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# Climate Change Adaptation and Implementation Actions Plan for the Eastern Anatolia Region, Türkiye

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## List of Abbreviations

| Abbreviation | Full Form |
|---|---|
| **AFAD** | Disaster and Emergency Management Authority (Afet ve Acil Durum Yönetimi Başkanlığı) |
| **DAP** | Eastern Anatolia Project Regional Development Administration (Doğu Anadolu Projesi Bölge Kalkınma İdaresi) |
| **DKMP** | General Directorate of Nature Conservation and National Parks (Doğa Koruma ve Milli Parklar Genel Müdürlüğü) |
| **DSİ** | State Hydraulic Works (Devlet Su İşleri Genel Müdürlüğü) |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **GIS** | Geographic Information Systems |
| **HHAP** | Heat Health Action Plan |
| **IPA** | Instrument for Pre-Accession Assistance (European Union) |
| **IUCN** | International Union for Conservation of Nature |
| **IWRM** | Integrated Water Resources Management |
| **MGM** | Turkish State Meteorological Service (Meteoroloji Genel Müdürlüğü) |
| **MoEUCC** | Ministry of Environment, Urbanization and Climate Change |
| **NGO** | Non-Governmental Organization |
| **OGM** | General Directorate of Forestry (Orman Genel Müdürlüğü) |
| **PPP** | Public-Private Partnership |
| **SECAP** | Sustainable Energy and Climate Action Plan |
| **SMS** | Short Message Service |
| **TARSİM** | Agricultural Insurance Pool (Tarım Sigortaları Havuzu) |
| **TEİAŞ** | Turkish Electricity Transmission Corporation (Türkiye Elektrik İletim A.Ş.) |
| **TÜBİTAK** | Scientific and Technological Research Council of Türkiye |
| **TÜBA** | Turkish Academy of Sciences |
| **UNDP** | United Nations Development Programme |

| Abbreviation | Full Form |
|---|---|
| **WWF-Türkiye** | World Wide Fund for Nature – Türkiye Office |

# 1. Introduction

Eastern Anatolia—a high-altitude, continental region—has warmed well above the global average over the past half-century. Mean winter temperatures are up by roughly 2 °C and summers by 1.5 °C, shortening snow cover by about two weeks and reducing peak snow depths by 16 cm. This earlier, faster melt deprives communities and ecosystems of the steady spring runoff they once relied on. While total annual precipitation has remained broadly stable, its delivery is becoming more erratic: prolonged dry spells punctuated by intense downpours now trigger flash floods and landslides on steep terrain. Historic cold snaps still occur, and new summer heatwaves—once inconceivable at high elevations—pose fresh health and agricultural risks.

**Key Climate Risks in Eastern Anatolia**

- **Drought & Water Scarcity:** Longer dry periods and higher evaporation threaten rivers, lakes (e.g., Lake Van's shoreline has retreated over a kilometer), and headwater runoff—projected to decline by up to 55 % by century's end.
- **Flash Floods & Landslides:** Intense rain-on-snow or cloudbursts cause rapid river rises and slope failures, as seen in Muş (July 2024), damaging farmland and infrastructure.
- **Snowmelt Variability:** Warmer winters mean more rain than snow, earlier melt-offs, spring floods, and reduced summer streamflow—undermining agriculture and hydropower scheduling.
- **Extreme Cold Events:** Despite overall warming, sudden cold-air incursions still strike (temperatures below –30 °C), demanding continued winter-proofing of homes, pipes, and roads.

# 1. Climate-Resilient Water Resources and Drought Management

The high-altitude basins of Eastern Anatolia are experiencing deeper droughts, earlier and faster snowmelt, and more erratic rainfall. These shifts threaten drinking water supplies, spring-fed villages, irrigated agriculture, and reservoir operations. A coordinated mix of supply-side

storage, demand-side efficiency, watershed restoration, and early warning is essential to safeguard water security.

## 2.1 Integrated Adaptation Actions and Implementation Measures

- **Integrated Water Resources Management (IWRM)**
  - Establish a **basin-level Water Coordination Board** including DSİ, provincial officials, and user associations.
  - Revise **reservoir operating rules** using updated climate projections to balance surface water, groundwater, and ecological flow needs.
- **Enhanced Water Storage**
  - Expedite the construction of **small and medium-sized reservoirs** and **off-stream storage ponds** with DAP funding.
  - Rehabilitate **traditional stone cisterns** and **revive village ponds** to store excess wet-season runoff.
  - Line and pipeline **existing canals** to reduce losses during water conveyance.
- **Water Conservation and Efficiency**
  - Promote **drip and sprinkler irrigation systems**, supported by DAP incentives and technical guidance from agricultural extension teams.
  - Repair and modernize **urban and rural water distribution networks** with support from İller Bank.
  - Launch and maintain **public awareness campaigns** such as “Save Every Drop” to foster behavioral change around water use.
- **Drought Early Warning and Response**
  - Deploy **real-time weather and soil moisture monitoring stations** to detect early signs of drought.
  - Publish a **monthly Drought Warning Index** to activate preemptive measures, including borehole deployment, water rationing, and emergency tanker delivery.
  - Establish and activate **Provincial Drought Task Forces** based on defined drought thresholds.
- **Watershed Protection and Restoration**

- Afforest **degraded upland areas** and implement erosion control structures such as **check dams and terraces** to slow runoff and improve groundwater recharge.
- Collaborate with local communities and herders to introduce **rotational grazing** and **sustainable pasture management** in vulnerable watersheds.

## 2.2 Key Institutions Involved

- **State Hydraulic Works (DSİ)** — IWRM leadership, reservoir rule updates, storage projects
- **DAP Regional Development Administration** (Ministry of Industry & Technology) — funding and coordination of dams, irrigation modernization
- **Meteorological Service (MGM)** — climate monitoring stations, Drought Warning Index
- **Ministry of Agriculture and Forestry** — watershed afforestation, erosion control, extension services
- **Provincial Governorates & Water Coordination Board** — convening IWRM stakeholders, activating drought response
- **Local Water User Associations & Farmers' Cooperatives** — participatory irrigation scheduling and canal management
- **Iller Bank & Municipal Water Utilities** — financing and executing leak repairs and network upgrades


Figure 1. Climate Resilient Water Resources and Drought Management in Eastern Anatolia: Integrated Adaptation and Implementation Measures

Table 1. Adaptation Actions and Mitigation Measures for Climate-Resilient Water Resources and Drought Management – East Anatolian Region.

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| Integrated Water Resources Management | Form Water Coordination Board; update reservoir operating rules with climate data | DSİ; Provincial Governorates; Water Coordination Board |
| Enhanced Water Storage | Build small/medium reservoirs; rehabilitate cisterns; line irrigation canals | DSİ; DAP Regional Development Administration |
| Water Conservation & Efficiency | Subsidize drip/sprinkler systems; train farmers; repair urban/rural leaks | Ministry of Agriculture & Forestry; DAP; Iller Bank; Municipal Utilities |
| Drought Early Warning & Response | Install automated weather/soil stations; publish Drought Warning Index; activate drought task forces | Meteorological Service; Provincial Drought Task Forces |
| Watershed Protection & Restoration | Implement afforestation; check dams and terraces; rotational grazing plans | Ministry of Agriculture & Forestry; Local Water User Associations |

# 2. Agriculture & Food Security

Eastern Anatolia's farming systems—centered on cereals, sugar beets, legumes, and livestock—are under pressure from deeper droughts, erratic rainfall, temperature extremes, and emerging pests. Building resilience requires drought-tolerant crops, efficient water use, adaptive decision-making, strengthened livestock systems, and financial safety nets.

## 3.1 Integrated Adaptation Actions and Implementation Measures

- **Drought-Resilient Crops and Crop Diversification**
  - Introduce **fast-maturing, water-efficient varieties** of wheat, barley, lentils, chickpeas, and sorghum.

    - Establish **model climate-smart farms** in each province to demonstrate resilient cropping practices.
    - Distribute **improved seeds** with training and input subsidies through provincial agriculture directorates.
- **Efficient Irrigation and Rainwater Harvesting**
    - Expand **drip and sprinkler irrigation** systems with DAP-supported technical assistance and low-interest loans.
    - **Rehabilitate traditional farm cisterns** and ponds to harvest rainwater for supplemental irrigation.
    - Promote **contour plowing and mulching** techniques to conserve soil moisture and reduce erosion.
- **Adaptive Planting Schedules and Climate Services**
    - Install **automated weather stations** and build a localized **Climate Information System** for farmers.
    - Deliver **seasonal forecasts and advisories** via SMS, radio, and farmer field schools.
    - Update **sowing and harvesting calendars** based on shifting rainfall and temperature patterns.
- **Livestock and Pasture Adaptation**
    - Reseed degraded rangelands with **drought-tolerant forage species** and implement **pasture rotation plans**.
    - Construct **pasture water points**, **fodder storage facilities**, and **fodder banks** to ensure dry-season feed availability.
    - Promote **climate-resilient livestock breeds** and enhance **veterinary services and breed improvement programs**.
- **Crop Insurance and Safety Nets**
    - Expand and regionalize **TARSİM insurance coverage** to include drought and extreme climate events.
    - Provide **premium subsidies** for smallholder farmers and develop **mobile-based damage assessment teams**.
    - Establish **rapid-release relief funds** and activate **cash-for-work or direct aid** schemes during severe climate shocks.

## 3.2 Key Institutions Involved

- **Ministry of Agriculture & Forestry** (General Directorates of Crop Production & Agricultural Reform)
- **Provincial Agriculture Directorates & Extension Centers**
- **Erzurum Atatürk University & Research Institutes** (crop breeding, pilot trials)
- **DAP Regional Development Administration** (funding and coordination)
- **State Hydraulic Works (DSİ)** (canal lining, water storage)
- **Meteorological Service (MGM)** (weather stations, advisories)
- **TARSİM (Agricultural Insurance Pool)**
- **Farmers' Cooperatives & Water User Associations**
    - schemes during severe climate shocks.

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- **Ministry of Agriculture & Forestry** (General Directorates of Crop Production & Agricultural Reform)
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- **Meteorological Service (MGM)** (weather stations, advisories)
- **TARSİM (Agricultural Insurance Pool)**
- **Farmers' Cooperatives & Water User Associations**

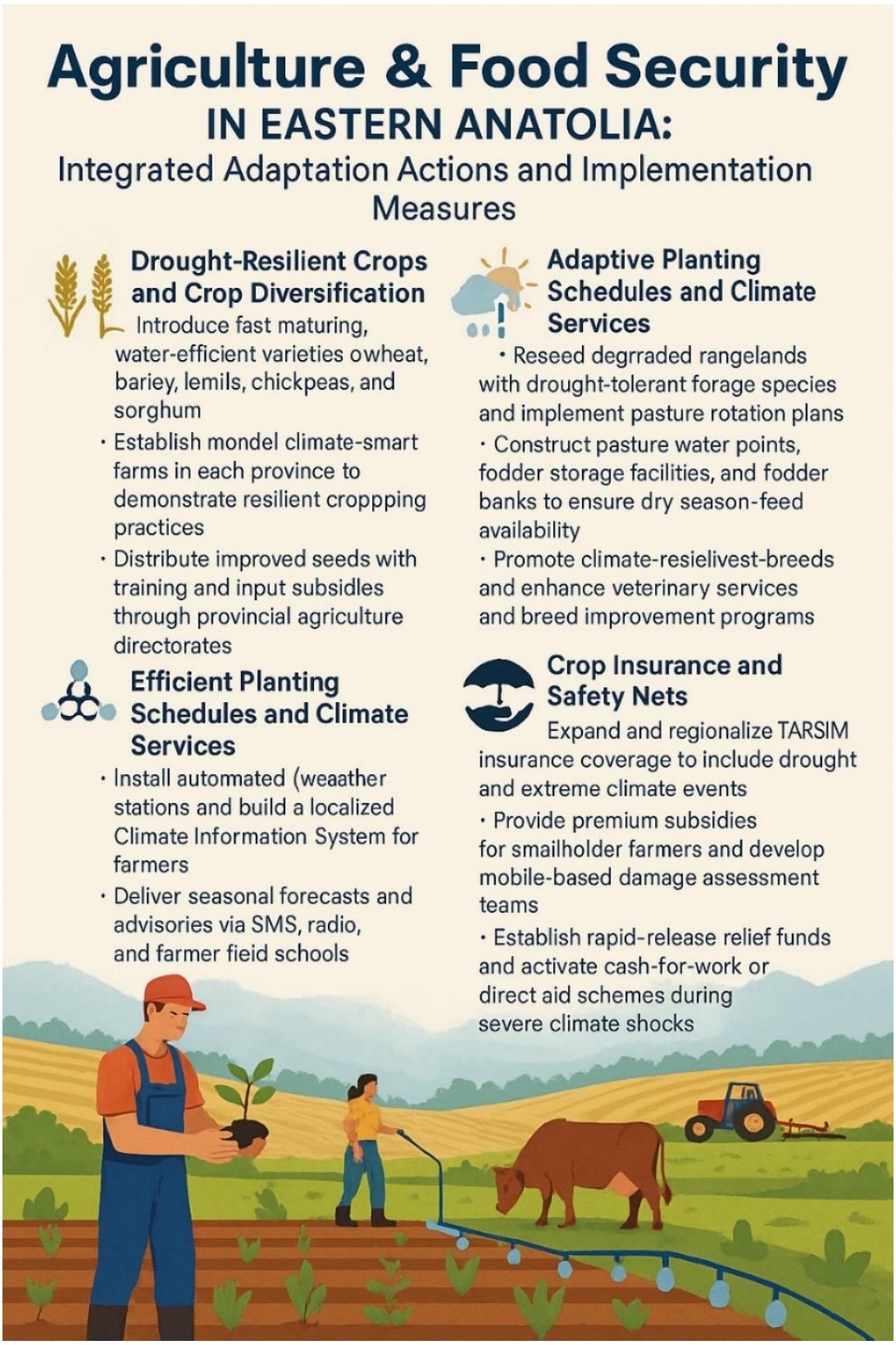


Figure 2. Agriculture & Food Security in Eastern Anatolia: Integrated Climate Adaptation and Implementation Measures

Table 2. Adaptation Actions and Mitigation Measures for Agriculture and Food Security – East Anatolian Region.

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| Drought-Resilient Varieties & Diversification | Model farms; seed distribution; training and input subsidies | Ministry of Agriculture & Forestry; Provincial Directorates; Universities |
| Efficient Irrigation & Rainwater Harvesting | Micro-irrigation loans; cistern rehabilitation; canal lining under DAP | DSİ; DAP Administration; Extension Centers |
| Adaptive Planting Schedules & Climate Services | Weather stations; SMS/radio advisories; Farmer Field Schools | MGM; Ministry of Agriculture; Farmers' Cooperatives |
| Livestock & Pasture Adaptation | Rangeland reseeding; water point construction; communal fodder banks; breed improvement and vet outreach | Ministry of Agriculture & Forestry; Local Herders' Associations |
| Crop Insurance & Safety Nets | Regional TARSİM schemes; premium subsidies; rapid-release relief funds; mobile assessment teams | TARSİM; Provincial Governorates; Ministry of Agriculture |

# 3. Sustainable Energy & Infrastructure Resilience

Eastern Anatolia's energy landscape is highly sensitive to both climate variability and long-term climate change. The region's heavy reliance on hydropower exposes it to risks from reduced river flows and changing snowmelt patterns, while rising urban cooling needs and extreme weather events are putting increasing pressure on both electricity demand and infrastructure reliability.

To build a resilient and sustainable energy future, the region must act on multiple fronts: diversifying renewable energy sources beyond hydropower, upgrading infrastructure to withstand climate extremes, improving energy efficiency in buildings, and embedding climate

adaptation directly into energy planning processes at local levels. This integrated strategy will ensure that both climate risks and emission reduction goals are addressed simultaneously, creating a modern and secure energy system for the decades ahead.

## 4.1 Integrated Adaptation Actions and Implementation Measures

- **Diversify Renewable Energy Sources**
  - Harness **solar energy potential** in high-altitude, clear-sky regions by installing **rooftop solar panels** on public buildings (schools, hospitals, municipal centers).
  - Accelerate **wind energy development** through fast-track feasibility studies in plateaus and ridges (e.g., Ardahan, Ağrı, Iğdır).
  - **Modernize the grid** to support the integration of variable renewable energy sources and enable smart energy management (smart grids and demand response systems).
  - Promote **net metering** and **community energy cooperatives** to encourage local-scale renewable adoption.
- **Enhance Energy Efficiency and Climate-Resilient Building Design**
  - Conduct **energy audits** of public buildings and launch large-scale **retrofit programs** targeting insulation, efficient stoves, and heat pumps.
  - Provide **grants and soft loans** for private buildings to invest in **energy efficiency upgrades**, such as double-glazing and thermal envelopes.
  - Promote **urban cooling solutions**, including **Cool Roofs** (reflective surfaces) and **Green Roofs** (vegetated surfaces), to reduce urban heat island effects and improve indoor thermal comfort.
  - Reduce peak electricity demand and heat-related health risks through improved building standards.
- **Strengthen Energy Infrastructure Resilience**
  - Convert vulnerable **overhead power lines** to **underground cabling** in critical zones; install **weatherproof and insulated wiring** and **stronger utility poles** to withstand snow, wind, and ice loads.
  - **Update hydropower dam operations** to improve resilience to both droughts and sudden floods from snowmelt variability.

    - Install **solar-plus-battery** or **hybrid backup systems** in **critical infrastructure** (hospitals, emergency centers, communication towers) to ensure functionality during climate-induced grid failures.
- **Mainstream Climate Adaptation in Energy Planning (SECAPs)**
    - Support municipalities in developing **Sustainable Energy and Climate Action Plans (SECAPs)** within the Covenant of Mayors framework.
    - Provide **technical guidance, standardized planning tools, and localized climate data** to embed climate adaptation and mitigation goals into long-term energy planning.
    - Train **municipal engineers and planners** in climate-resilient energy system design and renewable energy integration through dedicated workshops and capacity-building programs.
- **Enable Investment and Financing for Energy Transition**
    - Foster **public-private partnerships (PPPs)** to mobilize capital for utility-scale **solar and wind projects**.
    - Reform regulations to expand **net metering** and incentivize **small-scale renewable energy investments** by households and businesses.
    - Establish and support **community-owned energy cooperatives** to enhance public engagement and ownership in clean energy development.

## 4.2 Key Institutions Involved

- **Ministry of Energy and Natural Resources**
  Responsible for national renewable energy policy, feasibility studies, regulatory reform, and incentives to ensure diversified and climate-resilient energy generation.
- **Turkish Electricity Transmission Corporation (TEİAŞ)**
  Leads grid upgrades, system resilience planning, undergrounding projects, and smart grid deployments.
- **Iller Bank and Regional Development Agencies**
  Provide financial support for local governments and cooperatives to invest in energy efficiency, renewable installations, and climate-resilient infrastructure.

- **Ministry of Environment, Urbanization & Climate Change**
  Guides SECAP preparation, climate risk assessments, and sets energy performance standards for buildings.
- **Municipalities and Provincial Administrations**
  Local implementation of SECAPs, oversight of building retrofit programs, operation of municipal renewable energy installations.
- **Electricity Distribution Companies**
  Execution of distribution-level resilience projects, including overhead line reinforcement, underground cabling, and maintenance of local grids.
- **Universities, Technical Institutes, and Research Centers**
  Conduct feasibility studies, workforce training, and provide expertise in renewable energy technologies, energy planning, and climate risk modeling.

# SUSTAINABLE ENERGY & INFRASTRUCTURE RESILIENCE

Eastern Anatolia's energy landscape highly sensitive to both dimate variability and long-term climate-change las preszed simplitento spadrour er buids into risks from reduced river flows, changing snowmeit patterns, while fising urbon cooling neestod, This intograted strategy will ensure that both climate risks and emission reduce -goal are addressed simpllimeimend and secure energy system for the decades ahead.

## Diversify Renewable Energy Sources

- Harness solar energy potential in high-altidude, clear-sky regions by installing roottop solor panels on public buildings (schools, hospitals, municipal centers)
- Accelerate wind energy deelopment through fast-track feasibility studies in olateaus and ridges (e:g. Ardahan. Agri, ldgh)
- Modernize the glid to support the integration of variable renewable energy sources and enable smart energy management (smart grids and demand response systems)
- Promote net metering and community energy cooperative= to encourage local-scale renewable adeption

## Enhance Energy Efficiency and Climate-Resillent Building Design

- Conduct energy audits of public buildings and launch large-scale retrofit programs fargeting insulation. efficient stoves, and heat pumps.
- Provide grants and soft loans for private buildings to invess in energy efficiency upgrades: such as double glazing and thermal envelopes
- Promete urban cooling solutions. Including. Cool Roofs (reflective surfaces) and Green hofs (vegetated surfaces), to reduce urban heat island effects and improve inidoor. thermal comi-t antards

## Mainstream Climate Adaptation in Enargy Planning (SECAPs)

- Support muntcipalities in developing Sustainable Energy and Climate Action Plans (SECAPs) within the Covenant of Maysrs framework
- Provide technical guidance, standardized larning tools and localized climple data to embed climate adap-

Figure 3. Sustainable Energy & Infrastructure Resilience in Eastern Anatolia: Integrated Adaptation and Implementation Measures

Table 3. Adaptation Actions and Mitigation Measures for Sustainable Energy & Infrastructure Resilience – East Anatolian Region.

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| Diversify with Solar & Wind | Equip public buildings with rooftop solar; identify wind farm sites; expand smart grid and transmission systems | Ministry of Energy, TEİAŞ, Iller Bank |
| Energy Efficiency & Green Buildings | Conduct energy audits; retrofit homes and public buildings with insulation, cool/green roofs, efficient heating/cooling systems | Municipalities, Ministry of Environment, Development Agencies |
| Climate-Proof Energy Infrastructure | Underground critical power lines; upgrade to storm-resistant poles and wiring; install backup power at essential service sites | TEİAŞ, Electricity Distributors, Ministry of Energy |
| Integrate into Energy Planning (SECAPs) | Municipal staff training; provide planning toolkits; assist in SECAP preparation and implementation | Ministry of Environment, Municipalities, Provincial Administrations |
| Modernize Hydropower Operations | Update reservoir management to accommodate more variable inflows; balance flood safety and energy security | Dam Operators, Ministry of Energy, DSİ |
| Build Public-Private and Community Models | Develop PPP frameworks for renewable investments; promote community energy cooperatives; encourage net metering adoption | Ministry of Energy, Private Sector, Cooperatives |

# 4. Public Health

In Eastern Anatolia, climate change is reshaping health risks beyond the cold-related challenges the region is accustomed to. Rising temperatures, water scarcity, flood events, the northward spread of disease vectors, and mental health stresses linked to climate-related disruptions are all emerging as serious threats. To safeguard community well-being, health systems must

anticipate, adapt, and build resilience across prevention, treatment, infrastructure, and community outreach.

## 4.1. Integrated Adaptation Actions and Implementation Measures

- **Heat Health Action Plans (HHAPs) and Heatwave Response**
  - Develop and activate **early warning systems** linked to Turkish State Meteorological Service (MGM) alerts.
  - Issue **public advisories via SMS**, radio, and social media during high-heat periods.
  - Establish **community cooling centers** in schools, mosques, municipal buildings, and nursing homes.
  - Ensure **hospital preparedness protocols** are updated for surge capacity during heatwaves.
- **Climate-Proofing Healthcare Infrastructure**
  - Retrofit clinics and hospitals with **thermal insulation**, **backup generators**, and **emergency water storage**.
  - Elevate electrical systems in **flood-prone health centers** and strengthen building resistance to temperature extremes.
  - Deploy **mobile health units** to ensure continued access in remote or disaster-affected areas, equipped for year-round operations.
- **Disease Surveillance and Vector Control**
  - Expand **early warning systems** for **climate-sensitive diseases** (e.g., Crimean-Congo Hemorrhagic Fever, malaria, food/waterborne illnesses).
  - Integrate **One Health approaches** by linking human, animal, and environmental disease surveillance.
  - Intensify **vector control campaigns**, **vaccination outreach**, and **public education** especially during extended warm seasons.
- **Emergency Health Preparedness and Response**
  - Pre-stock **medical emergency kits** in high-risk flood, drought, and landslide zones.
  - Train **first aid volunteers** (Red Crescent, local NGOs) in climate-induced emergency care.

    - Expand **mental health mobile teams** for psychological first aid and long-term climate trauma support.
    - Revise and test **provincial disaster health response plans** to account for multiple and compound hazards.
- **Food and Nutrition Security**
    - Monitor **child health and nutrition indicators** to detect early signs of climate-linked malnutrition.
    - Scale up **supplementary feeding and nutrition assistance** programs during harvest failures or prolonged droughts.
    - Partner with agriculture and social services to create **resilience-based safety nets** for at-risk households.
- **Climate-Health Risk Assessments**
    - Conduct **climate-health vulnerability mapping** across provinces to identify hotspot communities.
    - Integrate findings into **provincial health master plans**, ensuring data-driven resource allocation and capacity planning.
- **Community Engagement and Digital Health Services**
    - Form **community health committees** to champion local resilience measures and act as first responders.
    - Promote **telemedicine** and remote diagnostics to maintain healthcare delivery during extreme weather or road inaccessibility.
    - Utilize local leaders and NGOs to **bridge communication gaps**, especially in underserved and nomadic populations.

## 5.2 Key Institutions Involved

- **Ministry of Health** — Lead coordination for climate-health risk assessments, infrastructure resilience, disease surveillance, vaccination, and health workforce training.
- **Meteorology General Directorate (MGM)** — Issue early warnings for extreme heat and support public alert systems.
- **AFAD (Disaster and Emergency Management Authority)** — Lead health-related emergency preparedness and integrate health risks into disaster planning.

- **Provincial Health Directorates** — Implement local HHAPs, disease monitoring, hospital preparedness, and community outreach.
- **Turkish Red Crescent (Kızılay)** — Train community volunteers in first aid, run mobile health units and post-disaster mental health teams.
- **Municipalities and Provincial Administrations** — Operate cooling centers, integrate health into climate adaptation planning, maintain clean water access.
- **Veterinary Services & Agricultural Agencies** — Coordinate animal health surveillance under the One Health framework to prevent zoonotic outbreaks.
- **Universities and Research Centers** — Conduct climate-health risk modeling and scenario-based planning studies to inform public health strategies.

## Public Health

In Eastern Antolia, climate.change is resphaping health risks beyond the cord-related challenges the region is accomusted to Risihg temperatures, water scarcity flond events, the norihward spread of disease vectors, and climate related disruptions are all emerging as serious threats. Health systems rruist anticipate, adapt, and bulld resilience acress prevention, treatment, infrastructure.

### Integrated Adaptation Actions and Implementation Measures

**Heat Health Action Plans (HHAPs) and Heatwave Response**

- Develop and activalo early warning systems linked to Turkish State Metegrological Service (MGM) alerts
- issul public advisories vis SMS, radio, and sociai media during high heat periods
- Establish community cooling centers in schools, musques, mumcipal buildings, and nuraing homes
- Update hospital preparedness protocols surge capacity during heatwaves.

**Climate-Proofing Healthcare Infrastructure**

- Retrofit clinics and hospitals with thermal lnisulation, beckup generators. and emergency water storage
- Elevate electrical systems in flood-prone health centers and strengthen bullding resistance to temperature extre-
- Deploy mobile health units to ensure continued access in remote or disaster-affected areas, equipn

**Emergency Health Preparedness and Response**

- Pre-stock medical emergency kits in high-risk hood, drought, and lansslide zones·
- Train first ald volunteprs (Red Crescent, local NGOs) in climate-induced emergency care
- Expand mental health mobile teans for psychological first aid and long-term climate traumd support
- Revise and test provincial disaster health resporians to account for multiple and compound hazards,

**Food and Nutrition Security**

Momtor child health and riutrhiph indicators to detect early signs of climate·linked malnutrition

- Scale up supplementary feeding and nutriton assistance programs dirring hatvest failures or prolonged droughts
- Partner with epticulture and social services to create resiilience-based safety nets for at-risk households

**Community Engagement and Digital Hnit Services**

- Form community health committees to champicn locall eece lience measures and act as responders.
- Telemedicine and remote diagnostics tics to maintain heallcarce delivery during extreme *weather* or road ıhaccessibility

Figure 4. Public Health in Eastern Anatolia: Integrated Adaptation and Implementation Measures

Table 4. Adaptation Actions and Mitigation Measures for Public Health – East Anatolian Region.

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| Heat Health Action Plans (HHAPs) | Launch heatwave early warning systems, establish cooling centers, issue public advisories | Ministry of Health, MGM, Municipalities |
| Healthcare Infrastructure Climate-Proofing | Insulate facilities, add backup power/water, flood-proof vulnerable sites, deploy mobile health units | Ministry of Health, Provincial Health Directorates, AFAD |
| Disease Surveillance & Vector Control | Expand monitoring for vector-borne and waterborne diseases, implement prevention campaigns | Ministry of Health, Veterinary Services, Municipalities, Red Crescent |
| Emergency Preparedness for Health | Pre-stock medical supplies, train first aid volunteers, expand mental health support after disasters | AFAD, Red Crescent, Provincial Health Directorates, Municipalities |
| Food and Nutrition Security | Scale up food aid, monitor malnutrition and provide targeted feeding in drought-affected or food-insecure areas | Ministry of Health, Ministry of Agriculture, Municipalities |
| Climate-Health Risk Assessments | Conduct long-term risk scenario mapping, integrate findings into public health planning | Ministry of Health, Universities, Research Centers |
| Community Engagement & Telemedicine | Establish health committees, expand telemedicine for continuity of care during extreme events | Ministry of Health, Municipalities, Red Crescent |

# 5. Climate-Resilient Urban Infrastructure and Housing

**Introduction:**

Eastern Anatolia's urban areas face growing risks from climate-related hazards such as floods, storms, landslides, and freeze-thaw cycles that damage infrastructure and housing. Adapting cities to withstand these stresses requires proactive urban planning, upgraded construction

practices, resilient transportation networks, and community engagement. This section outlines a comprehensive adaptation approach to strengthen urban safety, infrastructure reliability, and livability under changing climate conditions.

## 5.1. Integrated Adaptation Actions and Implementation Measures

- **Flood-Resilient Urban Infrastructure**
  - Map **flood-prone zones** using GIS-based vulnerability assessments.
  - Upgrade and expand **stormwater drainage systems** in at-risk neighborhoods to handle increased runoff.
  - Implement **nature-based solutions** such as **hillslope reforestation**, **wetland restoration**, and **urban green buffers** to complement engineered flood defenses.
- **Climate-Smart Construction and Building Retrofits**
  - Revise **urban building codes** to include structural adaptations for floods, landslides, and freeze-thaw stresses.
  - Establish **technical working groups** of architects, engineers, and climate scientists to ensure projections inform design standards.
  - Launch **municipal incentives and enforcement mechanisms** to support retrofitting of existing buildings for energy efficiency and structural resilience.
- **Relocation and Risk-Aware Land Use**
  - Restrict construction in **high-risk flood or landslide zones** through updated zoning regulations.
  - Offer **affordable housing alternatives** to support the relocation of informal settlements in hazardous areas.
  - Integrate **scenario-based climate risk analysis** into long-term urban development plans.
- **Resilient Transportation and Lifeline Infrastructure**
  - Assess and redesign **critical transport infrastructure** (roads, bridges, railways) for climate durability.
  - Include **climate-proofing upgrades** in routine **maintenance cycles** of public infrastructure.
  - Ensure **continuity of access** during disasters through diversified and redundant transport routes.

- **Heat-Resilient and Green Urban Design**
  - Expand **urban green spaces**, green roofs, and tree canopies to reduce urban heat island effects.
  - Promote **reflective and permeable surface materials** in building and road design.
  - Adopt **water-sensitive urban design** to manage stormwater sustainably and improve livability.
- **Climate-Proofing Water and Sanitation Systems**
  - Protect **drinking water and sanitation systems** from drought, flooding, and contamination threats.
  - Apply **early-warning technologies** and buffer storage to ensure uninterrupted water supply during extreme events.
- **Integrated Urban Climate Governance**
  - Develop **climate-informed urban master plans** that incorporate hazard maps, disaster risk reduction, and ecosystem-based planning.
  - Foster **multi-level governance coordination** among municipalities, provinces, and national institutions for policy alignment and resource mobilization.
  - Establish **participatory urban planning** processes to include local communities and traditional knowledge in shaping adaptation priorities.

## 6.2 Key Institutions Involved

- **Ministry of Environment, Urbanization and Climate Change (MoEUCC)** – Setting policy frameworks, updating building codes, flood risk mapping, and land-use regulation.
- **Provincial Municipalities and Local Governments** – Implementing infrastructure upgrades, urban planning, community engagement, and emergency preparedness.
- **State Hydraulic Works (DSİ)** – Riverbank protection, drainage system enhancement, and floodplain management.
- **Ministry of Transport and Infrastructure** – Assessing and climate-proofing roads, bridges, and railways.
- **Public Works Departments (Belediye Fen İşleri)** – Maintenance of drainage, roads, and urban services, ensuring preemptive adaptation steps are embedded.

- **Neighborhood Councils (Muhtarlıklar)** – Supporting community engagement and ground-truthing of local risks and adaptation needs.
- **Academic Institutions and Engineering Associations** – Providing technical expertise for climate risk assessments, building code revisions, and scenario planning.

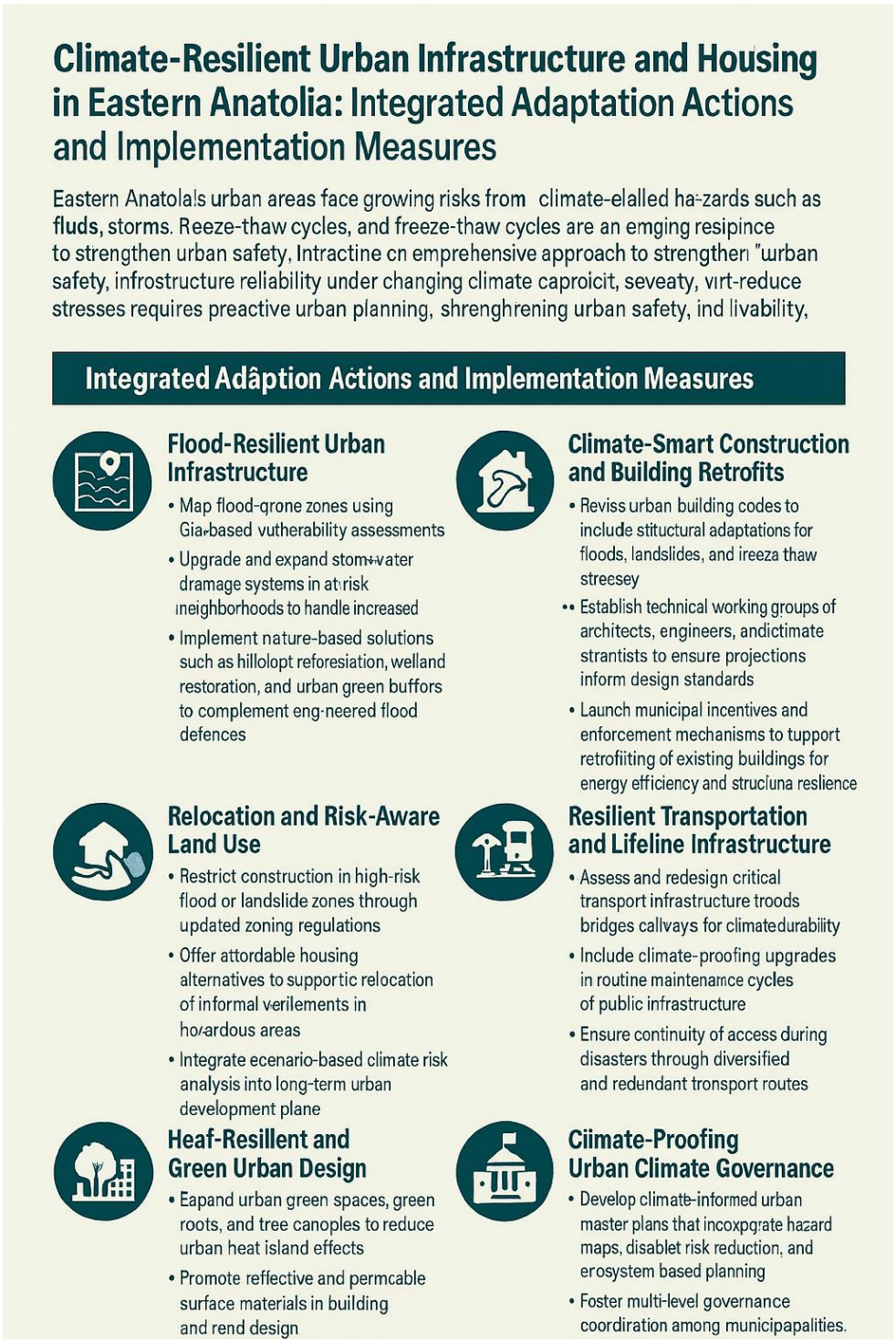


Figure 5. Climate-Resilient Urban Infrastructure and Housing in Eastern Anatolia: Integrated Adaptation and Implementation Measures

Table 5. Adaptation Actions and Mitigation Measures for Climate-Resilient Urban Infrastructure and Housing– East Anatolian Region

| **Adaptation Actions** | **Implementation Actions** | **Key Institutions Involved** |
|---|---|---|
| Urban Flood Management and Drainage Upgrades | Hazard and Vulnerability Mapping with GIS | MoEUCC, Municipalities, DSİ |
| Nature-Based Flood Mitigation Measures | Participatory Urban Planning | MoEUCC, Municipalities, Neighborhood Councils |
| Climate-Smart Building Codes and Retrofitting | Technical Working Groups for Building Code Revision | MoEUCC, Academic Institutions, Engineering Chambers |
| Relocation and Land-Use Regulation for High-Risk Areas | Scenario Planning for Urban Development | MoEUCC, Municipalities, Provincial Authorities |
| Resilient Transportation Infrastructure | Disaster-Ready Zoning Regulations | Ministry of Transport, MoEUCC, Municipalities |
| Water Supply and Sanitation System Protection | Resilient Infrastructure through Maintenance Cycles | Municipalities, DSİ, Public Works Departments |
| Heat-Resilient and Green Urban Design | Financial Incentives and Regulatory Enforcement | MoEUCC, Municipalities, Provincial Governments |
| Integrated Climate-Resilient Urban Planning | Multi-Level Governance Coordination | MoEUCC, Provincial Governments, Local Governments |

## 6. Ecosystems and Biodiversity Conservation

Eastern Anatolia is home to a rich and diverse array of ecosystems, from alpine meadows and forests to steppe grasslands and freshwater lakes. These ecosystems support unique biodiversity, including endemic species adapted to high altitudes, as well as wildlife such as wild goats, bears, wolves, and birds, especially around wetlands like Lake Van. However, these ecosystems are under significant threat from climate change, including warming temperatures,

shifting precipitation patterns, and the increased frequency of extreme weather events. The main challenges include habitat shifts, desertification, the drying of wetlands, increased wildfire risk, and pressures from overgrazing and agricultural expansion. Preserving and enhancing these ecosystems is crucial, as they provide essential services, such as water regulation, soil protection, and carbon sequestration, all of which are vital for both biodiversity conservation and human adaptation.

## 6.1. Integrated Adaptation Actions and Implementation Measures

- **Protected Area Expansion and Ecological Connectivity**
  - Designate new protected zones across altitudinal gradients to allow species migration under changing climate conditions.
  - Establish wildlife corridors linking fragmented habitats, particularly around wetlands and forest patches, to improve ecosystem connectivity and species survival.
  - Secure upland climate refugia to safeguard species as lowland areas become less habitable.
- **Restoration of Degraded Ecosystems**
  - Launch reforestation efforts using native, climate-resilient tree species to stabilize soils and sequester carbon.
  - Implement grassland rehabilitation projects through reseeding with drought-tolerant vegetation and controlling erosion.
  - Rehabilitate wetland ecosystems by constructing small-scale water retention structures to counter drying trends.
- **Conservation of Climate-Resilient Genetic Resources**
  - Establish seed banks and breeding centers to conserve local varieties of drought-tolerant crops and robust livestock breeds.
  - Support in-situ conservation through habitat protection and community partnerships to maintain genetic diversity in natural settings.
- **Community-Based Natural Resource Management**
  - Facilitate the formation of **community-managed conservation zones**, empowering local populations to co-manage forests, grasslands, and water bodies.

- Promote rotational grazing systems, reforestation by villagers, and the integration of traditional ecological knowledge with scientific methods.
- Establish local resource management committees to oversee sustainable use and monitor for illegal activities such as poaching or logging.

- **Monitoring, Research, and Adaptive Management**
  - Create a Climate Ecology Observatory to track long-term ecological and biodiversity changes and guide adaptive strategies.
  - Support citizen science initiatives and partnerships with academic institutions to generate data for climate-informed decision-making.
  - Continuously update management plans based on monitoring of species distributions, vegetation shifts, and ecosystem health indicators.
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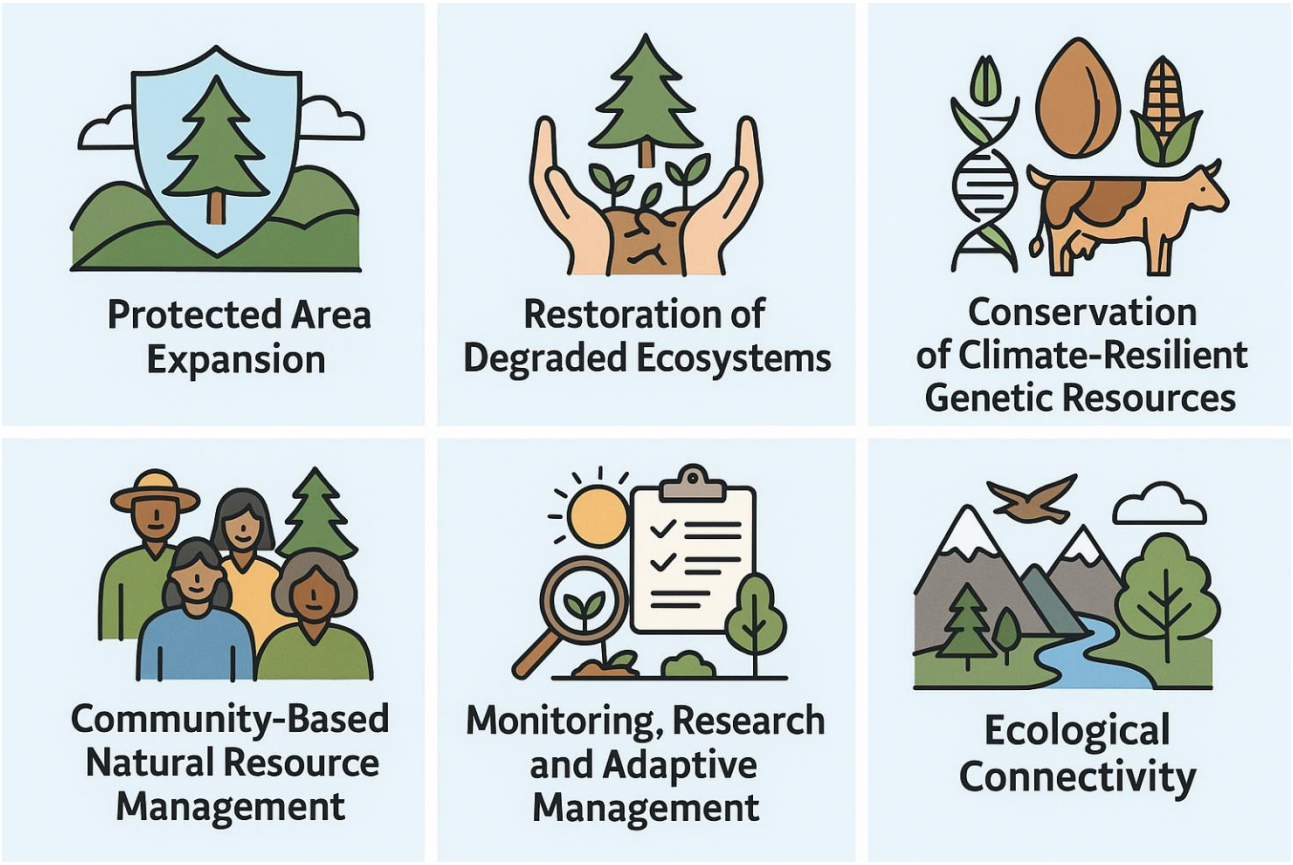


Figure 6. Key Strategies for Ecosystem and Biodiversity Conservation in Eastern Anatolia

## 7.2 Key Institutions Involved

**Ministry of Environment, Urbanization and Climate Change**
Leads national climate adaptation strategies, biodiversity protection policies, and designation of protected areas.

**Ministry of Agriculture and Forestry**
Responsible for forest management, agricultural sustainability, genetic resource conservation, and oversight of water and land use.

**General Directorate of Nature Conservation and National Parks (DKMP)**
Manages protected areas and wildlife conservation; implements ecological monitoring and species protection programs.

**General Directorate of Forestry (OGM)**
Conducts reforestation, forest restoration, erosion control, and wildfire prevention measures.

**General Directorate of State Hydraulic Works (DSİ)**
Plans and constructs water infrastructure; supports wetland rehabilitation and water retention systems.

**Provincial Directorates of Environment, Agriculture, and Forestry**
Coordinate local implementation of national policies and adaptation actions at the provincial level.

**Special Provincial Administrations and Municipalities**
Integrate climate adaptation measures into local planning, infrastructure, and community services.

**Eastern Anatolia Development Agencies (e.g., DAKA, KUDAKA)**
Provide funding, capacity building, and coordination for regional biodiversity and adaptation projects.

**Village and District-Level Forest Cooperatives**
Engage in community-based reforestation, grazing management, and natural resource co-management.

**Van Yüzüncü Yıl University, Erzurum Atatürk University, Ardahan University, and other regional universities**
Conduct research on biodiversity, ecosystems, and climate impacts; contribute to monitoring and capacity building.

**TÜBİTAK (Scientific and Technological Research Council of Türkiye)**
Funds scientific research and innovation; supports the establishment of monitoring observatories and ecological data systems.

**Turkish Academy of Sciences (TÜBA)**
Promotes scientific research in biodiversity and climate science; facilitates expert engagement.

**Doğa Derneği, KuzeyDoğa, WWF-Türkiye, and other NGOs**
Implement field conservation projects, support community mobilization, and promote public awareness and citizen science.

**Community-Based Natural Resource Management Committees**
Oversee local conservation efforts, enforce sustainable resource use, and integrate traditional ecological knowledge.

**Village Councils and Agricultural Cooperatives**
Support local-level implementation of adaptation actions such as rotational grazing, wetland restoration, and in-situ conservation.

**UNDP Türkiye**
Provides technical assistance and funding for nature-based solutions and climate resilience projects.

**FAO Türkiye**
Supports sustainable land management, climate-smart agriculture, and forest-based adaptation strategies.

**IUCN Mediterranean Office**
Provides scientific and technical guidance on ecosystem-based adaptation and species protection.

**European Union and Instrument for Pre-Accession Assistance (IPA) Programs**
Fund cross-border biodiversity conservation, ecosystem restoration, and climate adaptation initiatives.

Table 6. Adaptation Actions and Mitigation Measures for Ecosystems and Biodiversity Conservation – East Anatolian Region

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| **Expand and Connect Protected Areas** | Increase the number of protected areas, especially around vulnerable habitats and create wildlife corridors. | Ministry of Agriculture and Forestry, Local Government, NGOs, Community Groups |
| **Ecological Restoration and Reforestation** | Restore degraded ecosystems by planting native species, and rehabilitate wetlands using check dams or diverted wastewater. | Ministry of Agriculture and Forestry, Local Government, DAP Administration, NGOs |
| **Conservation of Climate-Resilient Genetic Resources** | Establish seed banks for drought-tolerant plant varieties and breeding centers for endangered species. | Ministry of Agriculture and Forestry, Universities, Seed Banks, NGOs |

| Adaptation Actions | Implementation Actions | Key Institutions Involved |
|---|---|---|
| **Community-Based Natural Resource Management** | Engage local communities in sustainable resource management, utilizing traditional knowledge and modern practices. | Ministry of Agriculture and Forestry, Local Governments, Indigenous Groups, NGOs |
| **Monitoring and Research for Adaptive Management** | Set up long-term ecological research plots and a Climate Ecology Observatory for monitoring and data collection. | Ministry of Environment, Urbanization and Climate Change, Universities, NGOs |

## 7.3 Explanation of Actions

1. **Expand and Connect Protected Areas**: Expanding protected areas allows species to migrate as climate conditions change, and wildlife corridors facilitate movement across landscapes to reduce habitat fragmentation.
2. **Ecological Restoration and Reforestation**: This action involves restoring ecosystems that have been degraded by planting native species suited to future climate conditions, as well as addressing soil erosion and drought stress by revitalizing grasslands and wetlands.
3. **Conservation of Climate-Resilient Genetic Resources**: Protecting genetic resources ensures that future agricultural and livestock breeding can adapt to new climate conditions by maintaining a reservoir of resilient species.
4. **Community-Based Natural Resource Management**: Involving local communities in the management of natural resources ensures that conservation strategies align with local needs and traditional knowledge while promoting sustainability.
5. **Monitoring and Research for Adaptive Management**: Continuous monitoring and adaptive management ensure that the conservation strategy remains effective and responsive to new climate information, with a focus on ecological shifts, species migrations, and ecosystem health.

These adaptation and implementation actions, alongside the cooperation of key institutions, will enhance the resilience of Eastern Anatolia's ecosystems and biodiversity to the impacts of climate change.

## 7. Conclusion

Eastern Anatolia is at the forefront of climate change impacts in Türkiye, facing increasing droughts, floods, and shifting seasons that threaten water resources, agriculture, ecosystems, and public health. This Climate Change Adaptation and Implementation Actions Plan offers a comprehensive approach to these challenges, focusing on securing water, ensuring food security, modernizing infrastructure, and protecting biodiversity. The plan emphasizes the need for coordinated action across all levels of government and society, ensuring a collective effort in adapting to climate impacts. By leveraging both local knowledge and modern science, it aims to build resilience, promote sustainable development, and reduce the region's vulnerability to future climate shocks.

While challenges such as financing and capacity building remain, this plan offers tangible solutions with co-benefits, including improved agricultural productivity, job creation, and enhanced public health. The plan aligns with Türkiye's national climate commitments, contributing to the country's goal of net-zero emissions by 2053. It sets the stage for a climate-resilient Eastern Anatolia, where adaptation measures drive both local prosperity and environmental protection. The journey towards this future begins now, and its success will be measured by the well-being of the region's people, the stability of its ecosystems, and the sustainability of its resources.

## References


- Akçalı, M. (2020). *Climate change in Eastern Anatolian region of Türkiye, 1965–2015* [PDF]. ResearchGate. https://www.researchgate.net/publication/345978768
- Climate Change Post. (n.d.). *Climate change: Türkiye*. https://www.climatechangepost.com/turkey/climate-change/

- Yale Environment 360. (2021). *As the climate bakes, Türkiye faces a future without water*. Yale School of the Environment. https://e360.yale.edu/features/as-the-climate-bakes-turkey-faces-a-future-without-water.

- Anadolu Agency. (2022, July 14). *Migratory birds flock elsewhere due to drought in Akgöl Lake*. Anadolu Images. https://anadoluimages.com

- Rudaw. (2023). *Türkiye's shrinking Lake Van worries locals*. https://www.rudaw.net/english/middleeast/turkey/07092023
- Daily Sabah. (2021, August 18). *Climate change intensifies loss of biodiversity in Türkiye*. https://www.dailysabah.com

- United Nations Development Programme Türkiye. (2020). *Türkiye: Climate change adaptation profile*. UNDP. https://adaptation-undp.org

- WWF-Türkiye. (2019). *Türkiye'de iklim değişikliği ve biyolojik çeşitlilik kaybı*. World Wide Fund for Nature Türkiye.

- IPCC. (2021). *Climate Change 2021: The Physical Science Basis*. Contribution of Working Group I to the Sixth Assessment Report. Cambridge University Press.

- T.C. Tarım ve Orman Bakanlığı. (2022). *Kuraklıkla mücadele ve su yönetimi stratejisi*. https://www.tarimorman.gov.tr

- Türkiye Cumhuriyeti Enerji ve Tabii Kaynaklar Bakanlığı. (2023). *Yenilenebilir enerji kaynakları ve iklim değişikliğine uyum*. https://www.enerji.gov.tr

- General Directorate of Meteorology (MGM). (2022). *Annual climate statistics of Türkiye*. https://www.mgm.gov.tr

- Eastern Anatolia Development Agency (DAKA). (2021). *Regional development strategies for Eastern Anatolia*. https://www.daka.org.tr

- AFAD. (2023). *Türkiye disaster statistics and climate-induced hazards report*. Disaster and Emergency Management Authority. https://www.afad.gov.tr

- Ministry of Environment, Urbanization and Climate Change. (2022). *Türkiye National Climate Adaptation Strategy and Action Plan (2021–2030)*. https://csb.gov.tr