



**T.C. ÇEVRE, ŞEHİRCİLİK VE  
İKLİM DEĞİŞİKLİĞİ BAKANLIĞI**  
ÇÖLLEŞME VE EROZYONLA MÜCADELE GENEL MÜDÜRLÜĞÜ

# **Climate Change Adaption and Mitigation Measures for Flood, Avalanche and Landslide Control**

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- The impacts of climate change on Turkey and the world continue to increase.
- Climate change leads to differences in precipitation regimes, increased desertification and drought, increased flooding, landslides and erosion in upstream basins and mountainous areas.
- The more frequent occurrence of floods and overflows causes great damage to settlements and agricultural lands and can cause major damage to the safety of life and property, social life, quality water and food needs.
- It is known that mitigation of erosion, flood, avalanche and landslide damages caused by climate change is possible through disaster resilient sustainable land management. In recent years, flood and erosion control works have come to the forefront as the most effective methods in increasing the disaster resilience of upper basins and ensuring sustainable land management.

# Flood Control Activities





## United Nations Office for Disaster Risk Reduction (UNDRR)

- Worldwide, floods are the most common type of disaster, followed by storms.
- In the period 2000-2019, 3254 (44%) floods, 2043 (28%) storms, 552 (8%) earthquakes, 432 (6%) extreme temperatures, 376 (5%) landslides and 338 (5%) drought events occurred worldwide.





**Turkey** is among the countries that will be most affected by this situation due to its geographical location.

### Transported Soil:

- ❖ 4.17% in forest areas,
- ❖ 38.71% in agricultural areas,
- ❖ 53.66% in pastures,

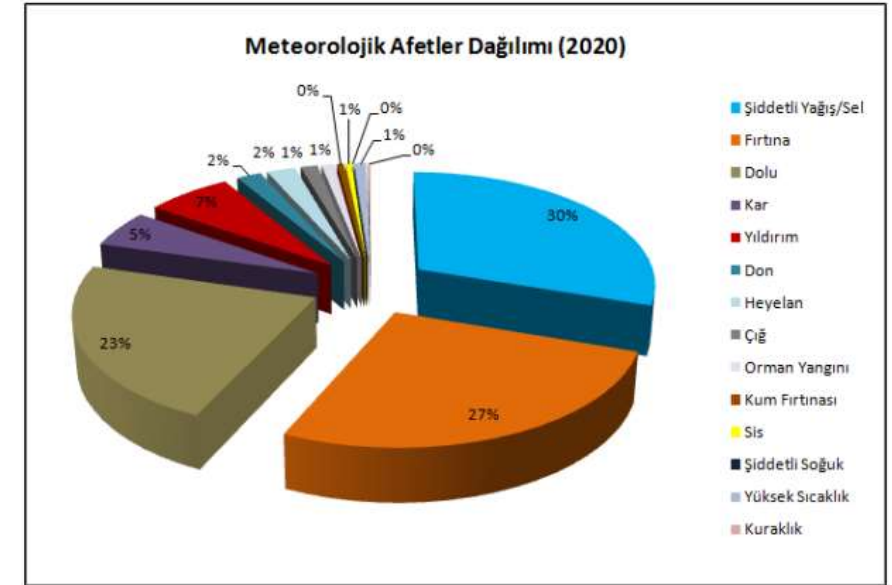




## Territories of Turkey

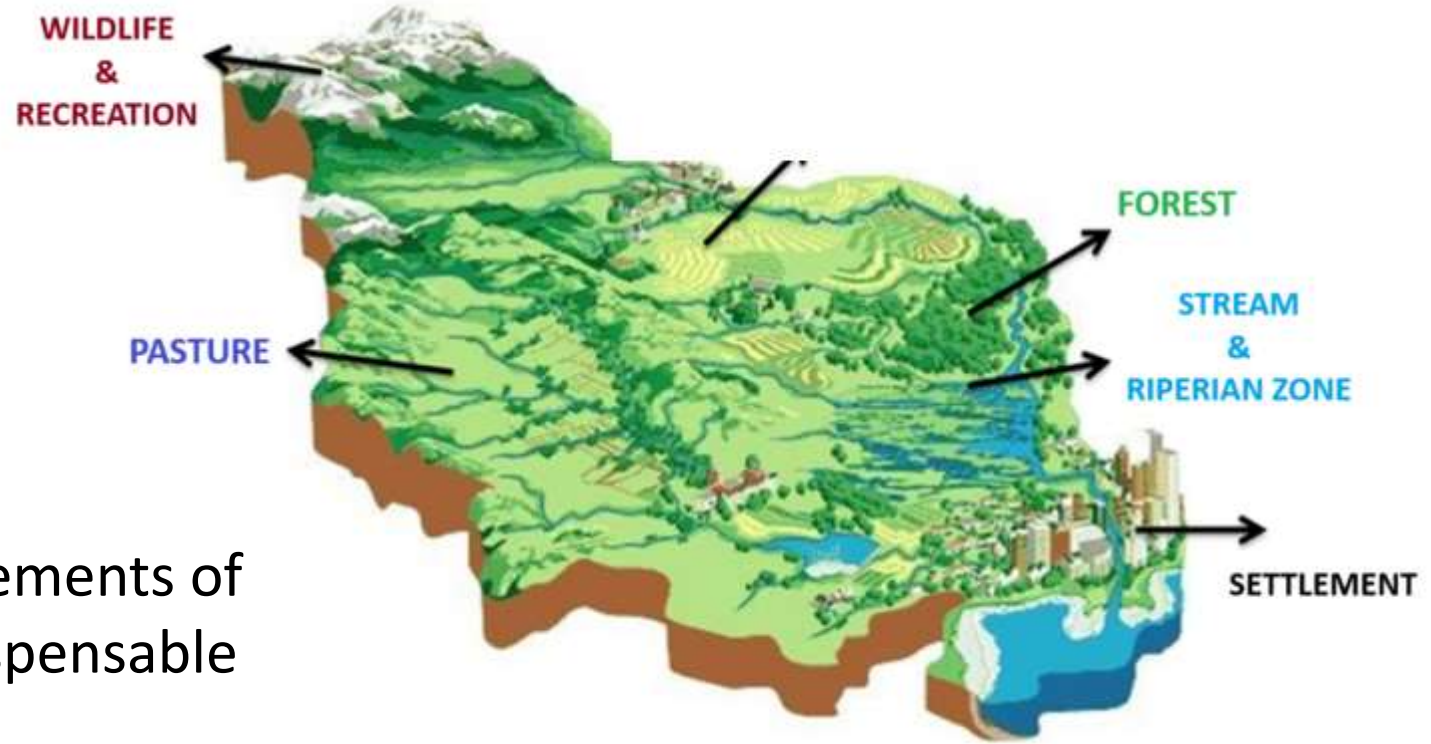
- **62.5%** have a slope above 15%,
- **67%** are shallow and very shallow,
- **40%** at 0-20 cm depth and 33% at 20-50 cm depth,
- Semi-arid climate conditions prevail in **37.3%**,
- **56%** are above 1,000 meters,

Due to the above reasons, the characteristics of the growing environment in Turkey change over **very short distances**, which leads to a high **risk of flooding**.





- It is a piece of land with a concave topographic structure, bounded by water separation lines, where the rainwater falling on it reaches a single outlet point as groundwater and surface water.
- Water and soil constitute the main elements of the basin. Water and soil are the indispensable common denominator of sustainable development, biodiversity and ecosystem within the basin integrity.





10 minutes before



10 minutes later





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## CLIMATE FACTORS

### A. Precipitation Characteristics

- Precipitation type
- Rainfall intensity
- Rainfall duration
- Precipitation distribution
- Direction of movement of precipitation
- Soil moisture before precipitation

### B. Interception

### C. Evaporation

### D. Transpiration





## PHYSIOGRAPHIC FACTORS

### A-Features of the Basin

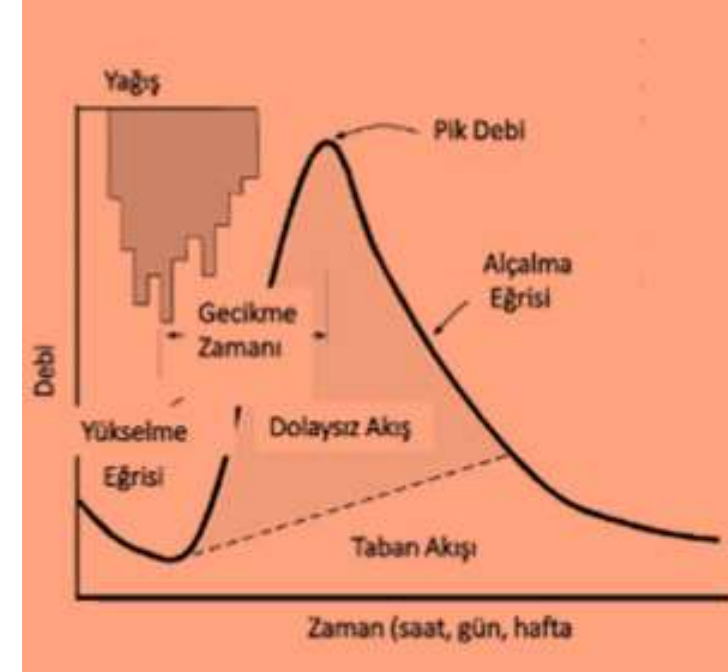
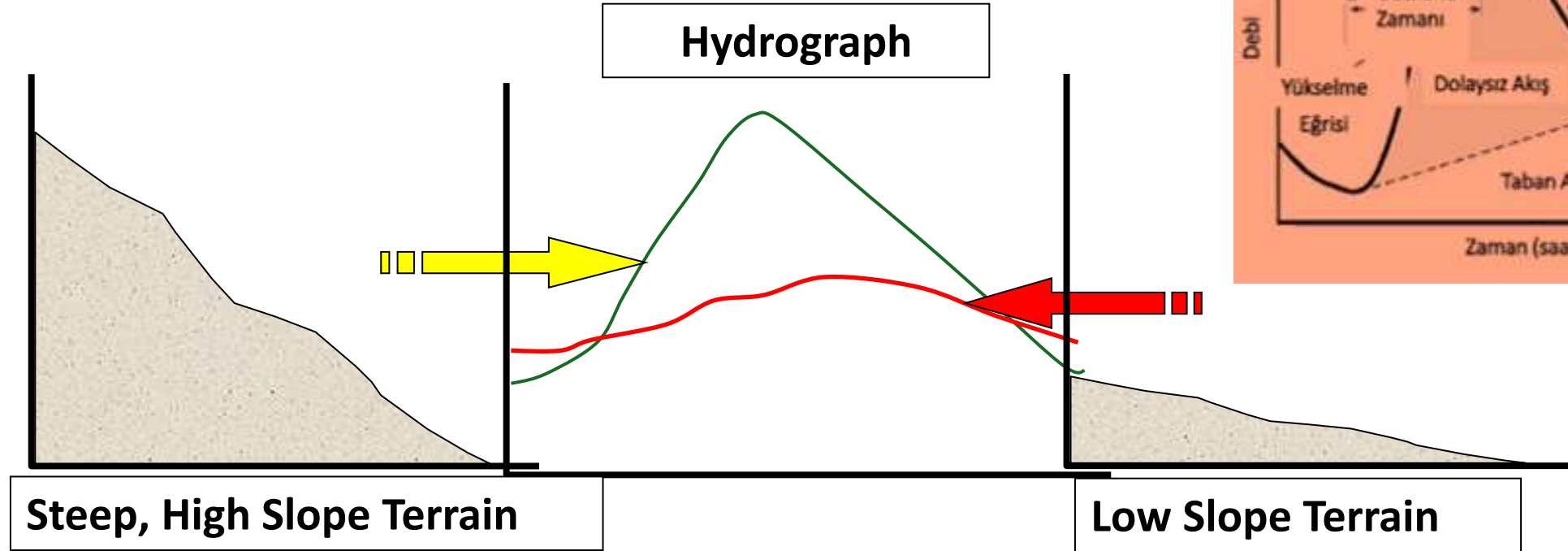
- Size and form
- Elevation
- Average slope
- Overview
- Drainage density
- Soil properties
- Land Use

### B-River Bed Features

- Width and depth of the riverbed
- Cross-sectional form and area
- Slope of the riverbed and slope breaks
- Curvature of the medium
- Type of material forming the riverbed, geological structure

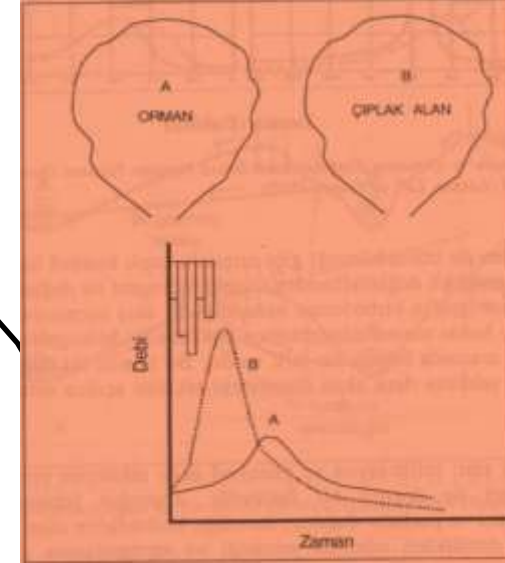
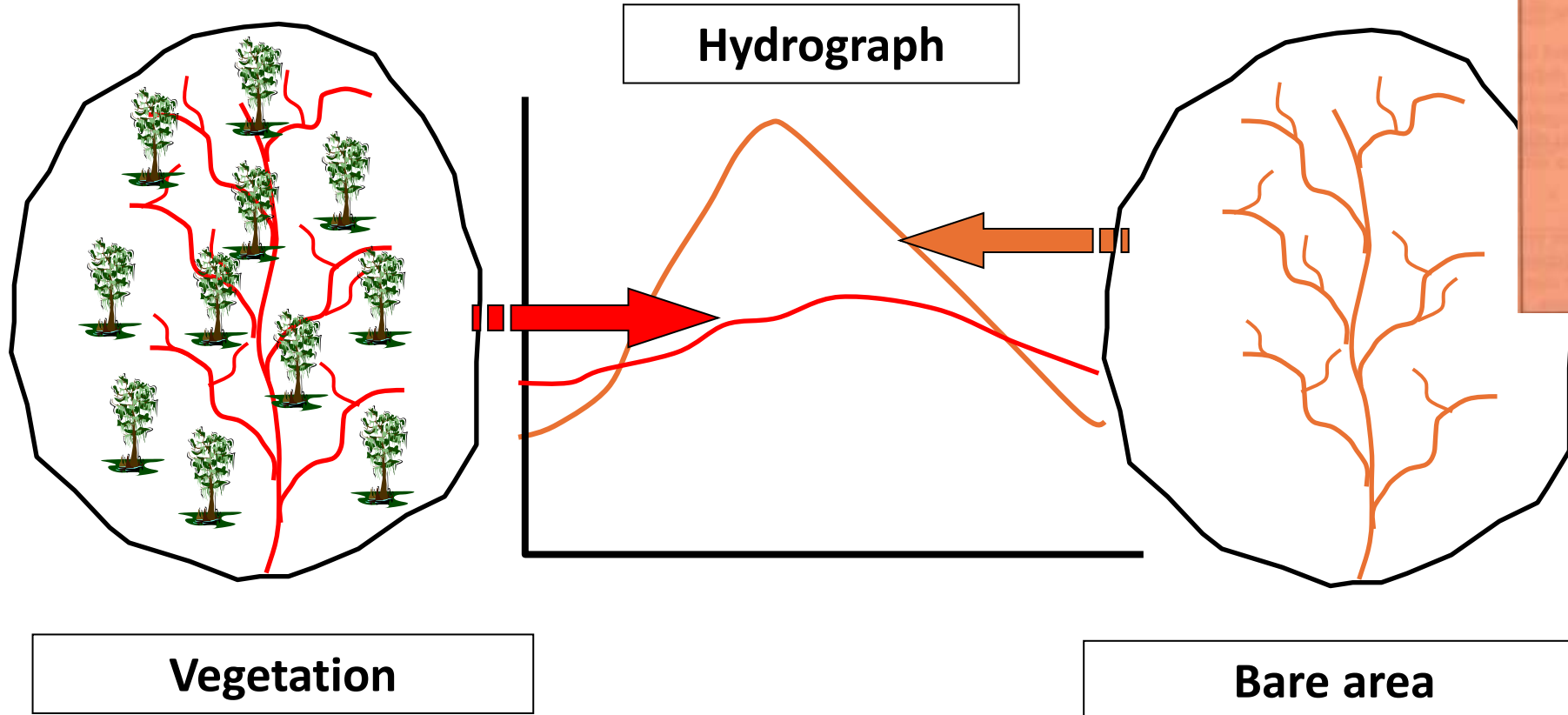


## Effect of Landform on Hydrograph



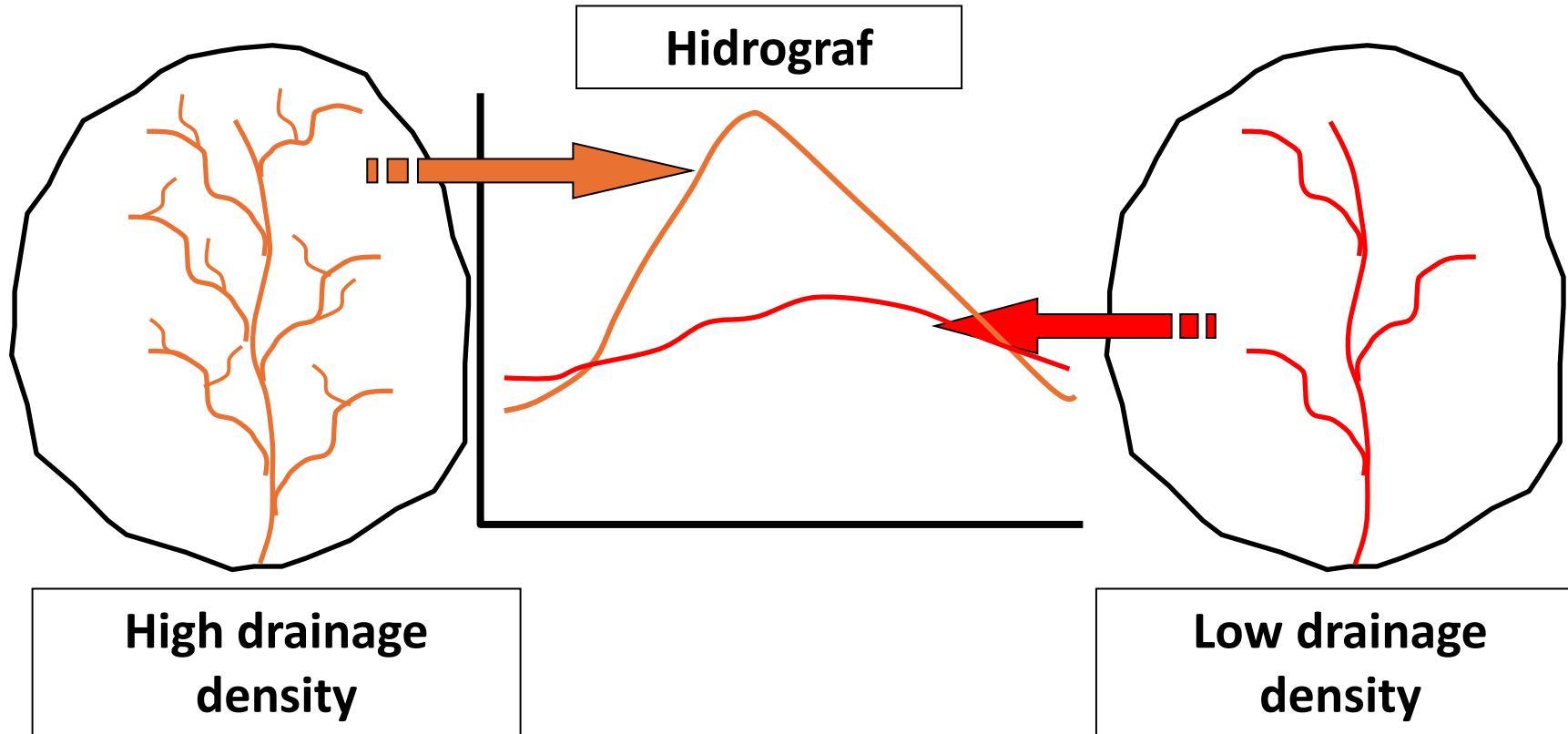


## Effect of Vegetation on Hydrograph





## Effect of Drainage Intensity on Hydrograph





Ground Sills and Check Dams (Kalkandere - Rize)



Ground Sills and Check Dams  
(Kisir - Aydın)



**Ground Sills and Check Dams  
(Zonguldak)**



**Ground Sills and Check Dams  
(Rize)**





**Ground Sills and Check Dams Built at Regular Intervals in a Streambed (Adana)**



**Steel-Mesh Debris Barrier (Güneysu – Rize)**



**Steel-Mesh Debris Barrier (Trabzon)**

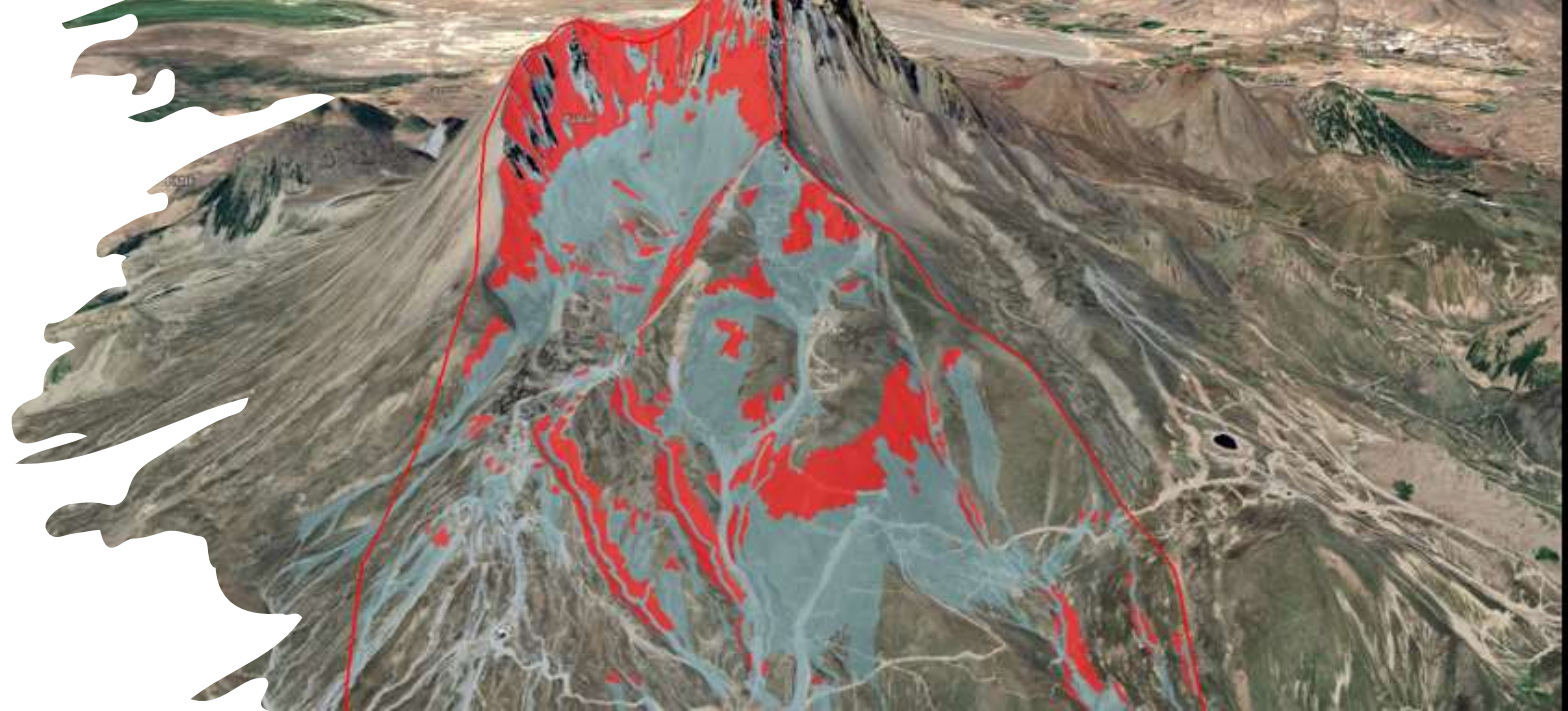


**Cage Wire Fence (Muş)**



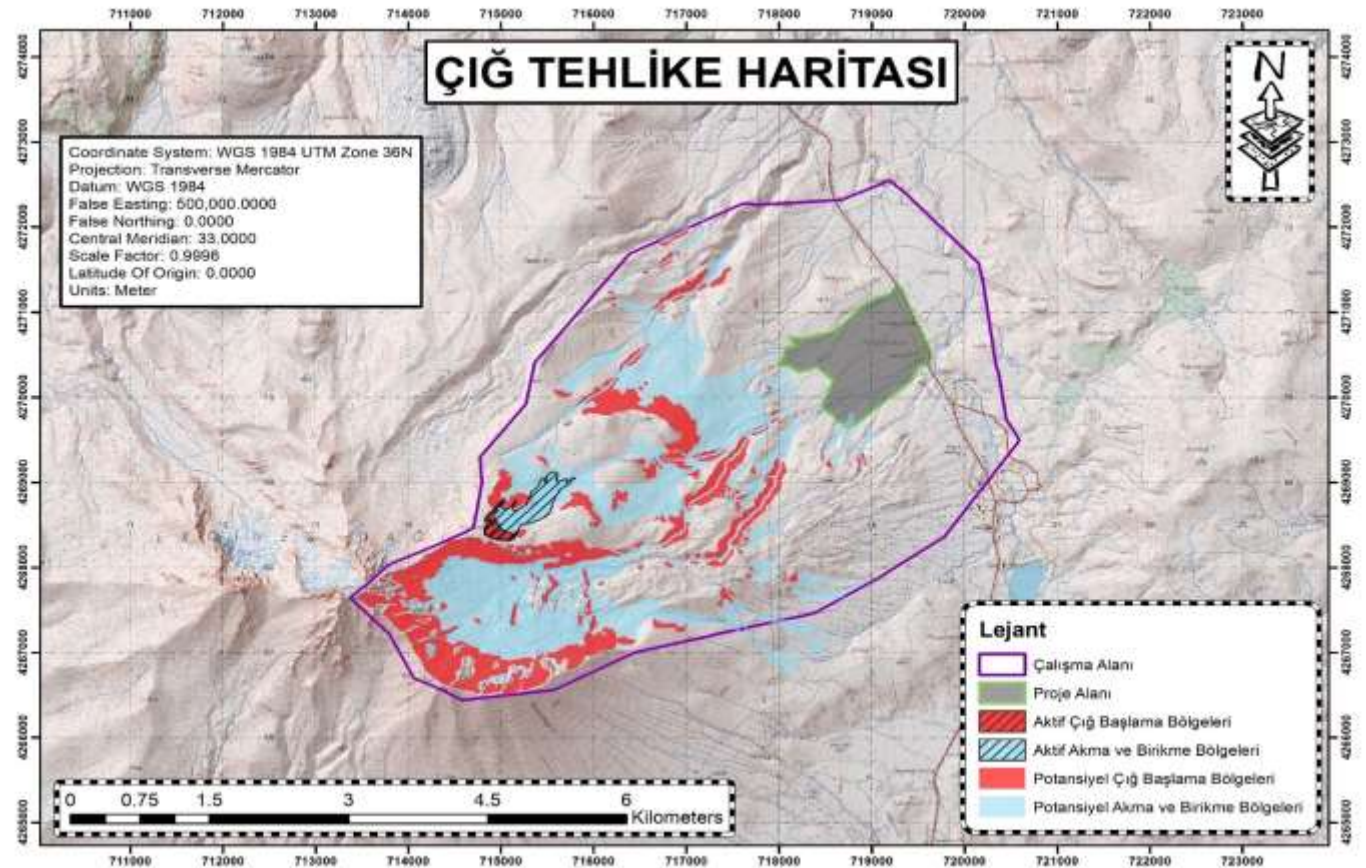
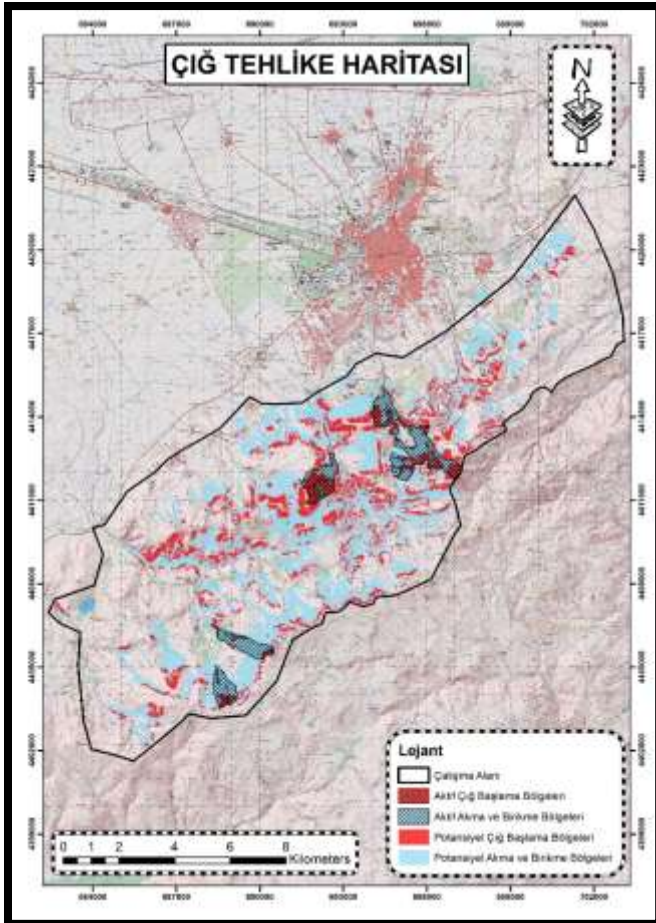
**Wooden Check Dam (Ankara)**

# Avalanche Control Activities





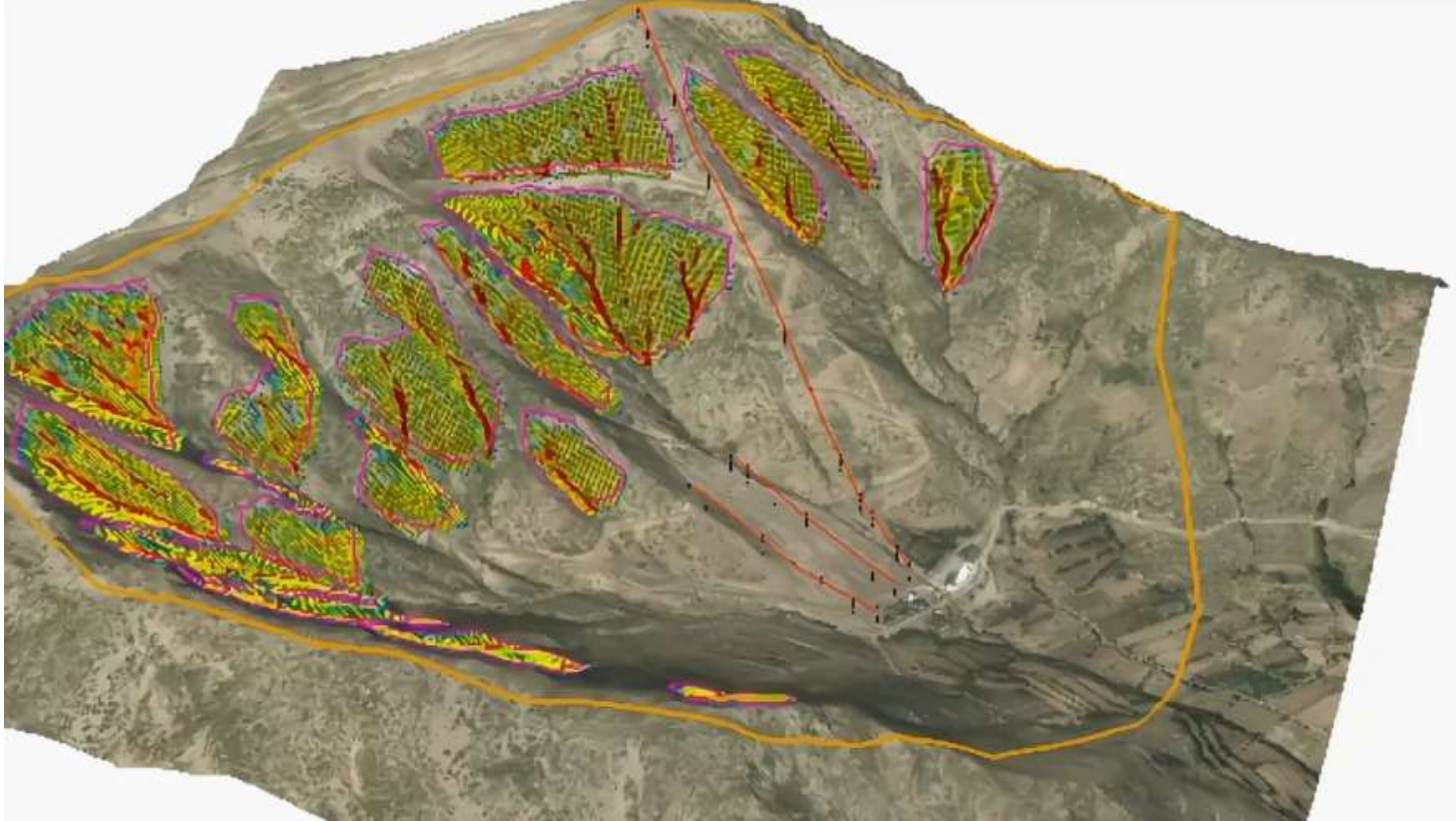
# ÇİĞ BAŞLAMA BÖLGELERİ ve AKMA BÖLGELERİNİN TESPİTİ İLE ÇİĞ TEHLİKE HARİTALARI





# ÇİĞ BAŞLAMA BÖLGELERİ ve AKMA BÖLGELERİNİN TESPİTİ ile ÇİĞ TEHLİKE HARİTALARI

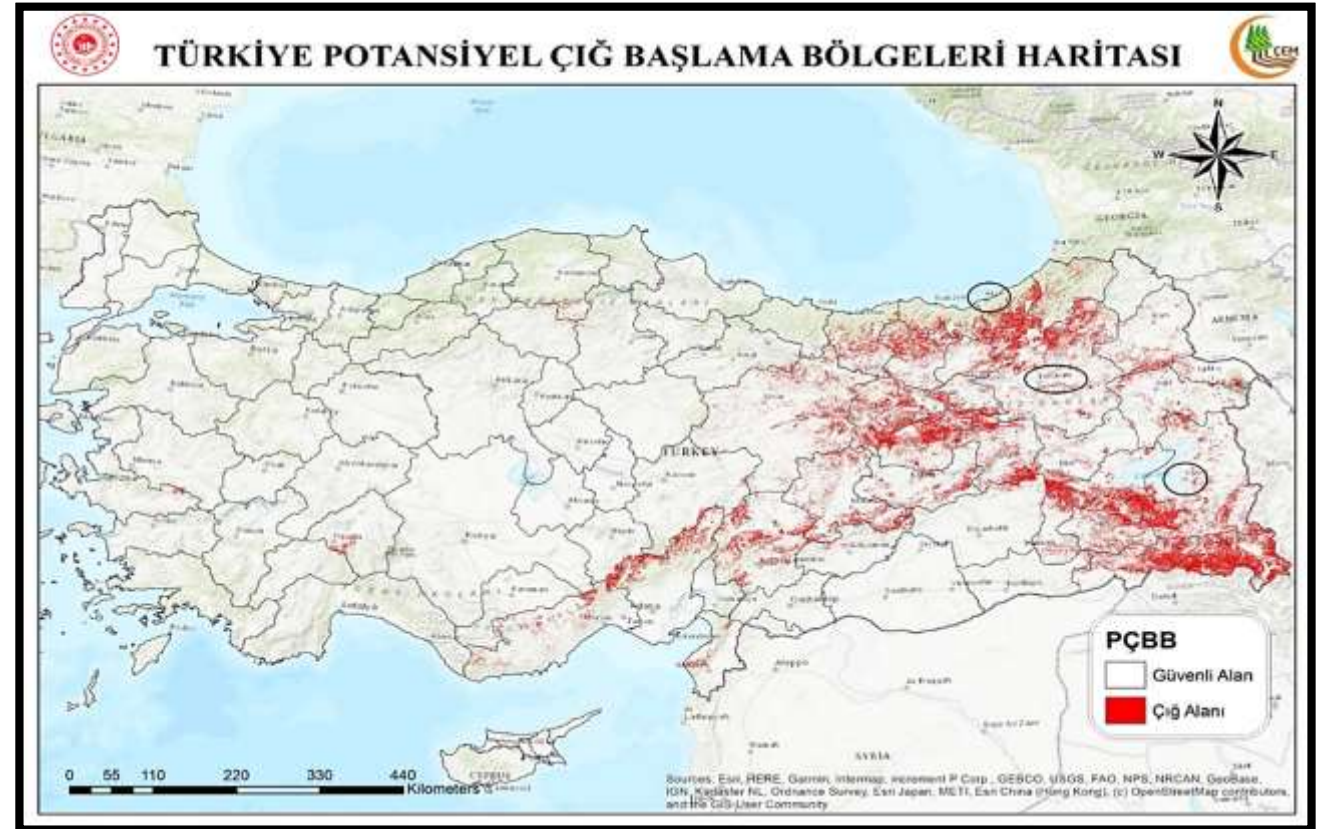
## IZMIR BOZDAĞ SKI CENTER AVALANCHE CONTROL PROJECT (2D RAMMS SIMULATION)





# ÇİĞ BAŞLAMA BÖLGELERİ ve AKMA BÖLGELERİNİN TESPİTİ ile ÇİĞ TEHLİKE HARİTALARI

Upon the request of the **Turkish Armed Forces**, we identify potential avalanche starting zones in the **Eastern and Southeastern Anatolia Region** for use in counter-terrorism activities during the winter months, and ensure the identification of safe walking routes.





# ÇİĞ BAŞLAMA BÖLGELERİ ve AKMA BÖLGELERİNİN TESPİTİ İLE ÇİĞ TEHLİKE HARİTALARI

## ÇEM AVALANCHE MOBILE APP



Mobil cihazdaki konum bilgisine göre çığ tehlike alanına girmeden önce belli mesafelerde **Uyarı Sistemi** devreye girerek kaç metre yaklaşıldığı sinyali verecektir.



**Dikkat! 500 m sonra çığ bölgesine gireceksiniz.**



**Dikkat! çığ bölgesi içindediniz.**





- (1) Snow Curtain (Ayıkayası - Bolu),
- (2) Wooden Snow Bridges (Ayıkayası - Bolu),
- (3) Tripods and Snow Stakes (Ayıkayası - Bolu),
- (4) Steel Snow Bridge (Karaçam - Trabzon)

## Wooden Snow Bridges (Ayıkayası – Bolu)



Çiğ Kontrolü Çalışmaları Üzungöl - Trabzon

Selçuk Akbaş 2010



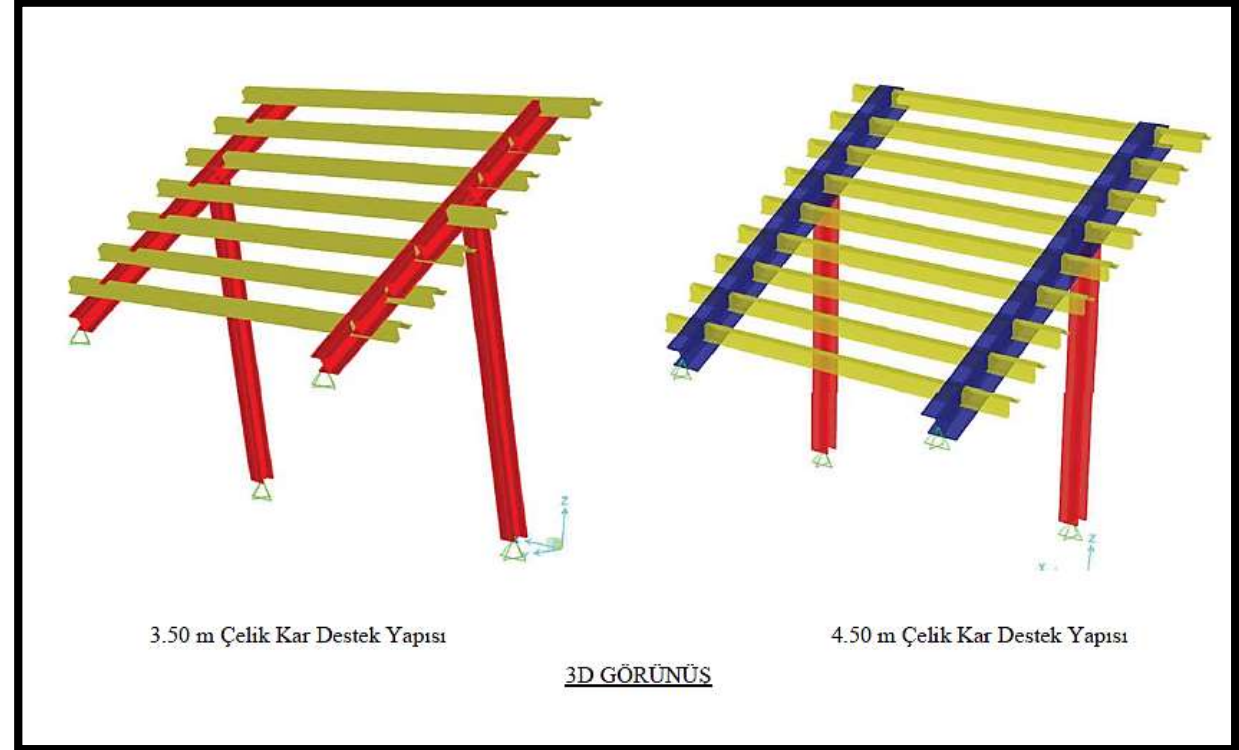
Çiğ Kontrolü Çalışmaları Üzungöl - Trabzon

Selçuk Akbaş 2010

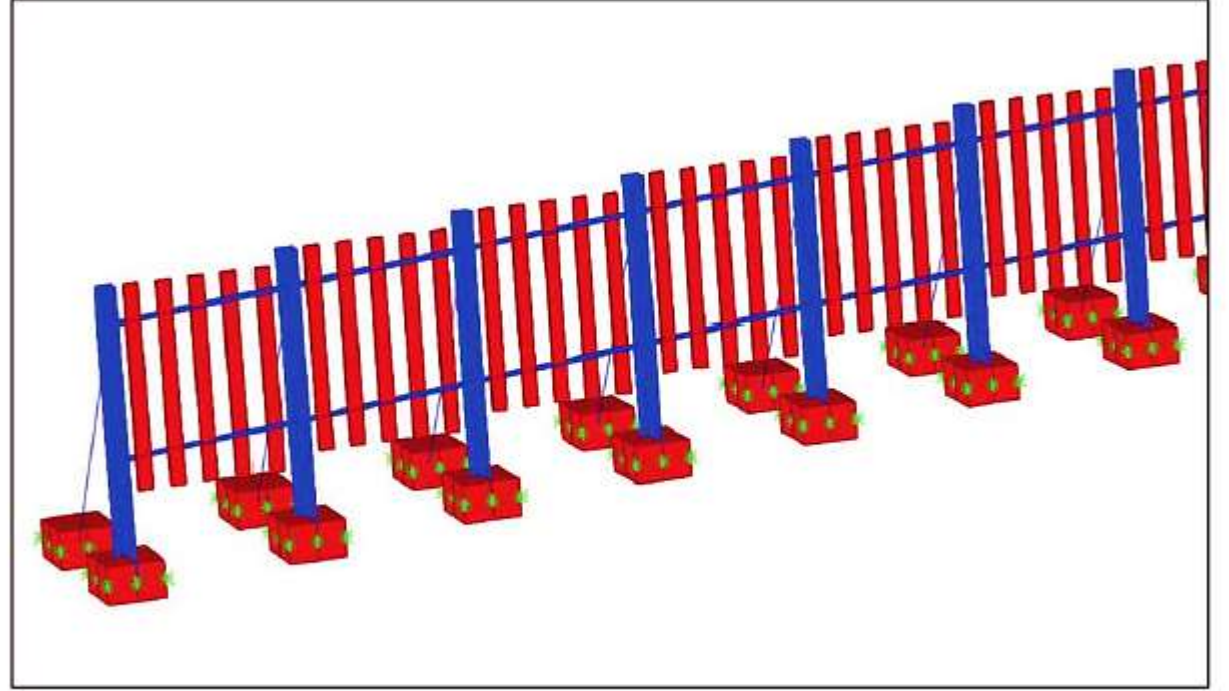
## Stell Snow Nets (Üzungöl - Trabzon)



## KAR KÖPRÜLERİ SAP2000 ANALİZLERİ



## Steel Snow Bridges (Bozdağ - İzmir)



3D GÖRÜNÜSÜ (4.5 m Rüzgar Perdesi)

## Snow curtains (Bozdağ - İzmir)



## Energy Breaker Dam and Storage Dam (Bozdağ - İzmir)

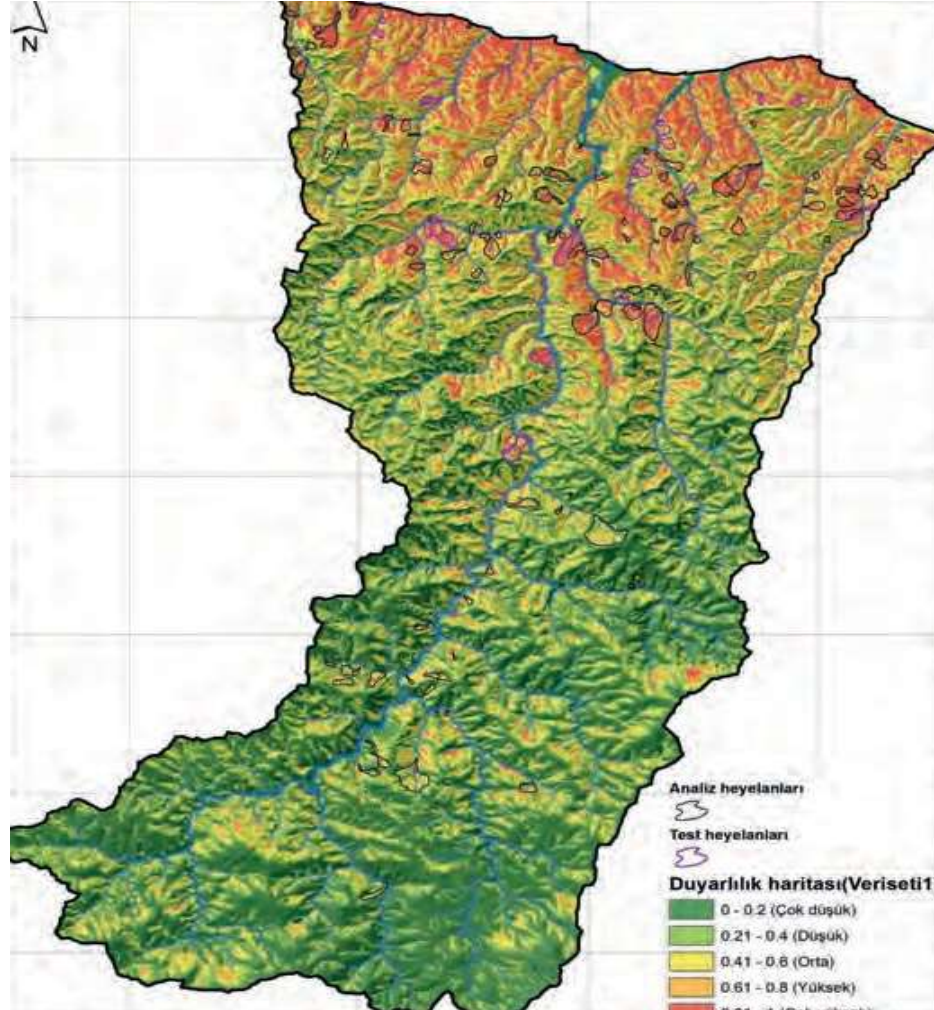


## Storage Dam (Bozdağ - İzmir)



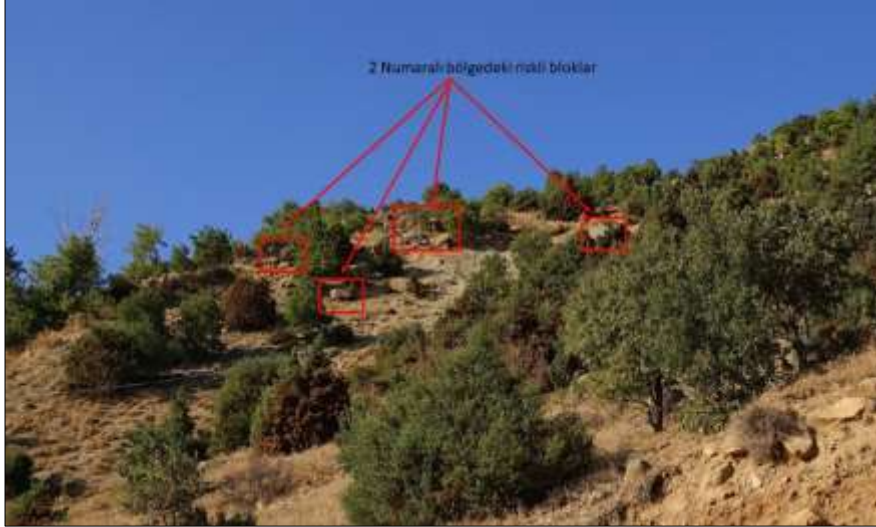
# Landslide Control Activities





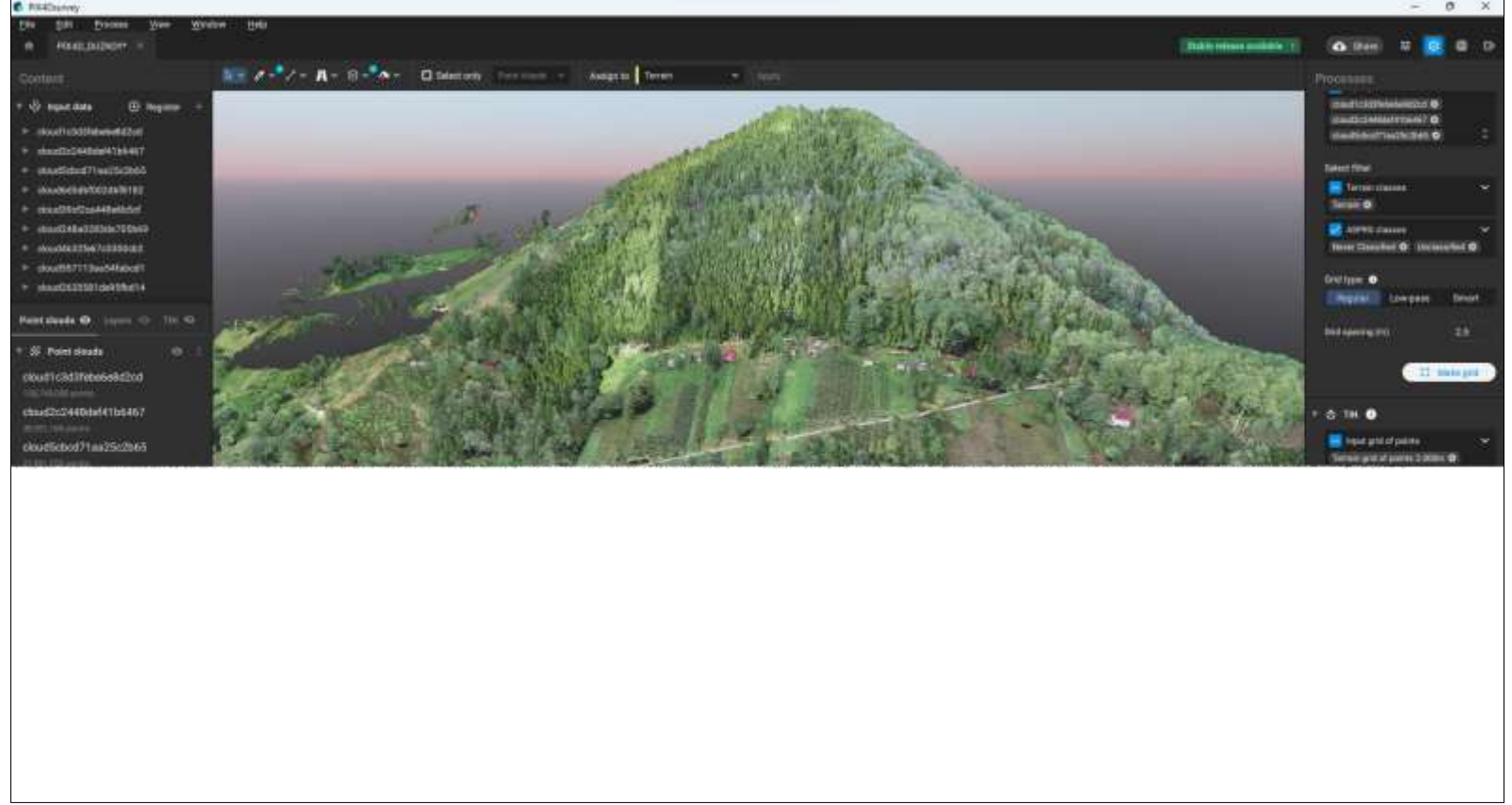
Landslide susceptibility and hazard maps can be produced with

1. Artificial Neural Network
2. Sinmap
3. Frequency Method
4. Logistic Regression Methods



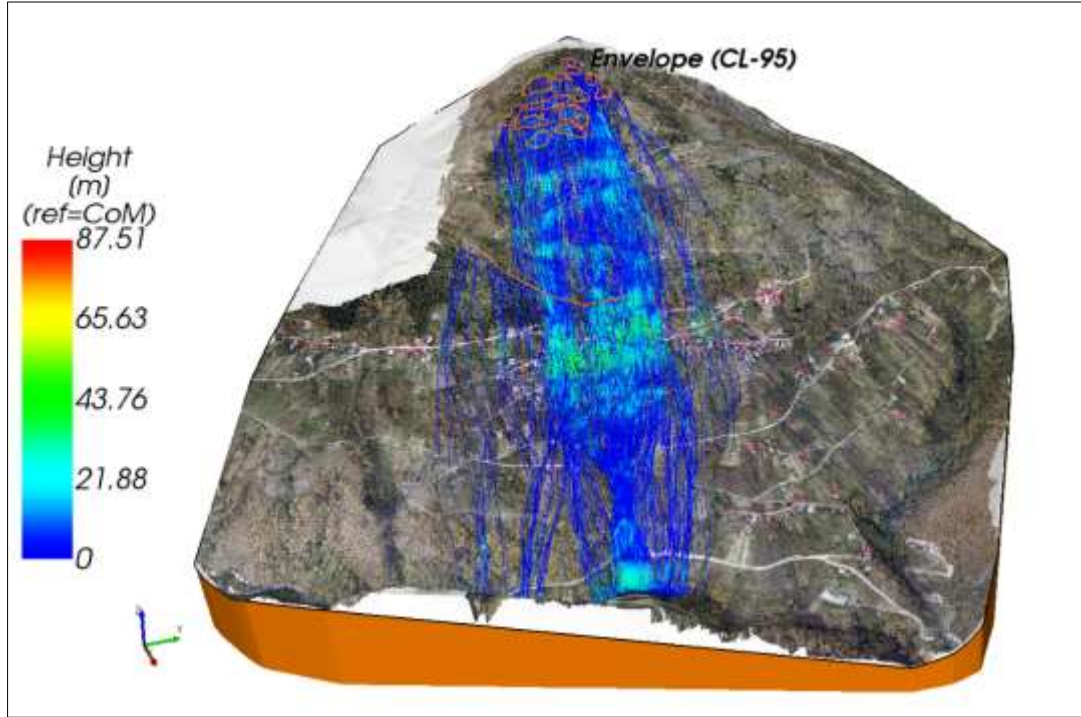
Line Surveys at Rock Source Points within the Scope of Tunceli Merkez Alibaba Area Rockfall Project and Terrain Model Created by Unmanned Aerial Vehicle



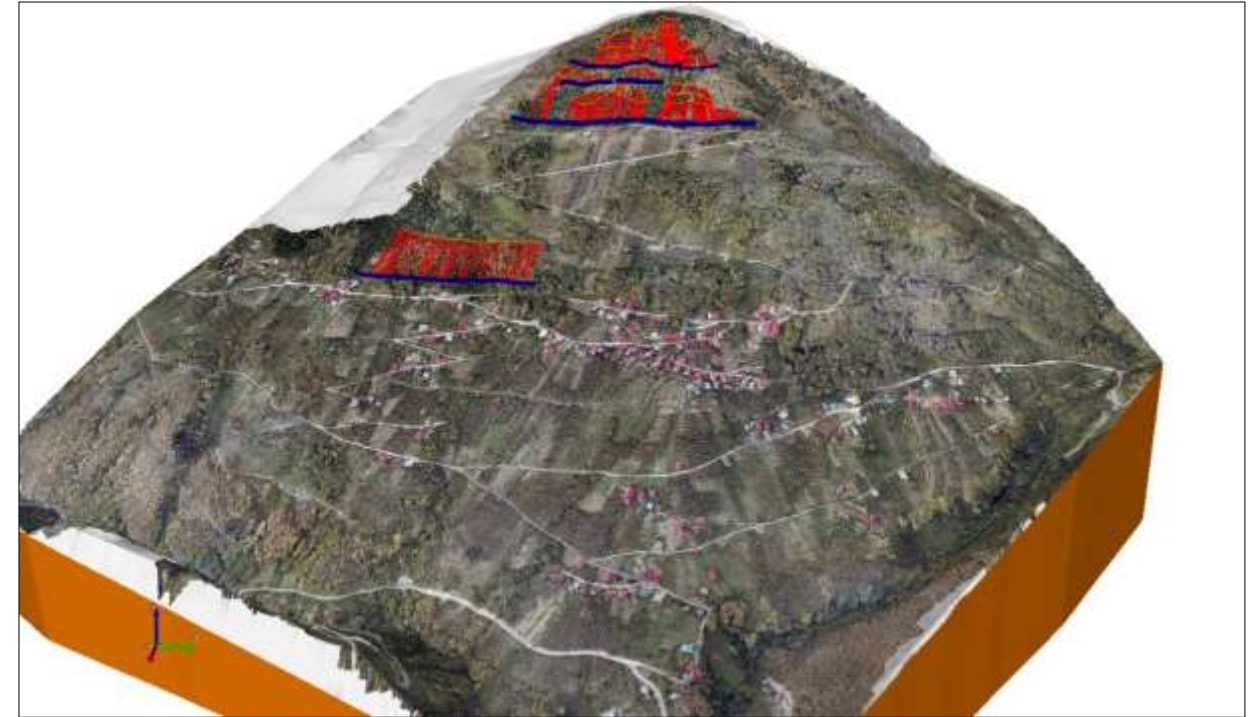


Large Rock Masses on Taşocağı Neighborhood of Düzköy District of Trabzon Province and Digital Surface Model obtained with LIDAR

## Trabzon İli Düzköy İlçesi Taşocağı Mahallesi



Map of bounce height of rolling blocks from welds



Stopping of moving blocks by steel barrier

