced or deficient over an extended period of time, this shortage will be reflected in declining surface and subsurface water levels.

# Hydrological Drought

Especially Central Anatolia and the Aegean Region suffer from drought and over exploitation of water (illegal abstraction).



**Konya Closed Basin (KCB)** is Turkey's 4th biggest basin according to precipitation area (approximately 7% of Turkey's area).



# Hydrological Drought



Moreover, in 1915, the 1930s and between 1970 and 1974, Turkey experienced serious drought hazards. Also, 1988 and 1989 were the hardest drought years for the south-eastern Anatolia Region.

The flow of the Euphrates River decreased to  $50 \text{ m}^3/\text{s}$  in these drought years.

It has been shown that river flows are decreasing according to the long-term average over most parts of Turkey.

Drought is common in Turkey, especially in the south and center of the country, with 2021 being the driest in 2 decades.[1] Drought events are forecast to occur more frequently due to climate change. Most water loss is due to poor irrigation. In 2022 the World Bank said that “without reform, a 10% fall in water supply in Türkiye could reduce GDP by 6%”.

GDP: Gross Domestic Product

## Hydrological Drought



Kızılırmak Delta January 2021

# Hydrological Drought



Besides global warming, it has been considered that low precipitation especially in the KCB (country and KCB's average precipitations are 643 mm/year and 300-350 mm/year, respectively) and unregistered wells cause excessive drawdown of groundwater.

KCB covers the main part of the Central Anatolia plateau and, has an altitude of 950-1200 m. It includes 8 cities and 39 districts. Nearly three million people live in that basin and 45% of them are in rural areas.

In Turkey's Konya Basin, a combination of drought and excessive abstraction of water for agriculture has led to the drying up of a number of lakes and wetlands.

# Hydrological Drought



After 1980's almost all groundwater levels in Central Anatolia have begun to decrease year to year.

Beside negative impacts of that dry period on the groundwater level, impacts of the unregistered (or illegal) wells in the basin are undeniable.

In Turkey, illegal groundwater extraction constitutes a severe problem especially in Central Anatolia, specifically in the KCB.

In Turkey, there are more than 200,000 wells and half of them are unregistered.

**Meke Crater Lake in Konya (before and after)**

## Most vulnerable water system: Lake Tuz

Lake Tuz has an area of 1500 km<sup>2</sup>, is very shallow and is a terminal lake. It is the second most saline lake in the world (32.9% salt), after the Dead Sea.

Due to decreasing rainfall and over use of water resources, almost half of the famous salt lake has dried out due to drought and continuous water withdrawal for irrigation.

The same conditions affect the Ereğli Marshes and Bafa Lake.

The Beyşehir Lake, the largest freshwater lake in Turkey, was 24 meters deep 25 years ago, and now reaches only up to 9 meters (2,4).

# Hydrological Drought



# Hydrological Drought



Akgöl disappeared in a period of 50 years, started in 1950 and fully dried in 2006)

# Hydrological Drought

The Ereğli Marshes with its lake, reed-beds, swamps and step lands constitute an eco-system, which is home to a large number of species. With the construction of three dams on the feeding waters of lake, the size of the wetland is continuously decreasing (actually 30 percent of its original size).

This decrease in the wetland area has affected many fish and bird species such as the Egyptian Vulture, which has disappeared from the lake region.

The project has focus on: **i)** introducing better irrigation techniques and to raise the public conscious on effective irrigation practices, **(ii)** raising local awareness on the lake's functions and values



# Edaphic droughts (of the soil, or influenced by the soil)

Pertaining to soil or to the physical, chemical, and biological properties of the soil or substratum which influence associated biota, such as pH and organic matter content.

In ecology, edaphic refers to plant communities that are distinguished by soil conditions rather than by the climate.



# Agricultural droughts

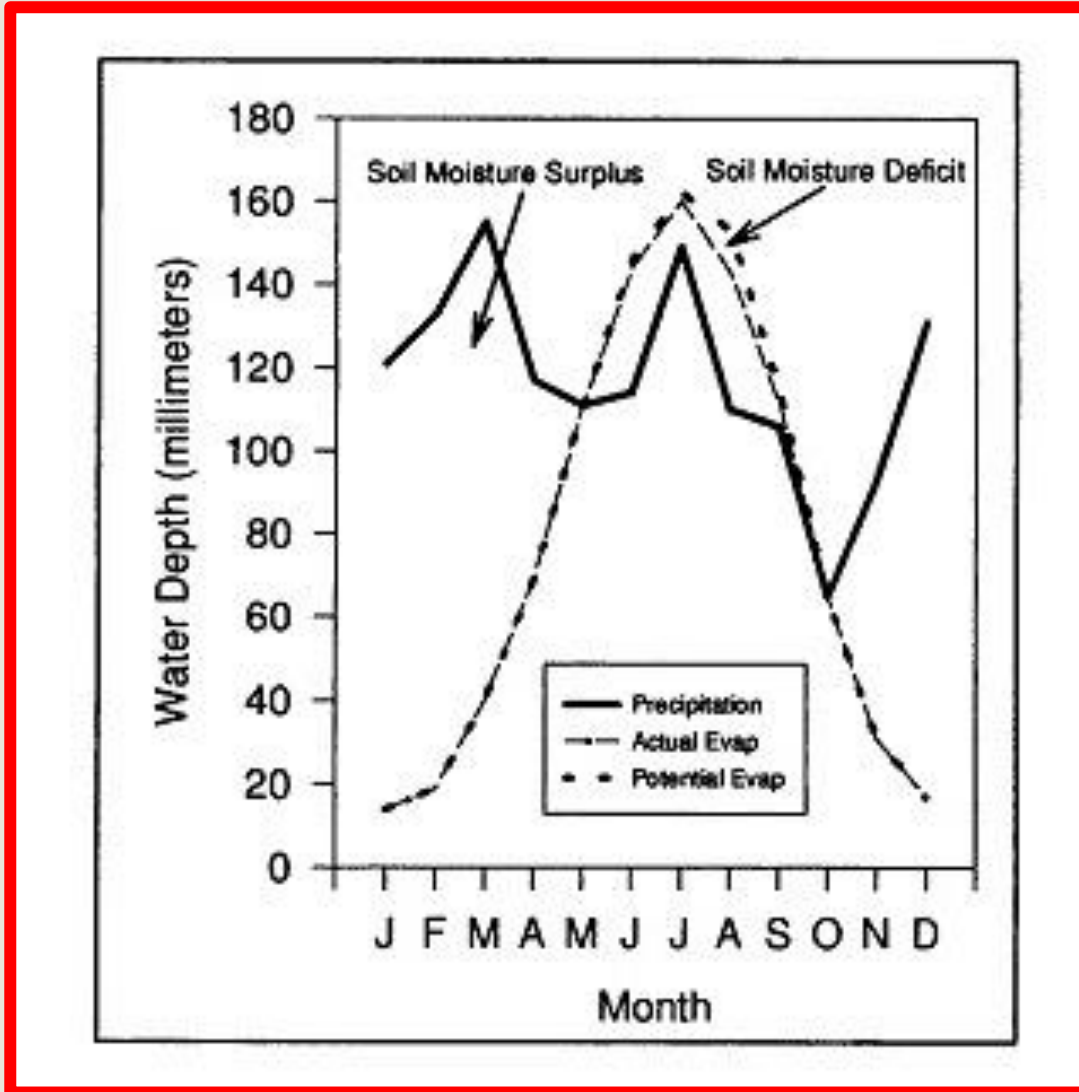
It is defined by the deficit of water versus the needs of agriculture. The last two are non-climatic droughts, caused by other than climatic factors.

Agricultural drought occurs when there isn't enough soil moisture to meet the needs of a particular crop at a particular time.

Agricultural drought happens after meteorological drought but before hydrological drought.

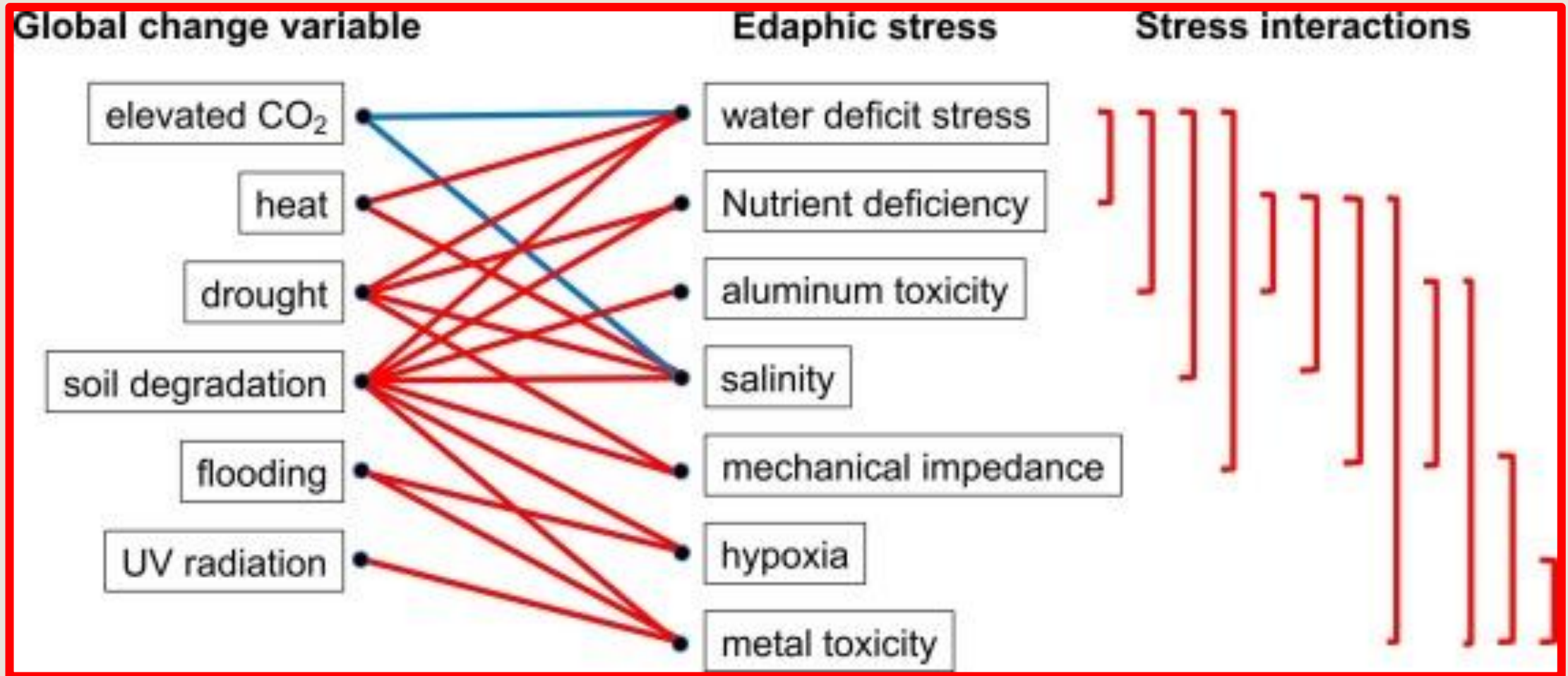


# Edaphic droughts X Agricultural droughts



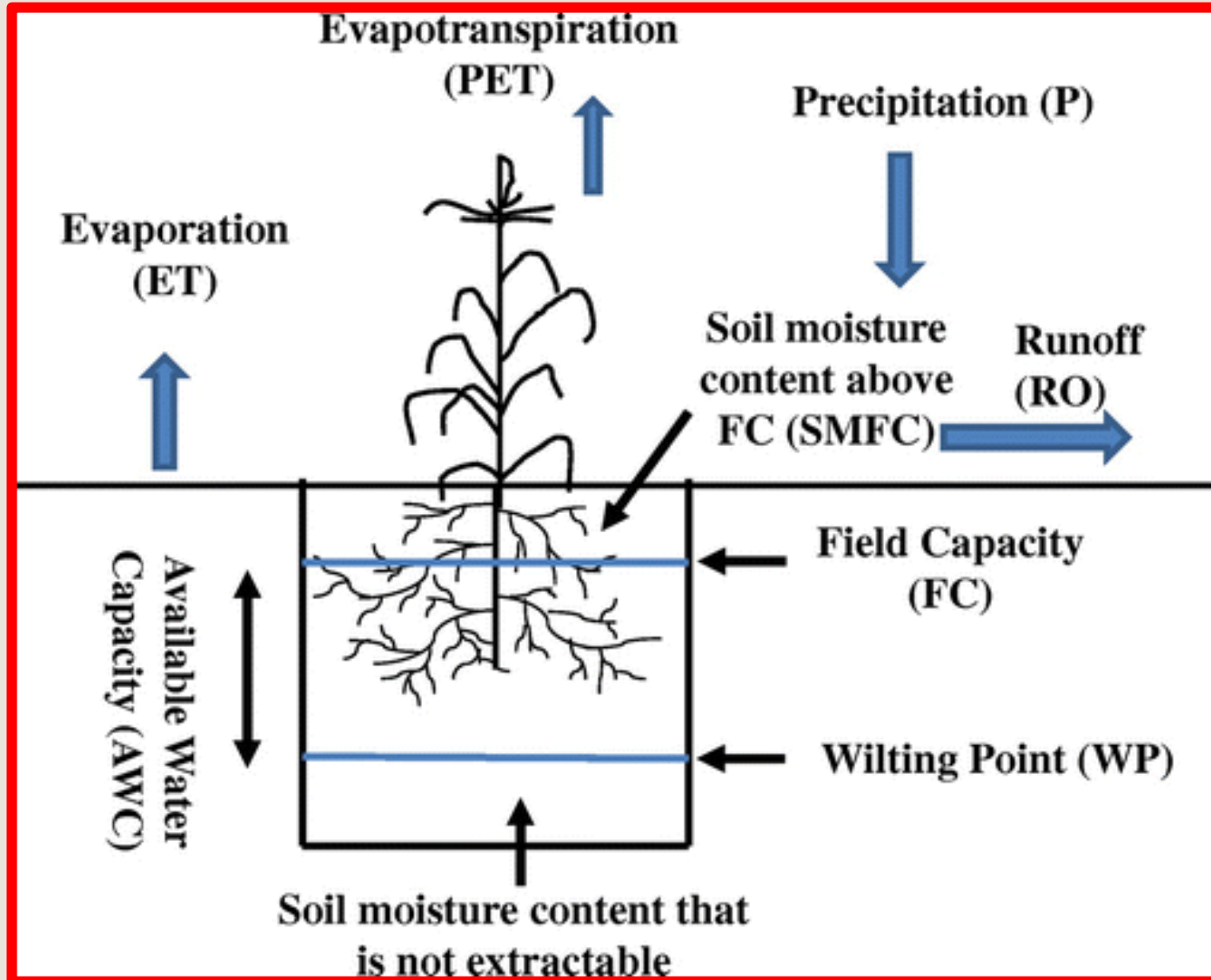
Edaphic droughts greatly interact with agricultural droughts

# Edaphic droughts (of the soil, or influenced by the soil)



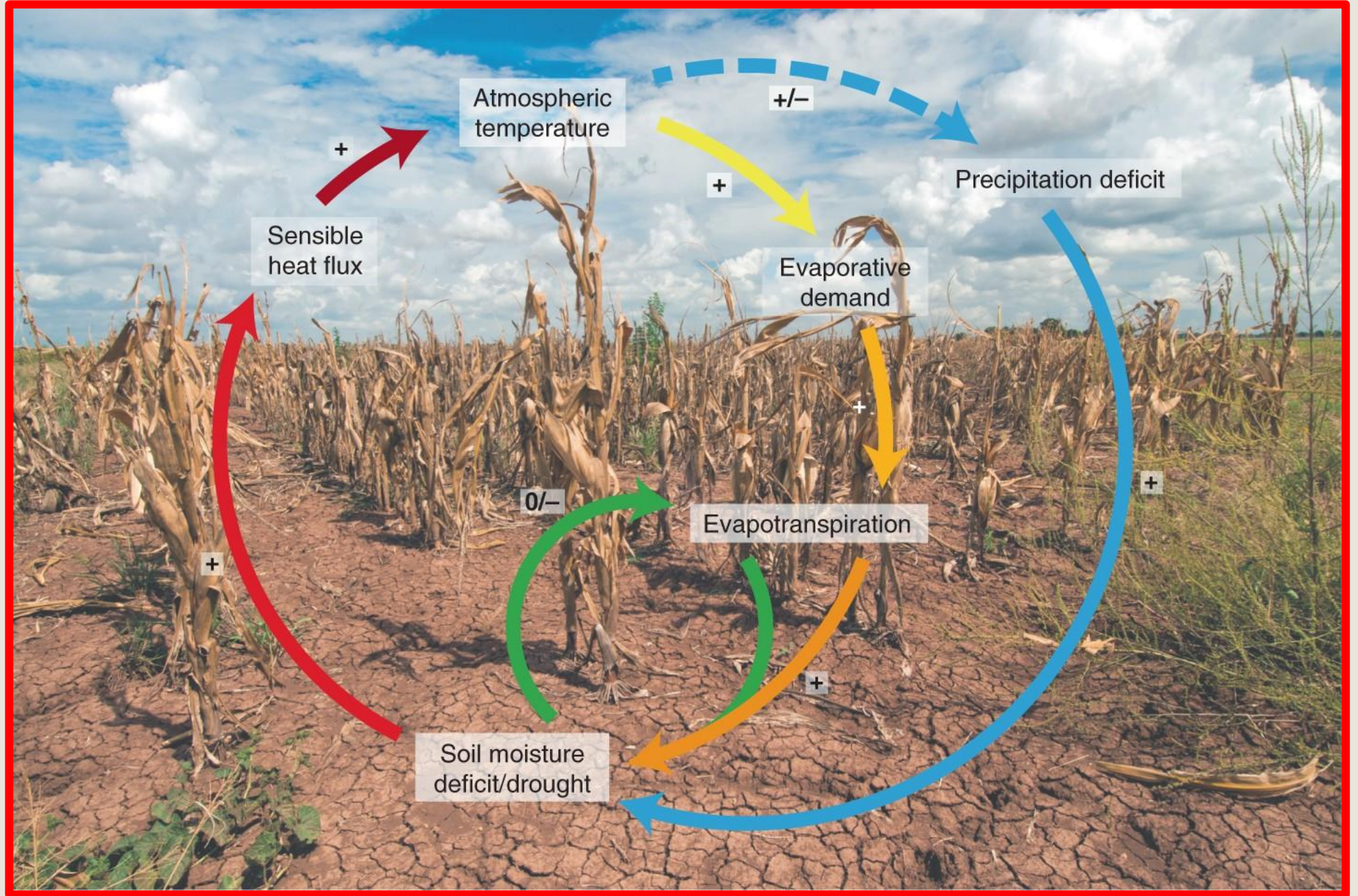
Edaphic stress, defined as soil conditions that reduce plant fitness, is a primary, pervasive constraint to plant productivity in terrestrial ecosystems.

# Edaphic droughts X Agricultural droughts



# Soil moisture deficit/drought

The difference between the amount of water actually in the soil and the amount of water that the soil can hold.



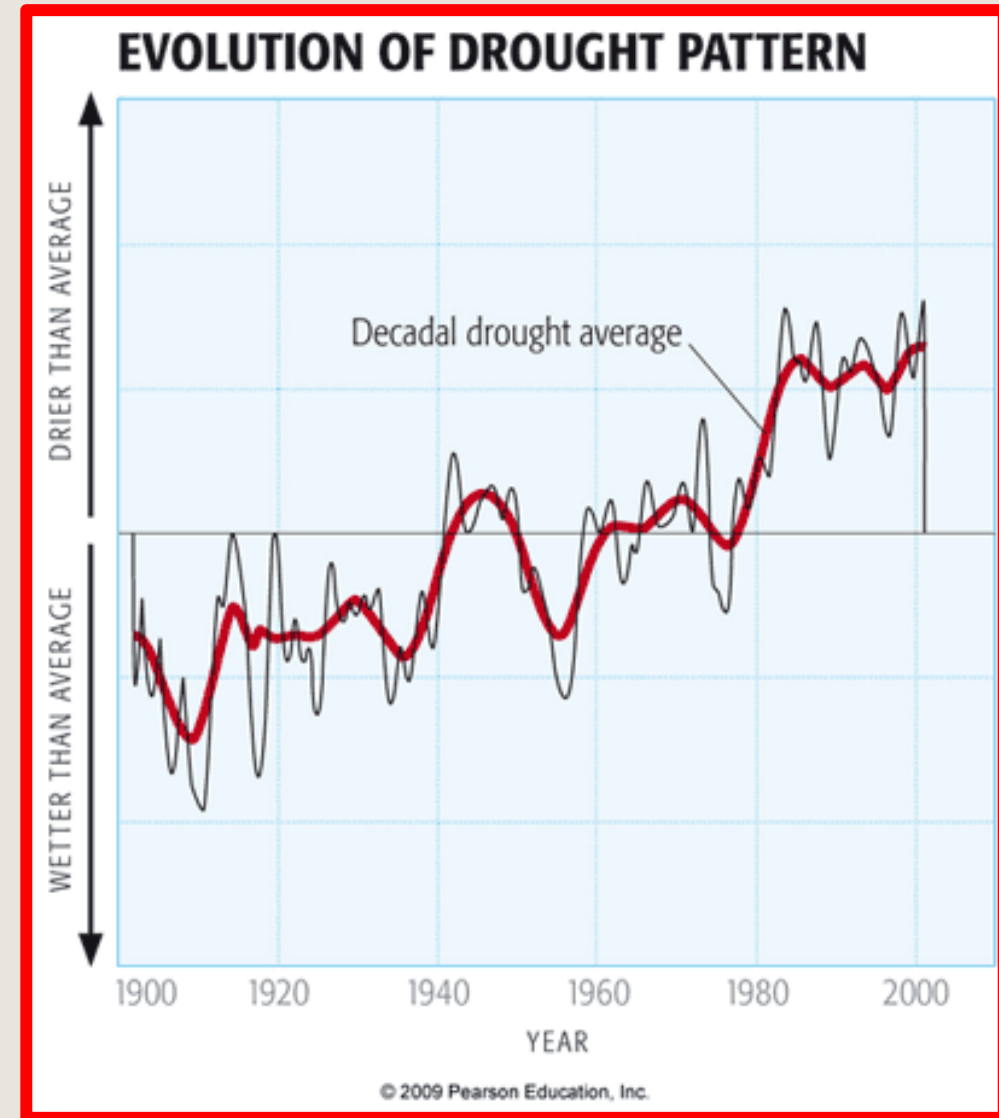
# As the Climate Bakes, Turkey Faces a Future Without Water

*No nation in the Mediterranean region has been hit harder by climate change than Turkey. But as heat and drought increase, Turkey is doubling down on water-intensive agriculture and development and spurring a water-supply crisis that is expected to get much worse.*

BY [PAUL HOCKENOS](#) • SEPTEMBER 30, 2021

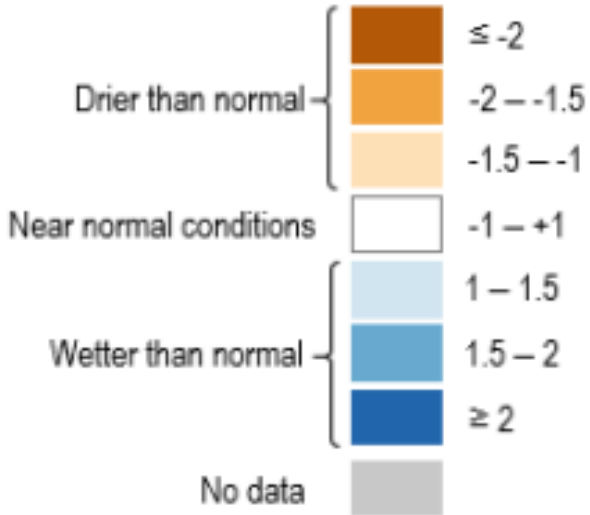
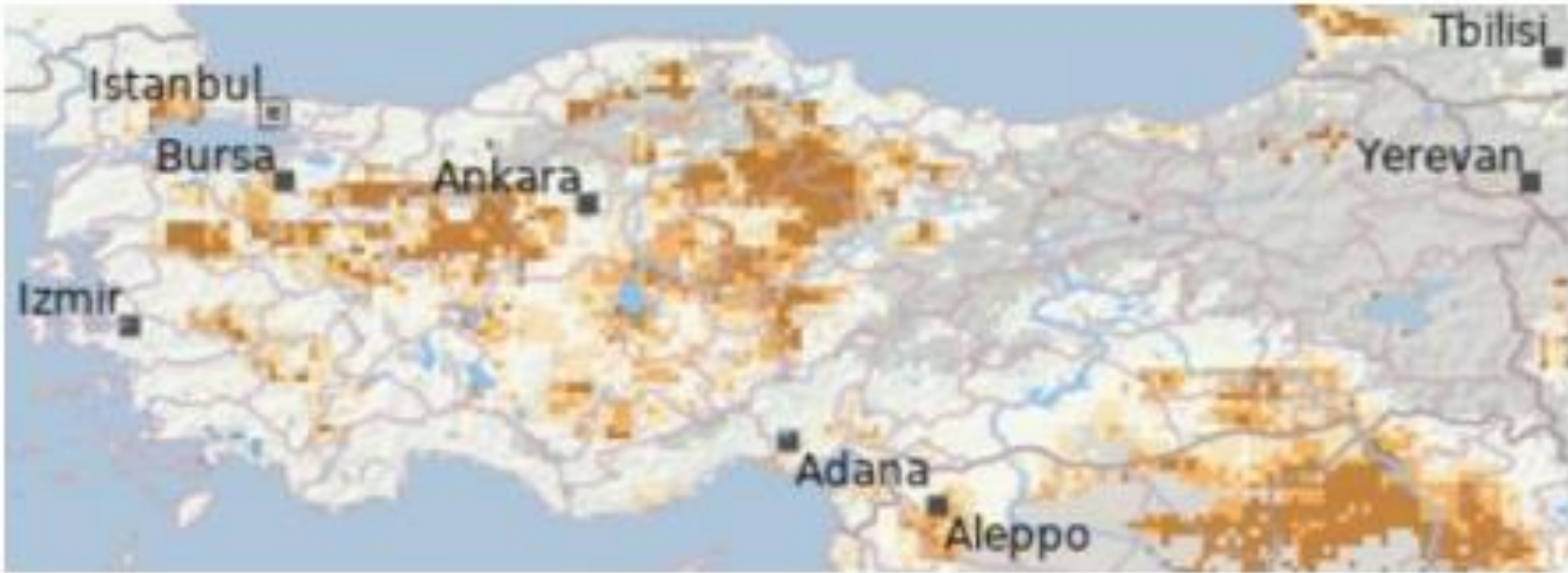
[Yale Environment 360](#)

Published at the [Yale School of the Environment](#)



Credit: Pearson, 2009

# Soil moisture deficit



Soil moisture anomaly in Turkey for December 2020 (top) and January 2021 (bottom).



# Socio-economic drought

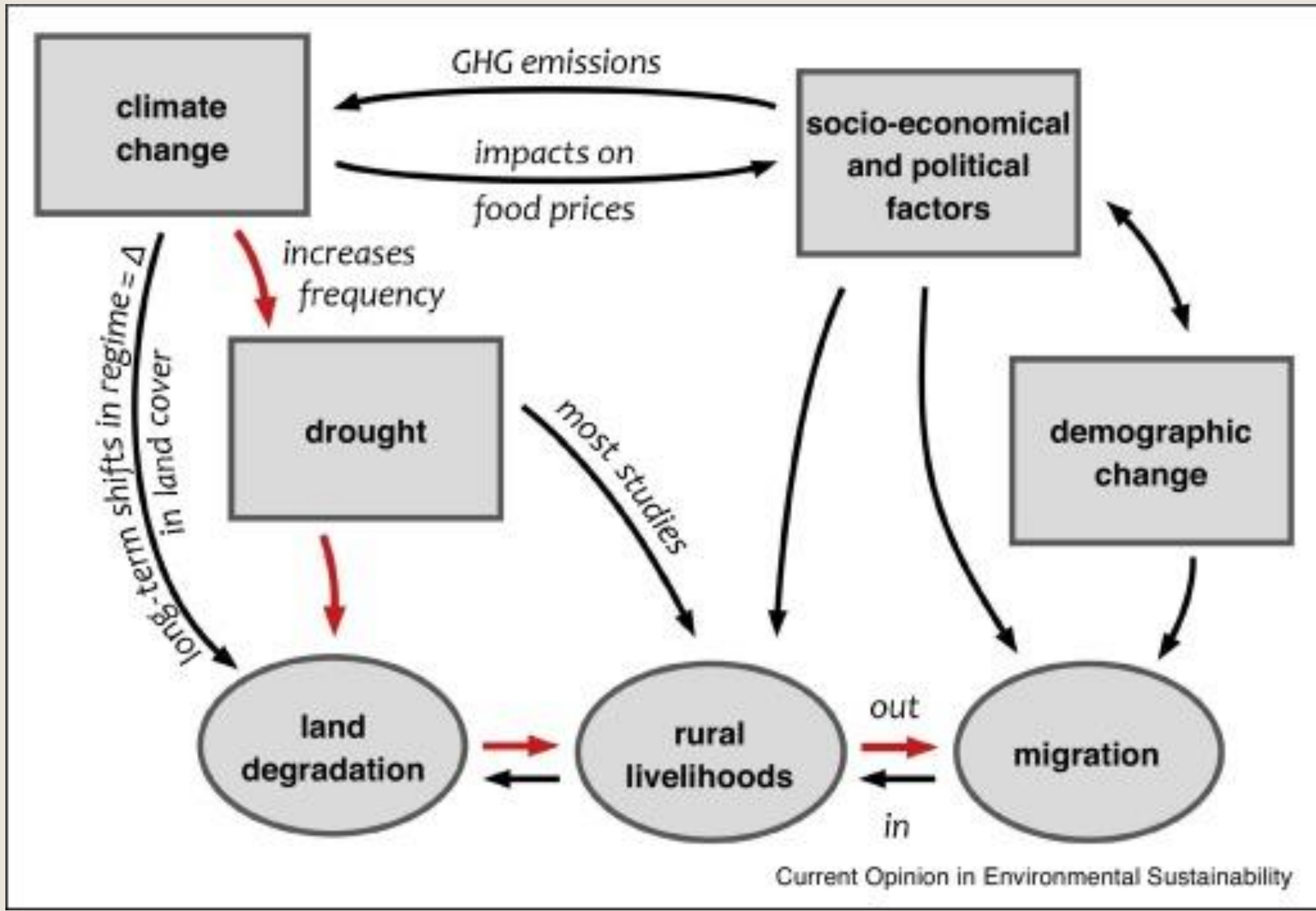
Socioeconomic drought constitutes the effect of drought on agriculture and living beings as well as its effect on water sources and on industries that use these resources.

In this context, we need to study the economic, social, and environmental effects of drought from a holistic perspective. [2]

Four main approaches can be used to measure drought: Meteorological, agricultural, hydrological, and socioeconomic drought.

In contrast to the other three approaches, socioeconomic drought does not study the measurable physical factors instead it studies the effect of drought on socioeconomic systems.

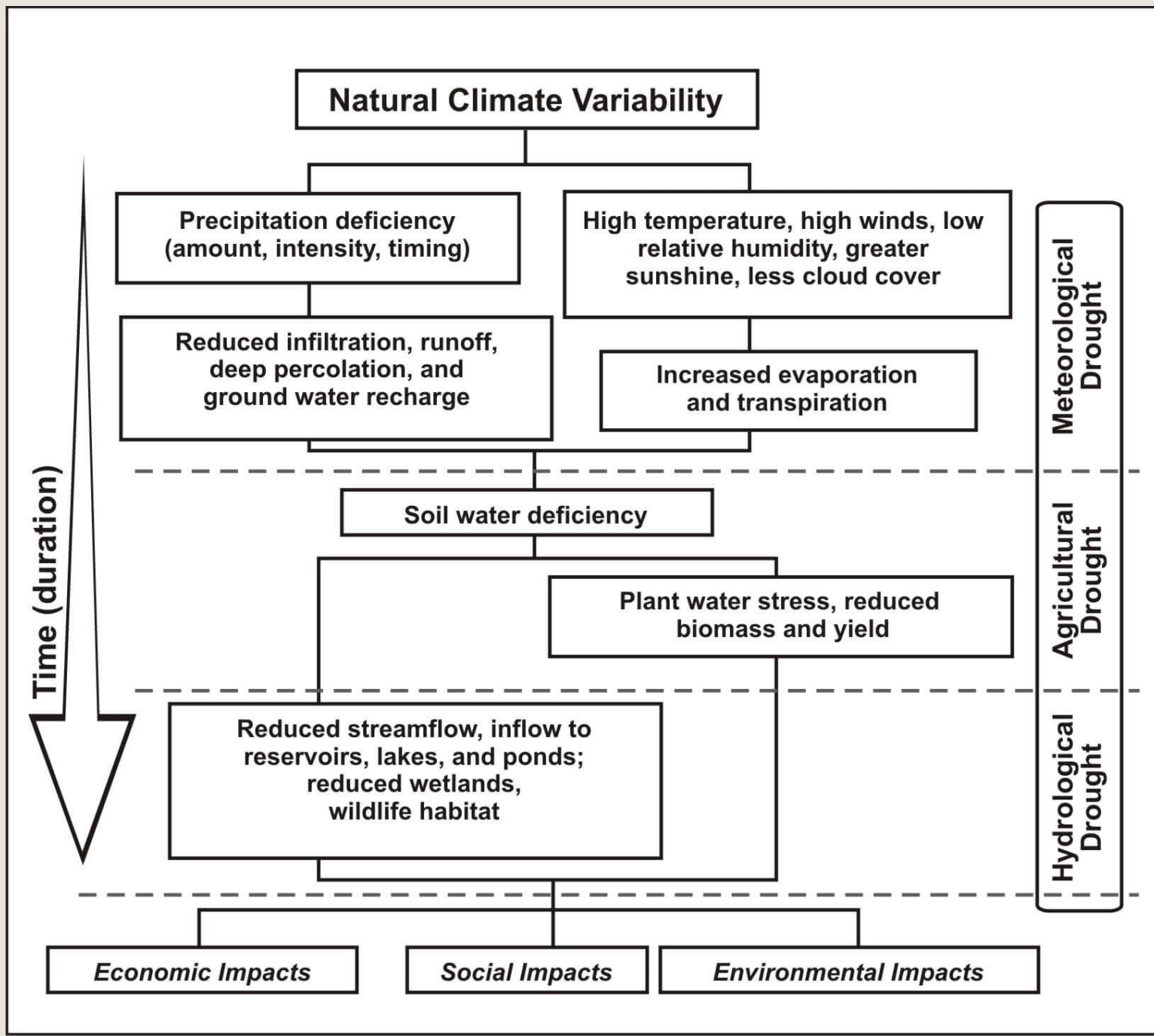
Hermans, K., McLeman, R. 2021. Climate change, drought, land degradation and migration: exploring the linkages. Current Opinion in Environmental Sustainability. 50\_ 236-244.



Causal linkages between climate change, drought, land degradation and migration

# Causal linkages

Sequence of drought occurrence and impacts for commonly accepted drought types. All droughts originate from a deficiency of precipitation or meteorological drought but other types of drought and impacts cascade from this deficiency. (Source: NDMC)



# Socio-economic drought

<u>Land Use</u>	<u>Mha</u>	<u>%</u>
Agricultural Land	38,2	49,1
<b>Cultivated land</b>	<b>24,5</b>	<b>31,5</b>
Natural grass land	14,6	18,8
Forest Land	21,5	27,6
Settlement and others	3,5	5.0
<b>Toplam</b>	<b>77,8</b>	<b>100.0</b>

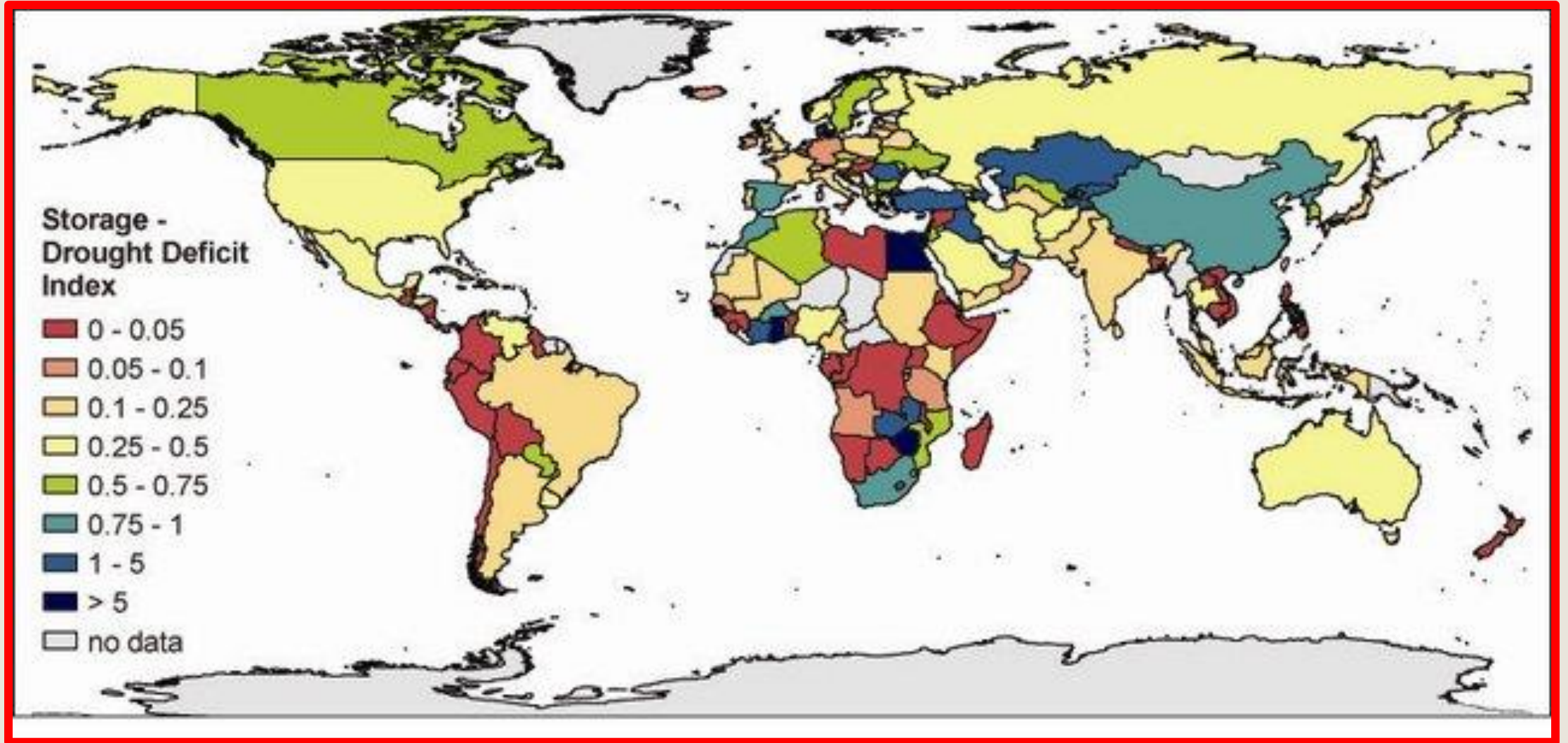


The big cities in Turkey that are most vulnerable to droughts are Ankara, Istanbul and Izmir.

These cities depend on fresh water storage in reservoirs (4).

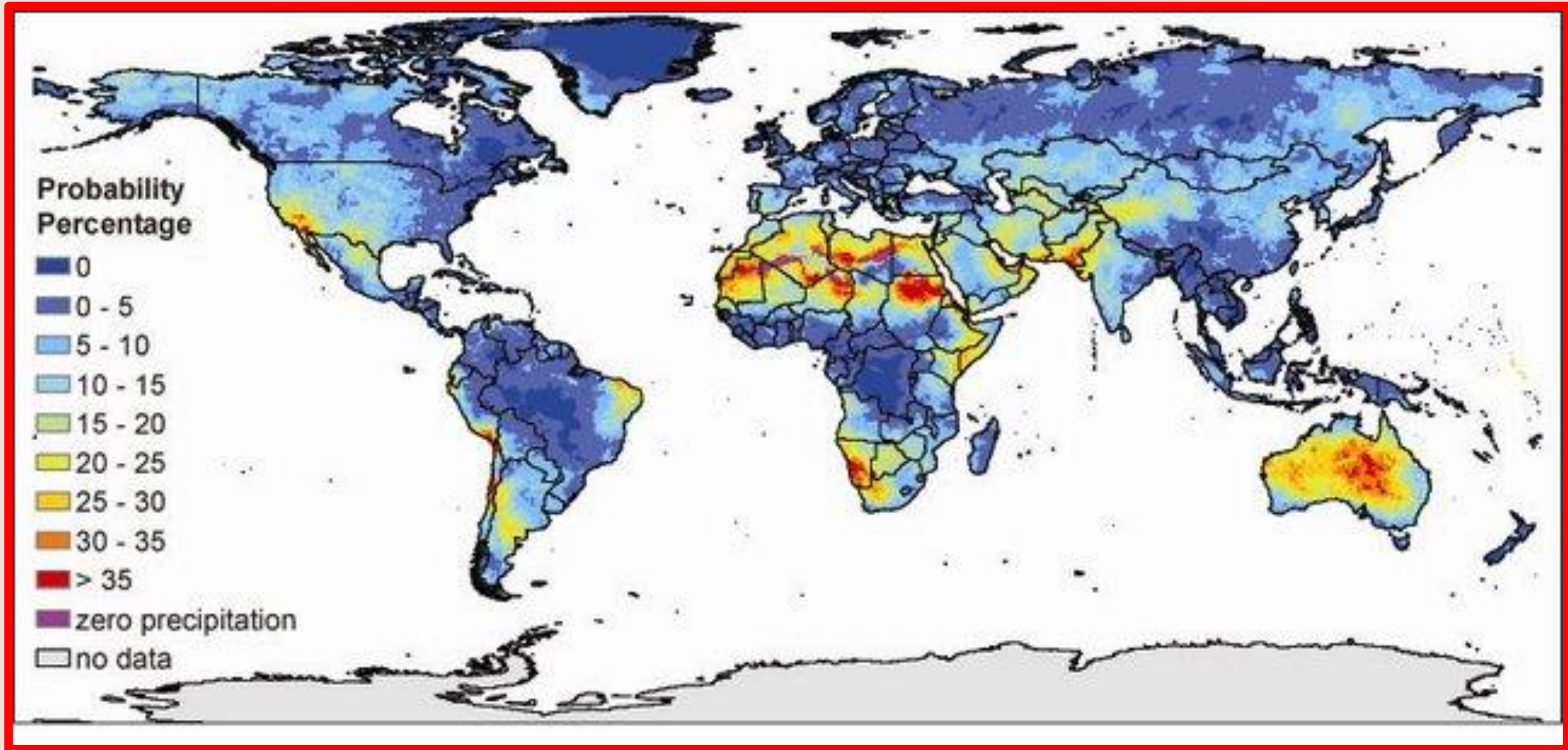
- Total Population 85,0 Million with 20,0 million tourists movement per year
- Rural Population (23.4%)
- Urban Population (76,6%)
- 81 - Province
- 900 - City
- 40.000 - Village and districts

# Storage-Drought Deficit Index



A global picture of drought occurrence, magnitude and preparedness N. Eriyagama, V. Smakhtin and N. Gamage International Water Management Institute (IWMI), PO Box 2075, Colombo (Sri Lanka)

# Socioeconomic Drought Vulnerability Index



Socioeconomic Drought Vulnerability Index based on crop diversity of individual countries and their dependence on agriculture for income and employment generation.

## Most vulnerable sector: agriculture



Agriculture is usually the first economic sector to be affected by drought  
Agriculture is the largest water using sector (72 percent of all withdrawals) in Turkey.

The main problem is the efficiency of irrigation methods. The water efficient sprinkling and drip irrigation technologies are used on only 6 percent of the total irrigation area.

Potentially inefficient surface irrigation is used in the majority of fields (94 percent) (FAO, 2017).

## Most vulnerable sector: agriculture

Recently, severe drought has occurred in 2007 in Turkey. This natural event affected agricultural production and hydrological flow.

While the wheat production, a basic crop of Turkey, was 21 500 000 tons in the year of 2005, it was 17 234 000 tons in 2007 and 17 782 000 tons in 2008.

Imports were made during the last two years since domestic production was not able to meet the demand.

Severe drought of 2007-2008 agricultural year experienced in Southeastern Anatolia Region caused series yield loses in common crops of the region.

For instance, while red lentil production was 520 000 tons in the year 2005, it decreased to 111 502 tons in 2008.

Normally, Turkey exporting red lentil had to import lentil in the year 2008.



## Most vulnerable sector: agriculture

Cotton production also decreased from 2 240 000 tons to 1 938 000 tons and Turkey had to import much more cotton (Kayam and Cetin; 2012).

In 2008, the damage to the agricultural sector due to droughts was about US\$2 million with 435 000 farmers being severely affected (MFWW, 2010).

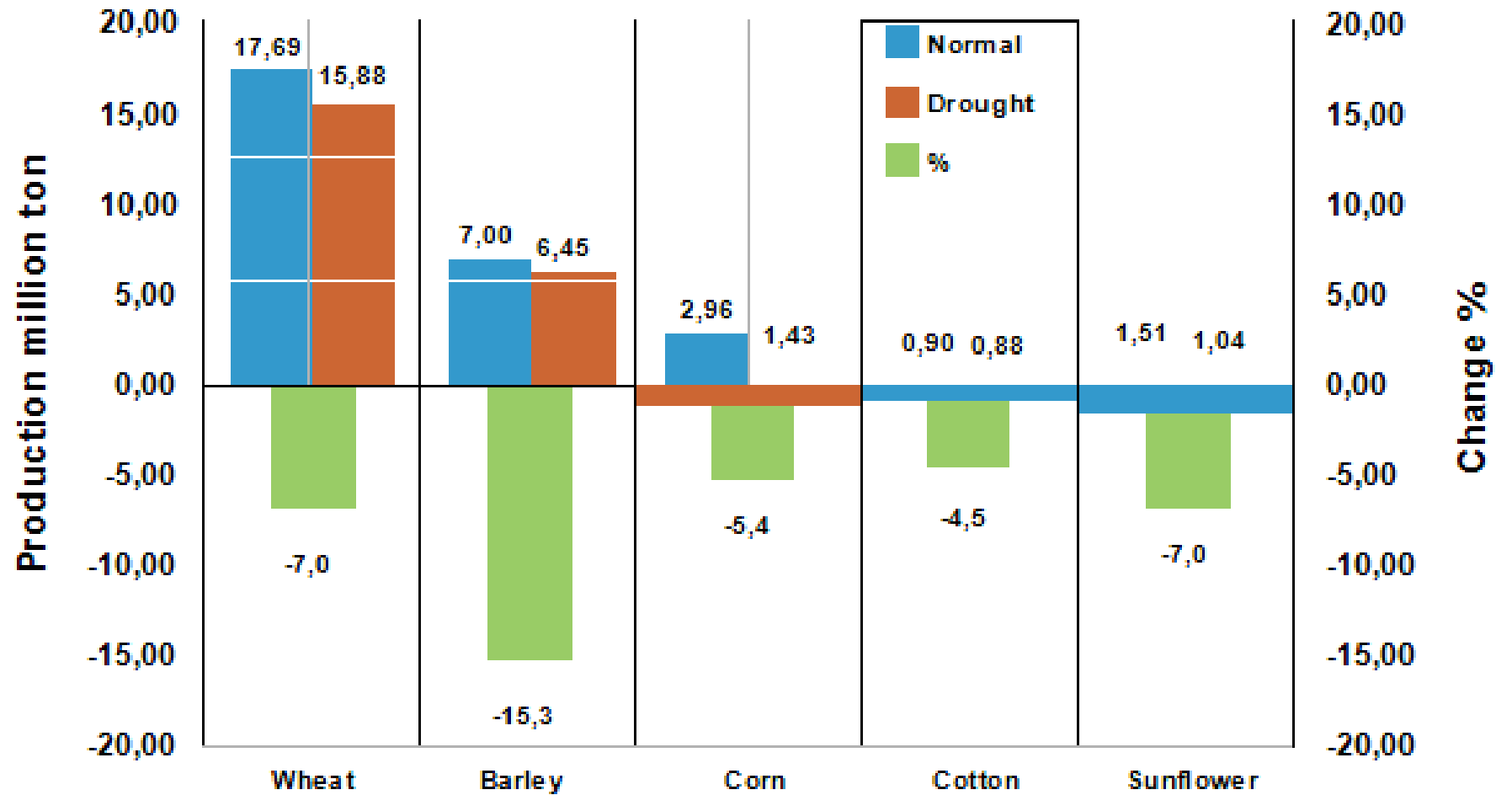
Major production losses occurred in cereals and lentil production.

In the south-eastern Anatolia Region, production losses were estimated to be 90 percent for wheat and grain, and 60 percent for red lentil (FAO, 2017).

# Socio-economic impacts

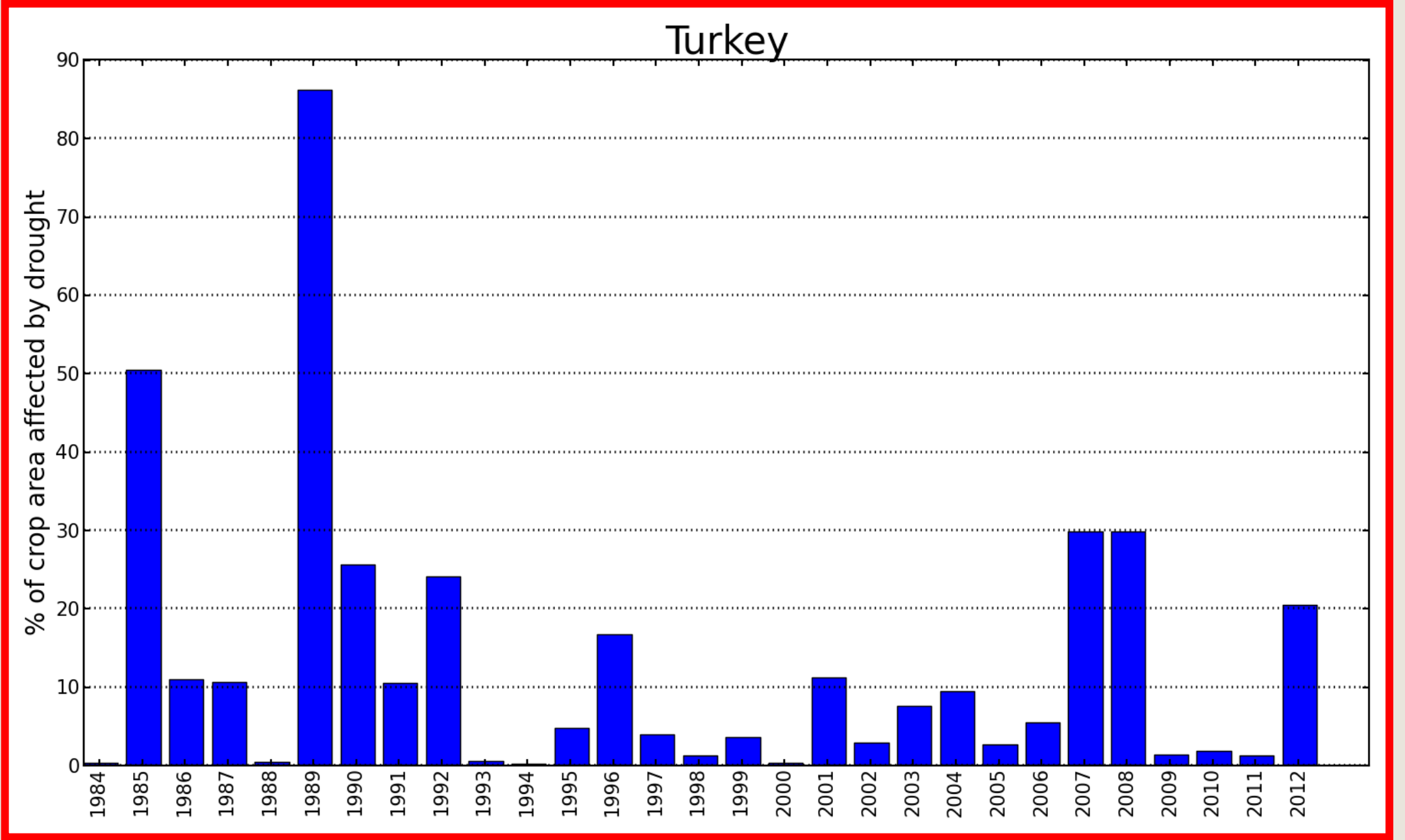
In 2007, the production level of all crops decreased from 4.5 percent to 15.3 percent as a result of drought (FAO, 2017)

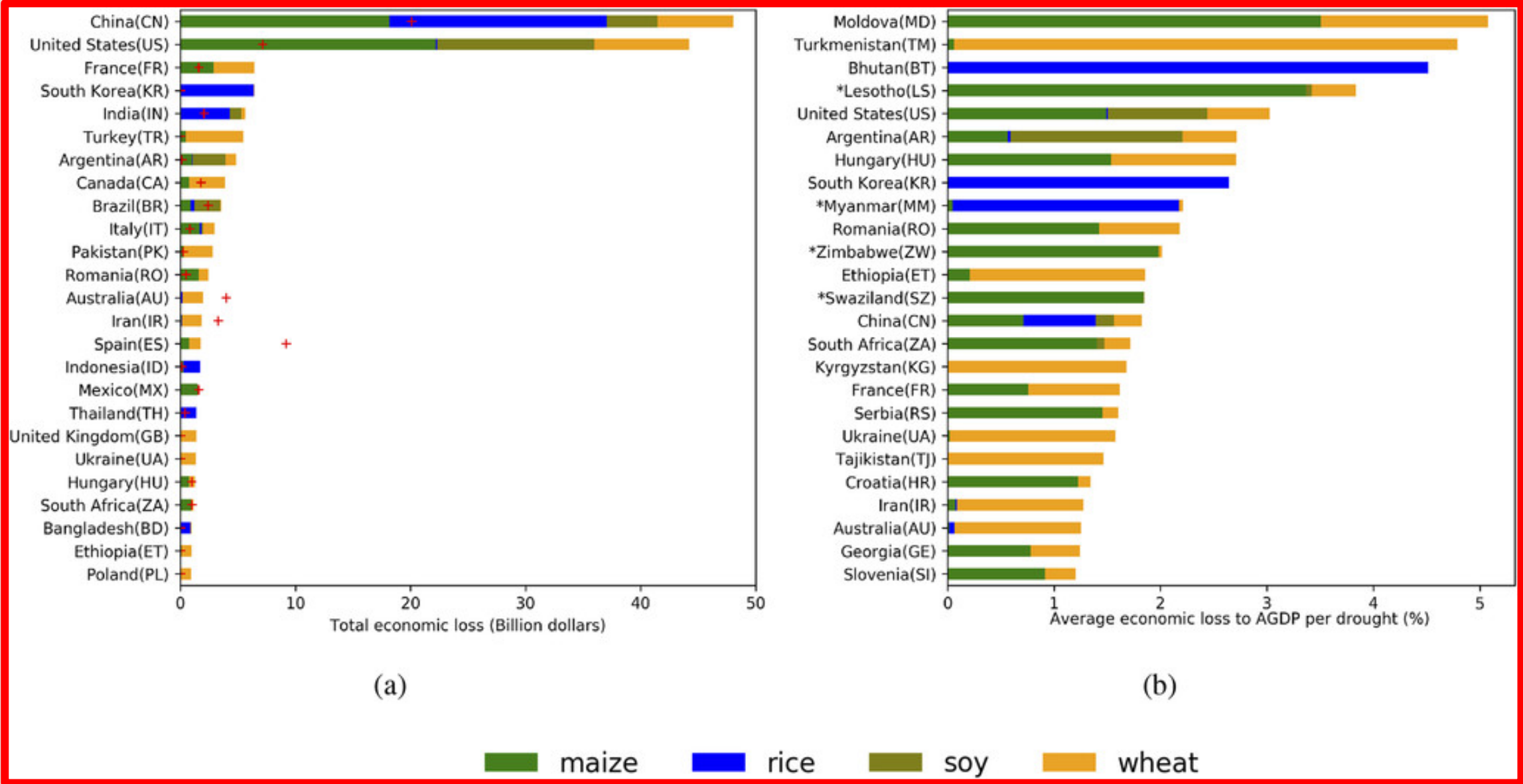
FIGURE 10  
Production changes in Turkey due to the 2007 drought



Source: Adapted from MGM bulletins, 2010.

(Rojas, O. FAO; 2013)



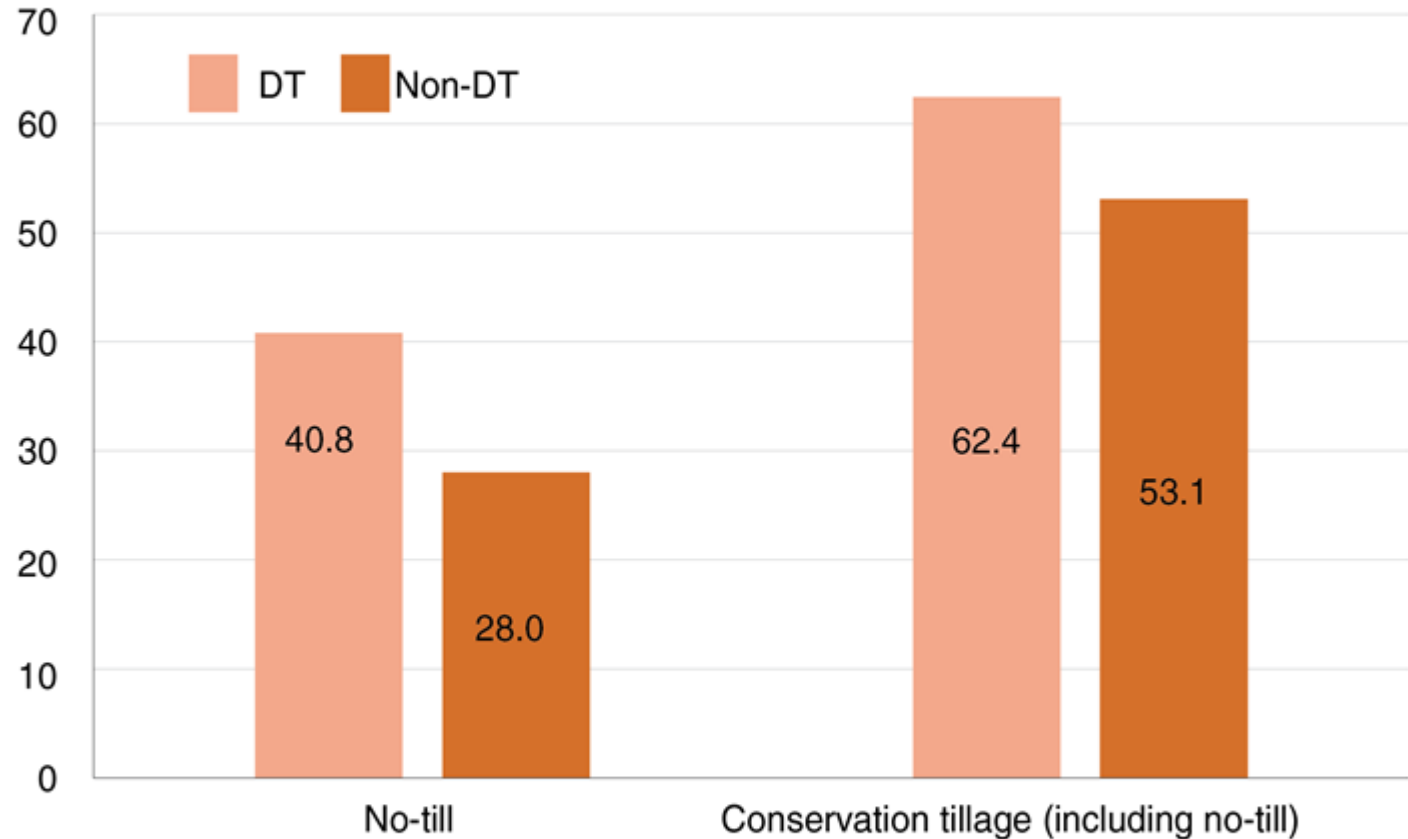


The 25 countries that have large cumulative drought-induced economic losses E for the period from 1983 to 2009. The data on the national producer prices of staple crops and the national-level agricultural gross domestic product (AGDP) in 2005 were obtained from FAO et al. (2017) and World Bank (2017), respectively.

Conservation tillage is an agricultural management approach that aims to minimize the frequency or intensity of tillage operations in an effort to promote certain economic and environmental benefits.

## Share of U.S. drought-tolerant (DT) and non-DT corn fields that used conservation tillage or no-till, 2016

Percent of corn fields in 2016



Notes: A no-till field did not at any point during normal operations use tillage equipment, such as plows, disks, packers, bedders, shapers, cultivators, harrows, drags, land plane levelers, or laser planers/levelers. Fields managed using conservation tillage kept at least 30 percent residue cover on the field after planting.

Source: USDA, Economic Research Service and USDA, National Agricultural Statistics Service, 2016 Agricultural Resource Management Survey.

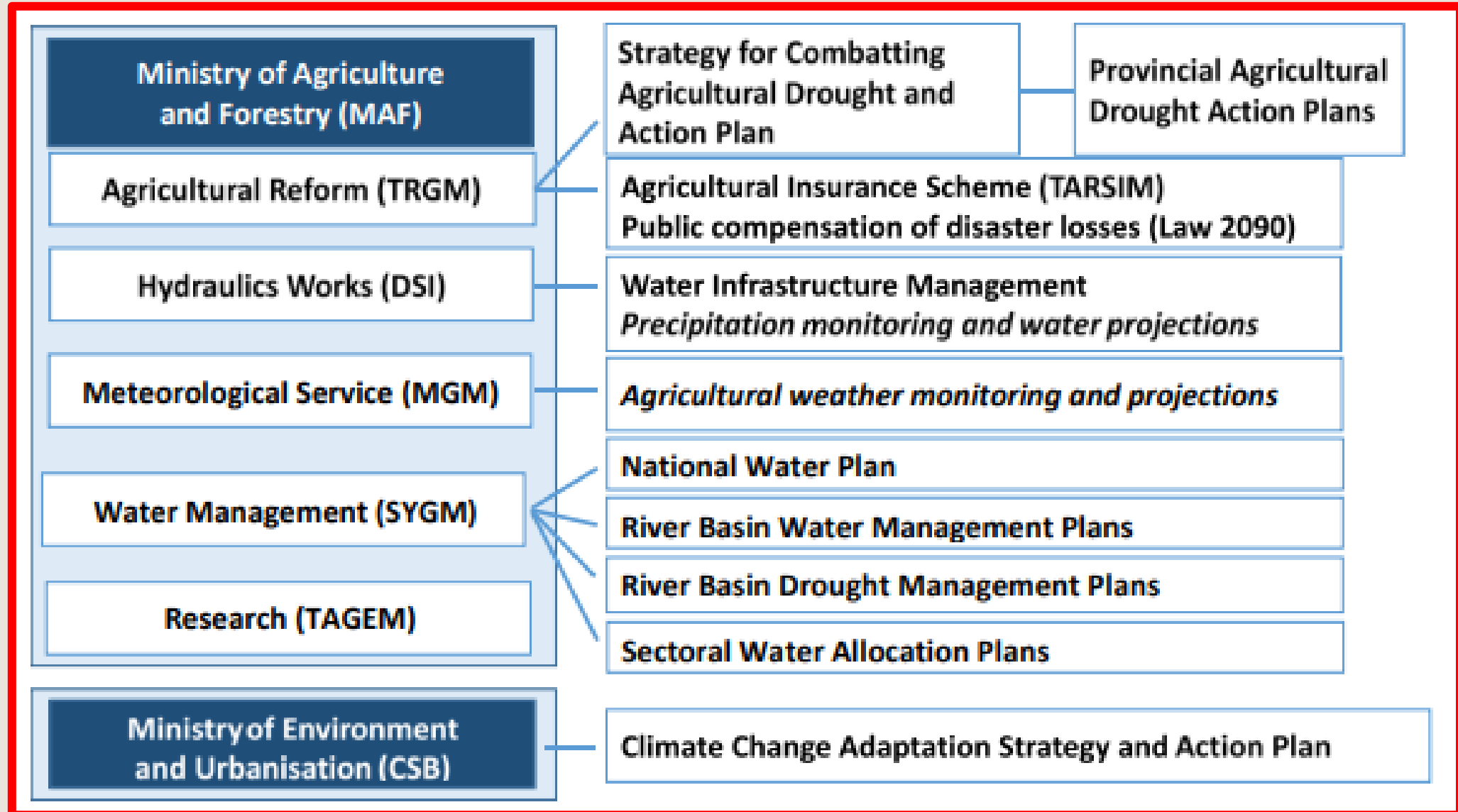
# Agricultural Drought Strategy of Turkey

**Turkey's Drought Management System (DMS)** has taken drought management just as a response mechanism until recently.

In-line with the *climatic changes* and *associated impacts on natural resources*, the government institutions have taken into consideration the risk reduction, mitigation and preparedness as important as the response itself.

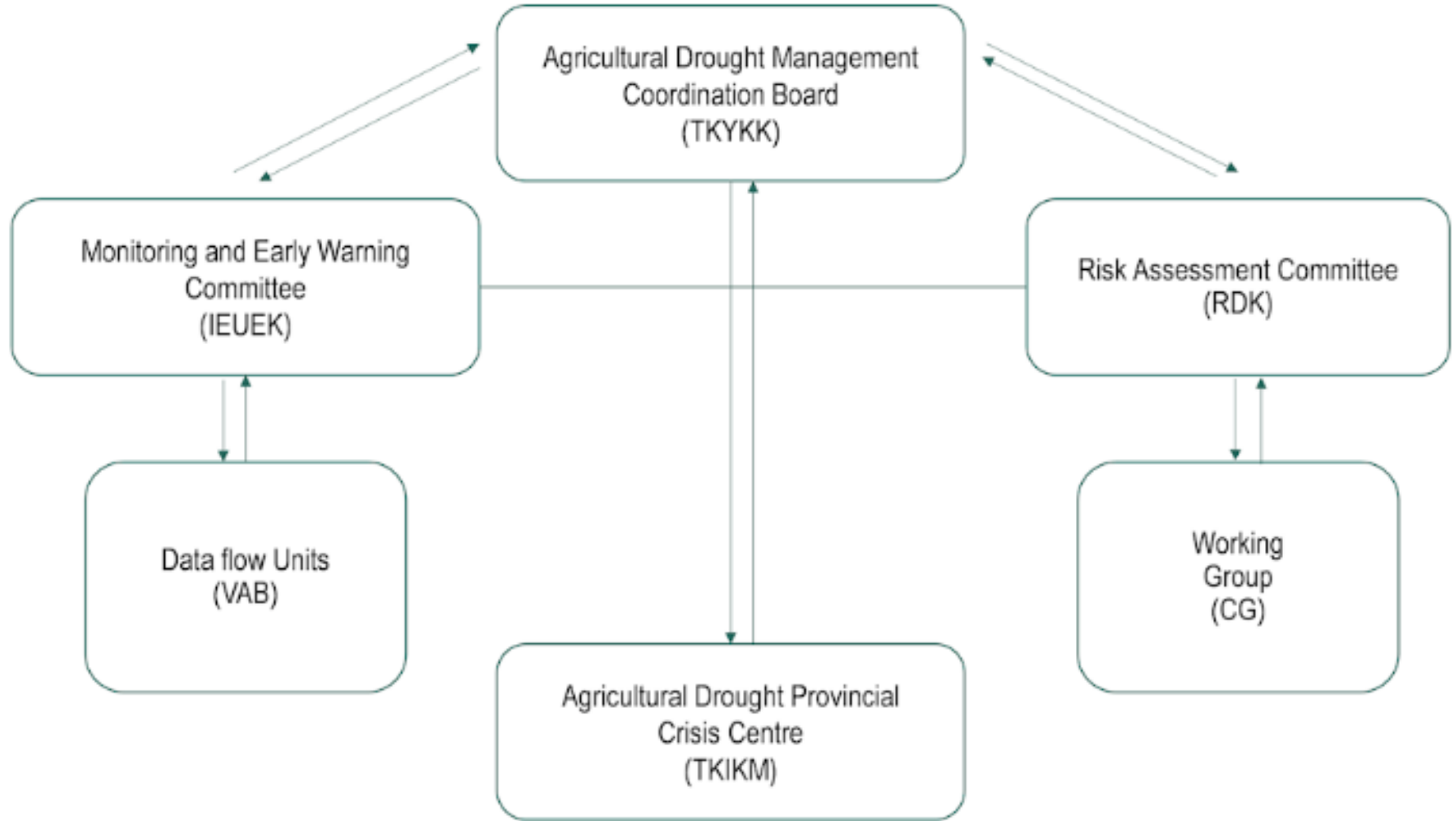


# Disaster risk management governance and frameworks for agricultural droughts in Turkey



# Agricultural Drought Management in Turkey

Central Management



Provincial management

Source: National Drought Management Policies (TKYKK, 2013[7]).



# Agricultural Drought Strategy of Turkey

These policy initiatives are expected to address some of the following critical issues:

- Data monitoring and analysis
- Risk assessment
- Distribution of information and communication
- Potential of reaction

**Regulation on Duties, Working Procedures and Principles of Agricultural Drought Management** was published on in the Official Gazette dated 02 March 2008.

The first **Strategy and Action Plan for Combating Agricultural Drought for the period 2008-2012** was prepared and put in to operation.

The second **Strategy and Action Plan for Combating Agricultural Drought for the period 2013-2017** was prepared and put in to operation.

# Agricultural Drought Strategy of Turkey

In order to carry out the coordination of the [Strategy and Action Plan for Combating Agricultural Drought](#) , a two part task allocation was carried out.

The work to be done in the center and province are determined.

## **A) Central Management (Coordination Council on Agricultural Drought Management)** (meet upon call)

- 1) Committee on Monitoring and Early Warning (meet monthly and prepare report)
- 2) Committee on Risk Evaluation (meet monthly and prepare report)
- 3) Unit of Data Flow

## **B) Provincial Administration** (meet at least once a year)

Province Crisis Center on Agricultural Drought (provide monthly data)

# Collected Data from 81 Provinces

Phenological Observation Report for growing agricultural products,  
Occupancy Rates of Irrigation Dams,  
Regional Monthly and Cumulative Rainfall Analysis,  
Water Basin Rainfall Analysis,  
Agricultural Basin Rainfall Analysis,  
Temperature Analysis,  
Monthly and cumulative precipitation assessment charts for regions  
Drought Analysis:

- Percent of Normal Index (PNI)
- Standardized Precipitation Index (SPI)
- Palmer Method maps

# Actions of Strategy and Action Plan for Combating Agricultural Drought

- 1) Drought Risk Prediction and Crisis Management
- 2) Providing Sustainable Water Supply
- 3) Effective Management of Agricultural Water Demand
- 4) Accelerating Supportive Research and Development Studies and Enhancing Training / Publishing Services
- 5) Institutional Capacity Development

In the Strategy, priorities and measures with start and end dates, responsible Ministry/Institution, partner Institution(s) were addressed for each action in detailed.

**Thank you**

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