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Climate Change Adaptation and Implementation Actions Plan for the Black Sea Region, Türkiye

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List of Abbreviation

Abbreviation	Full Form
AFAD	Disaster and Emergency Management Authority (Afet ve Acil Durum Yönetimi Başkanlığı)
BSEC	Black Sea Economic Cooperation
CERT	Community Emergency Response Team
DASK	Doğal Afet Sigortaları Kurumu (Turkish Catastrophe Insurance Pool)
DKMP	Directorate General for Nature Conservation and National Parks (Doğa Koruma ve Milli Parklar Genel Müdürlüğü)
DSİ	State Hydraulic Works (Devlet Su İşleri)
DOKA	Eastern Black Sea Development Agency (Doğu Karadeniz Kalkınma Ajansı)
DOKAP	Eastern Black Sea Project Regional Development Administration
EIA	Environmental Impact Assessment
FAO	Food and Agriculture Organization of the United Nations
HHWS	Heat-Health Warning System
ICT	Information and Communication Technology
ITU	Istanbul Technical University
KTU	Karadeniz Technical University (Karadeniz Teknik Üniversitesi)
NGO	Non-Governmental Organization
OKA	Central Black Sea Development Agency (Orta Karadeniz Kalkınma Ajansı)
OGM	General Directorate of Forestry (Orman Genel Müdürlüğü)
PES	Payments for Ecosystem Services
SMS	Short Message Service
TEMA	Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats

Abbreviation	Full Form
TUDAV	Turkish Marine Research Foundation (Türkiye Deniz Araştırmaları Vakfı)
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNICEF	United Nations Children's Fund
UNWTO	United Nations World Tourism Organization
WHO	World Health Organization
WWF	World Wide Fund for Nature

1. Introduction:

1.1. Climate Change Impacts and Adaptation Priorities in the Black Sea Region

The Black Sea Region, known for its year-round rainfall and rich natural diversity, is already facing the adverse effects of climate change. Rising temperatures — in line with Türkiye's national average increase of over 1.5°C since the early 20th century — have intensified rainfall variability and the frequency of extreme weather events.

In recent years, catastrophic floods and landslides, especially in provinces like Kastamonu, Sinop, Bartın, Rize, and Artvin, have exposed the region's vulnerability. Projections suggest wetter winters, drier and hotter summers, and more intense storm events, increasing both flood and water stress risks. Coastal areas face growing threats from sea-level rise, erosion, and storm surges, endangering infrastructure and settlements. Climate change is also altering local agriculture, biodiversity, marine life, and public health. Shifting seasonal patterns, invasive pests, fish stock changes, and heat-related health risks are already emerging.

This **Adaptation and Implementation Plan** prioritizes the sectors most at risk —agriculture, forestry, fisheries, water resources, biodiversity, public health, infrastructure, tourism, and disaster risk management — and sets out targeted strategies and institutional roles. The plan emphasizes integrated, region-wide solutions and highlights actions that offer both adaptation and mitigation benefits, helping ensure a resilient and sustainable future for the Black Sea Region.

2. Most Vulnerable Sectors to Climate Change in the Black Sea Region (Ranked by Vulnerability Level)

- **Agriculture and Food Security**
    - Region-specific crops such as hazelnuts, tea, and corn are directly affected by climate change.

  - Rising temperatures, irregular precipitation, and extreme weather events may reduce productivity.
  - Soil erosion and water stress could shrink arable lands.
- **Forests and Biodiversity**
  - Increased risk of forest fires, spread of invasive species, and habitat changes may occur.
  - Endemic species may face extinction threats.
  - Changes in high precipitation regimes can negatively impact forest ecosystems.
- **Urban Settlements and Infrastructure**
  - The frequency and severity of floods, flash floods, and landslides may increase.
  - Settlements near riverbeds are particularly at risk.
  - Infrastructure such as roads, sewage, and drainage systems may be damaged.
- **Transportation and Logistics**
  - Coastal roads (e.g., the Samsun-Trabzon highway) are threatened by sea level rise and coastal erosion.
  - Landslides may frequently disrupt road transportation.
- **Water Resource Management**
  - Variability in rainfall patterns makes managing floods and water shortages more difficult.
  - Both the quantity and quality of drinking and irrigation water may decline.
- **Public Health**
  - Higher humidity may lead to the spread of vector-borne diseases (e.g., ticks, mosquitoes).
  - Heatwaves can pose serious health risks for the elderly and individuals with chronic diseases.
- **Tourism**
  - Nature-based, highland, and coastal tourism may be disrupted by climate-related disasters and seasonal uncertainty.
  - Erosion and shifts in rainfall patterns may reduce landscape quality.

Table 1. Most Vulnerable Sectors to Climate Change in the Black Sea Region

Rank	Sector	Vulnerability to Climate Change
1	**Agriculture and Food Security**	- Region-specific crops (hazelnut, tea, corn) are climate-sensitive.- Rising temperatures, irregular rainfall, and extreme events reduce yields.- Soil erosion and water stress threaten arable land.
2	**Forests and Biodiversity**	- Risk of forest fires, invasive species, and habitat loss.- Threats to endemic species.- Altered precipitation patterns disturb forest ecosystems.
3	**Urban Settlements and Infrastructure**	- Increased flood, flash flood, and landslide risk.- River-adjacent settlements are highly exposed.- Critical infrastructure (roads, drainage) may be damaged.
4	**Transportation and Logistics**	- Coastal roads are vulnerable to sea level rise and erosion.- Landslides frequently disrupt transport routes.
5	**Water Resource Management**	- Rainfall variability complicates flood and drought control.- Quantity and quality of water for drinking and irrigation may decline.
6	**Public Health**	- Increased humidity supports the spread of vector-borne diseases.- Heatwaves pose a risk to vulnerable populations.
7	**Tourism**	- Climate disasters and seasonal unpredictability affect nature and coastal tourism.- Landscape degradation from erosion and rainfall shifts.

3. Climate-Resilient Agriculture

3.1. Adaptation Actions

- Develop and adopt **drought-resilient crop varieties** for key Black Sea crops (tea, hazelnuts, corn).
- Promote **efficient irrigation systems** and **rainwater harvesting** to reduce vulnerability to summer droughts.
- Apply **soil conservation and erosion control** measures (terracing, contour plowing, cover crops) to protect agricultural land.
- Encourage **crop diversification and agroforestry** to reduce dependency on single crops and increase climate resilience.
- Strengthen **farmer training and climate advisory services** to prepare for changing weather patterns, pests, and diseases.

3.2. Implementation Actions

•Drought-Resilient Crop Varieties

- Conduct research and field trials for climate-adapted tea and hazelnut cultivars.
- Distribute proven drought/heat-resistant varieties to farmers through extension services.

- Organize training on the cultivation of new varieties.

•Efficient Irrigation and Rainwater Harvesting

- Construct small-scale water storage systems (ponds, cisterns, reservoirs) in vulnerable areas.
- Introduce modern irrigation technologies (drip, sprinkler) to optimize water use.
- Establish drought early warning systems and provide farmers with irrigation scheduling guidance.

Soil Conservation and Erosion Control

- Implement terracing and contour farming on sloped agricultural fields.
- Promote cover cropping, mulching, and no-till practices to enhance soil health and prevent erosion.
- Construct physical erosion control structures (check dams, vegetative buffer strips).

Crop Diversification and Agroforestry

- Support farmers to interplant and rotate crops for diversified income streams.
- Encourage the integration of shade trees or fruit trees in tea and hazelnut plantations (agroforestry).
- Launch pilot projects and demonstration farms to showcase successful diversification models.

Farmer Training and Climate Advisory Services

- Establish climate-focused field schools for farmers in each province.
- Integrate seasonal forecasts, pest/disease alerts, and adaptive farming advice into extension services.
- Deploy SMS-based warning and advisory systems for frost, heavy rain, drought, and pest outbreaks.

3.3. Key Institutions Involved

- **Ministry of Agriculture and Forestry**
  - General Directorate of Crop Production
  - Provincial Agriculture Directorates
- **State Hydraulic Works (DSİ)**
  - Planning and implementation of irrigation infrastructure.
- **Local Municipalities & Special Provincial Administrations**
  - Support rural infrastructure: water storage, farm roads, drainage improvements.
- **Regional Development Agencies**
  - DOKAP, DOKA, OKA — financial and technical support for multi-province adaptation projects.

- **Agricultural Cooperatives**
    - Tea producers, hazelnut cooperatives — facilitating farmer outreach, seedling distribution, and training.
- **Academic and Research Institutions**
    - Tea Research Institute (Rize), Hazelnut Research Programs (Giresun) — variety development, pest monitoring, research support.
- **Meteorological Service**
    - Provide localized forecasts, drought warnings, frost alerts, and climate trend updates to farmers and institutions.

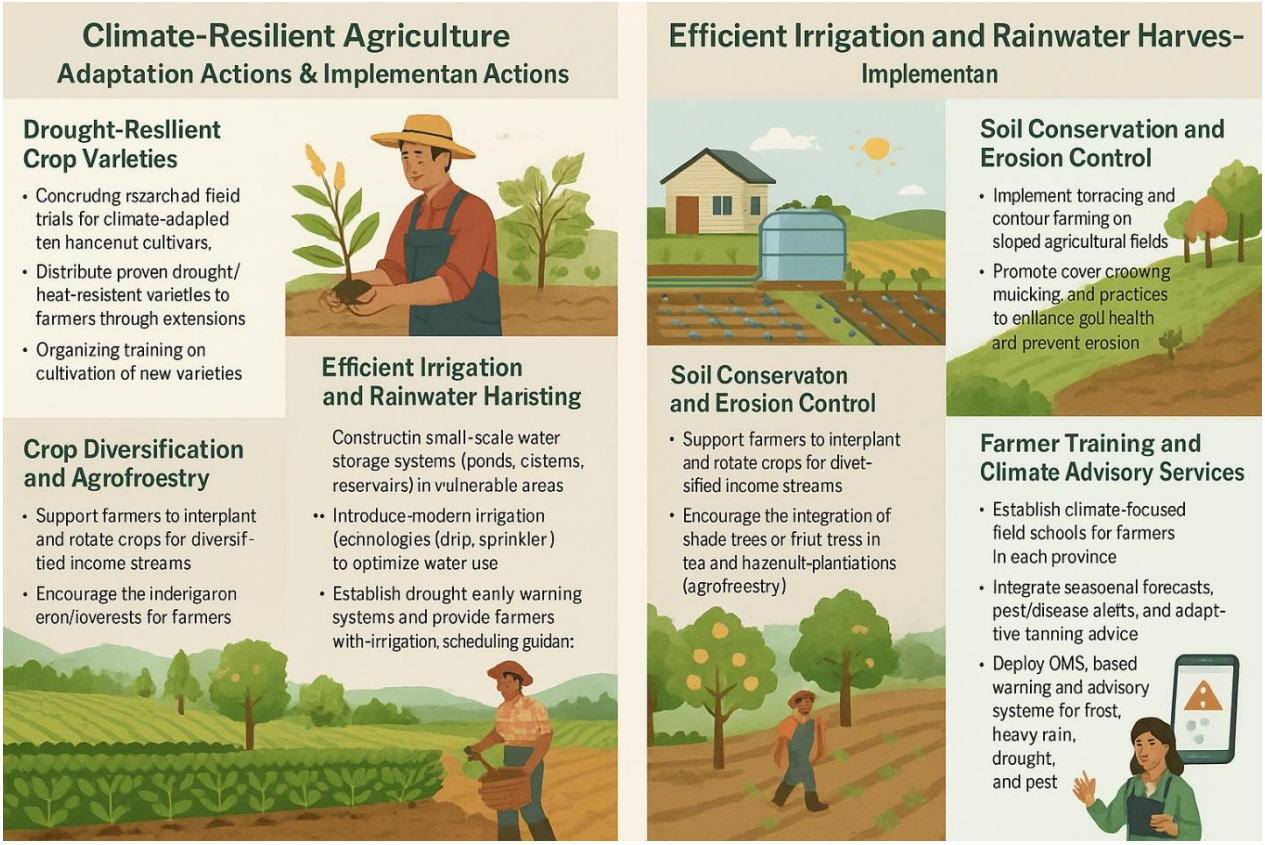

Figure 1. Climate-Resilient Agriculture: Adaptation and Implementation Strategies for Sustainable Farming

Table 2. Consolidated view of Adaptation actions and implementation measures for Climate-Resilient Agriculture in Black Sea Region.

Adaptation Action	Implementation Actions	Key Institutions Involved
Drought-Resilient Crop Varieties	• Research & field-trial heat- and drought-tolerant tea, hazelnut, corn cultivars • Distribute proven varieties via extension services • Organize farmer training on new cultivars	Ministry of Agriculture & Forestry (Gen. Dir. of Crop Production; Provincial Dir.s)Agricultural CooperativesResearch Institutes (Tea & Hazelnut institutes)
Efficient Irrigation & Rainwater Harvesting	• Build small-scale storage (ponds, cisterns, reservoirs) • Introduce drip and sprinkler systems • Set up drought early-warning and optimal irrigation scheduling	State Hydraulic Works (DSİ)Local Municipalities & Special Provincial AdministrationsAgricultural Cooperatives
Soil Conservation & Erosion Control	• Terracing and contour farming on slopes• Promote cover crops, mulching, low-till/no-till practices • Install check-dams and vegetative buffer strips	Ministry of Agriculture & Forestry (Provincial Offices) Local Municipalities & Special Provincial Administrations
Crop Diversification & Agroforestry	• Support intercropping and rotation (e.g., hazelnut-kiwi, walnut-hazelnut) • Introduce shade and fruit trees in plantations • Launch pilot/demo farms for diversified systems	Regional Dev. Agencies (DOKAP, DOKA, OKA) Agricultural Chambers & Cooperatives
Farmer Training & Climate Advisory	• Establish “Climate Field Schools” in each province • Integrate seasonal forecasts, pest alerts into extension services • Deploy SMS alerts for frost, heavy rain, drought, and pest outbreaks	Ministry of Agriculture & Forestry (Extension Services) Meteorological ServiceAgricultural Cooperatives

4. Sustainable Forestry and Biodiversity

The Black Sea's lush forests not only harbor rich biodiversity but also act as a vital "green shield," anchoring steep slopes and protecting communities from landslides and erosion. However, rising temperatures, altered precipitation patterns, and more frequent extreme events are increasing pest outbreaks, stressing trees in dry spells, and saturating soils during heavy downpours. Even wildfire risk—historically low here—could rise during sporadic heatwaves. To safeguard both ecosystem health and human settlements, a coordinated strategy is needed that combines conservation, proactive management, and community engagement.

4.1. Adaptation Actions

- **Sustainable Forest Management with Climate Integration**
  - Enhance species and age diversity; enrichment planting of mixed stands.
  - Strictly protect mature and steep-slope forests against unplanned deforestation.
- **Reforestation and Afforestation of High-Risk Slopes**
  - Prioritize landslide-prone and degraded slopes for planting native, climate-adapted species.
- **Integrated Pest and Disease Management**
  - Establish routine monitoring (traps, aerial/satellite surveys) and rapid biological/mechanical controls.
- **Adaptive Forest Management Planning**
  - Update silvicultural practices, rotation lengths, and designate no-harvest buffer zones on critical terrain.
- **Community-Based Slope and Forest Protection**
  - Form village "Eco-Guardian" committees for patrols, risk reporting, and small-scale agroforestry.
- **Fire Preparedness Measures**
  - Maintain natural and engineered firebreaks; train volunteer crews; pre-position water storage and rapid-response teams.

4.2. Implementation Actions

• **Reforestation of High-Risk Slopes**

- Map landslide-vulnerable areas; launch a "Green Slopes Initiative" with contour-line planting, geojute mats, and check-dams.
- Provide 3–5 years of sapling care (watering, replacement) and employ local villagers for planting.

• **Integrated Pest Management**

- Deploy pheromone traps and remote sensing; activate rapid response (salvage logging, biological controls, targeted sprays).
- Partner with universities to trial pest-resistant genotypes and diversify plantation age structures.

• **Adaptive Forest Management Plans**

- Revise regional plans to mandate mixed-species stands, adjust harvest rotations, and enforce no-harvest slope buffers.
- Train forestry personnel in climate-smart silviculture; review plans every five years using updated climate data.

• **Community-Based Slope Management**

- Establish village committees to combat illegal logging, clear drainage ditches, and plant buffer trees around fields.
- Offer incentives (grants or payments for ecosystem services) to communities preserving protective forest strips.

• **Fire Preparedness in Forests**

- Create and maintain strategic firebreaks; ensure forest roads can support firefighting vehicles.
- Install lookout towers; train and equip local volunteer brigades; pre-deploy rapid-response crews and water tanks during heatwaves.

4.3. Key Institutions Involved

- **General Directorate of Forestry (OGM)** & Regional Directorates (Bolu, Kastamonu, Trabzon)
- **Ministry of Environment, Urbanization and Climate Change** (protected area oversight, policy integration)
- **Local Municipalities & Special Provincial Administrations** (logistics, rural infrastructure support)
- **Village Headmen & Community Leaders** (local mobilization, early risk detection)

- **Academic & Research Institutions** (Karadeniz Technical University, Bartın University; monitoring, species selection)
- **Environmental NGOs** (TEMA Foundation, local associations; awareness-raising, volunteer plantings)
- **Regional Development Agencies & Provincial Administrations** (funding nurseries, firefighting assets, technical assistance)

Climate-Resilient Forestry:

Adaptation Strategies and Implementation Actions

Adaptation Actions

Sustainable Forest Management with Climate Integration

Enhance species and age diversity as High risk florsests against unplanned deforestation

Integrated Pest and Disease Management

- Establish routine moniforing (traps, aerial/satellite survy)

Community-Based Slope and Forest Protection

- Establish village committees for patrols risk reporing, and small-scale agroforestry

Fire Preparedness Measures

- Create ed maintain strategic fire breaks, train volunteer crews, pre po- sition water and rapid response teams

Fire Preparedness Measures

- Form viilage 'Eco Guardian' com mittees for patrols, risk reporting, and small-scale agroforestry

Implementation Actions

Reforestation of High-Risk Slopes

- Mapp landsiide vulnerable areas: launch a 'Green Slopes initiative' with confour line planting, gegjute mats, and heck dams
- Provide 3-5 years sapling care (watering, replacement)
- Partner with universities to trial pest resistant genotypes and diversify polantation age struuctures

Adaptive Forest Management Plans

- Revise regional plans to mandate mixed species stands. adjust dralnageerotations and encorce
- Incéerel incentives cgrefelocal volunteer brigades to communignies preserying protective forest strips

Fire Preparedness in Forests

- Create and malntain strategic firebreaks
- Ensure forest roads can support firefighting vehicies
- Pre-deploy lpopid response crews and water tanks during heatwaves

Figure 2. Climate-Resilient Forestry: Adaptation and Implementation Strategies for Slope and Forest Ecosystems

Table 3. Consolidated view of Adaptation and Implementation measures for Sustainable Forestry and Biodiversity in Black Sea Region.

Adaptation Action	Implementation Actions	Key Institutions Involved
Sustainable Forest Management	• Enrich mixed-species and mixed-age stands • Enforce protection of mature/steep-slope forests• Integrate climate projections into routine silviculture	General Directorate of Forestry & regional directoratesMinistry of Environment, Urbanization & Climate ChangeForestry faculties (KTU, Bartın)
Reforestation & Afforestation of High-Risk Slopes	• Map landslide-prone/degraded slopes • "Green Slopes Initiative" planting along contours with geojute mats & check-dams • 3–5 years of sapling care (watering, replacements) using local labor	General Directorate of ForestryLocal Municipalities & Special Provincial AdministrationsRegional Development Agencies
Integrated Pest & Disease Management	• Deploy pheromone traps and remote-sensing surveys • Activate rapid response (salvage logging, biological controls, targeted sprays) • Partner with universities to trial pest-resistant genotypes and diversify stand structure	Forestry DirectorateAcademic & Research InstitutionsEnvironmental NGOs
Adaptive Forest Management Planning	• Revise regional plans: mixed stands, adjusted rotations, no-harvest slope buffers • Train forestry staff in climate-smart silviculture • Review and update plans every five years with new climate data	General Directorate of Forestry & regional directoratesMinistry of Environment, Urbanization & Climate ChangeForestry faculties
Community-Based Slope & Forest Protection	• Establish village "Eco-Guardian" committees • Patrol against illegal logging, clear drainage, plant buffer trees • Offer grants or payments for ecosystem services to communities preserving protective strips	Local Municipalities & Special Provincial AdministrationsVillage Headmen & Community LeadersEnvironmental NGOs
Fire Preparedness Measures	• Maintain firebreaks and forest access roads• Install lookout towers and water storage tanks/ponds• Train and equip local volunteer firefighting units• Pre-deploy rapid-response crews (helicopters, pumps) during heatwaves	General Directorate of ForestryLocal MunicipalitiesVolunteer Firefighting Units

5. Climate-Resilient Infrastructure and Urban Planning

The region's steep terrain, heavy rains, and coastal exposure make roads, buildings, utilities, and urban areas highly vulnerable to more intense downpours, landslides, floods, storm surges, and heat extremes. A resilient infrastructure strategy combines updated engineering standards, risk-based land-use planning, nature-based solutions, redundancy, and robust emergency preparedness.

5.1. Adaptation Actions

- **Climate-Proof Design & Retrofits**
  Update building codes and infrastructure standards for higher rainfall rates, deeper slope anchors, larger culverts, stronger bridge abutments, and elevated buildings.
- **Risk-Based Land-Use Planning**
  Use hazard maps to restrict development in floodplains, landslide-prone slopes, and erosion zones; relocate or fortify critical assets in high-risk areas.
- **Nature-Based Solutions**
  Stabilize slopes with bioengineering (deep-rooted vegetation, terracing), and manage urban stormwater with green spaces, permeable surfaces, and urban forests.
- **Network Redundancy & Backup Systems**
  Create alternate transport routes, deploy backup power (microgrids, solar+battery), and establish secondary communications (satellite, radio) to maintain services during failures.
- **Emergency Response Preparedness**
  Pre-position rapid-deployment equipment (bridges, machinery), install landslide sensors, and train multi-agency teams and community volunteers in rapid assessment and response.

5.2. Implementation Actions

- **Slope Stabilization & Drainage Upgrades**
  Survey high-risk road and rail segments; build retaining walls, rockfall nets, larger culverts, debris racks; install movement sensors; schedule biannual inspections and maintenance.
- **Flood-Safe Building & Zoning**
  Revise municipal zoning to channel new development away from hazard zones; require elevated or flood-resistant construction; incentivize retrofitting or voluntary relocation; carve urban greenways for flood diversion.

- **Energy & Communication Resilience**
  Underground or insulate power lines, elevate substations, add automatic sectionalizers; reinforce cell towers and kit backup generators and satellite comms for remote communities; pilot solar+storage microgrids at key sites.
- **Urban Green Infrastructure**
  Install rain gardens, bioswales, permeable pavements, retention ponds, and green roofs; expand street tree canopy; integrate sponge-city elements in public spaces to reduce runoff and heat.
- **Emergency Equipment & Training**
  Stockpile Bailey bridges, culvert replacements, sandbags, and heavy machinery at strategic depots; run annual multi-agency drills; train Community Emergency Response Teams on swift-water rescue and rapid infrastructure assessment.

5.3. Key Institutions Involved

- **Ministry of Environment, Urbanization & Climate Change**
  Sets and enforces updated building codes, zoning guidelines, and hazard mapping standards.
- **Local Municipalities & Provincial Administrations**
  Implement land-use plans, drainage upgrades, green infrastructure projects, and enforce development regulations.
- **General Directorate of Highways & State Railways**
  Lead slope stabilization, culvert and bridge enhancements, and transport network redundancy measures.
- **Ministry of Energy & Natural Resources; Utility Companies**
  Oversee power grid upgrades, microgrid installations, and backup power systems.
- **Information and Communication Technologies Authority; Telecom Operators**
  Strengthen communications infrastructure, install backup generators, and provide satellite links.
- **AFAD & Provincial Disaster Directorates**
  Coordinate emergency equipment placement, multi-agency drills, and community response training.
- **Universities & Engineering Institutions**
  Conduct risk assessments, develop localized design standards, and support monitoring technologies.

- **Chambers of Engineers & Architects; NGOs**
  Advocate for code enforcement, advise on best practices, and assist municipalities with pro bono expertise.
- **Infrastructure Resilience Task Force**
  A regional coordination platform uniting all stakeholders to align hazard data, project schedules, and resource sharing.

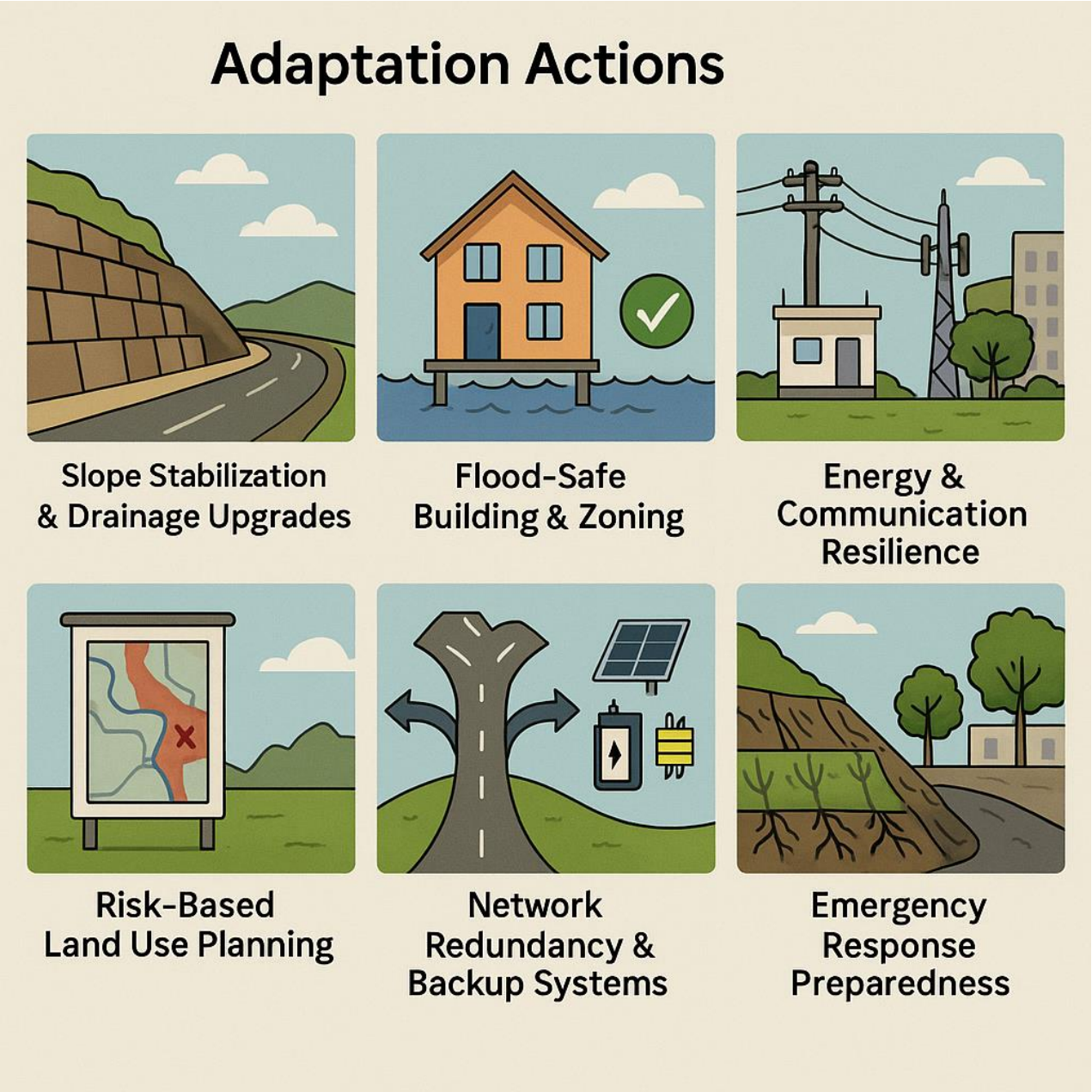

Figure 3. Climate-Resilient Infrastructure and Urban Planning: Key Adaptation Actions

Table 4. Consolidated view of Adaptation and Implementation measures actions for Sustainable Climate-Resilient Infrastructure and Urban Planning

Adaptation Actions	Implementation Actions	Key Institutions Involved
Climate-Proof Design & Retrofits	Update codes; retrofit bridges, slopes, buildings; enforce deeper foundations and larger drainage	Environment Ministry; Highways Directorate; Municipal Building Departments
Risk-Based Land-Use Planning	Zoning revisions; hazard-map-driven siting; incentives for relocation/retrofitting; create urban greenways	Municipalities; Provincial Administrations; Environment Ministry
Nature-Based Solutions	Bioengineer slopes; install green infrastructure (rain gardens, bioswales, trees, permeable surfaces)	Municipal Public Works; Forestry Units; NGOs
Network Redundancy & Backup Systems	Alternate routes; microgrid pilots; underground/insulated lines; satellite comms for remote areas	Energy Ministry; Utility Cos.; ICT Authority; AFAD
Emergency Response Preparedness	Stockpile bridges & equipment; sensor networks; annual multi-agency drills; CERT training	AFAD; Provincial Directorates; University Engineering Departments

6. Climate-Resilient Fisheries and Coastal Resource Management

The Black Sea's marine ecosystem and fisheries are vital to the regional economy and the sustainability of local communities. However, climate change — through rising sea temperatures, shifts in fish species distribution, ocean acidification, sea-level rise, and the spread of invasive species — threatens biodiversity and the economic viability of fisheries. Strengthening resilience requires integrated management strategies that consider both ecological and socioeconomic dimensions.

6.1. Adaptation Actions

- **Ecosystem-Based Fisheries Management**

  Promote sustainable fishing practices, enforce conservation zones, and restore critical habitats to strengthen the resilience of fish stocks and marine biodiversity.
- **Flexible and Dynamic Fishing Regulations**

  Adapt catch limits, fishing seasons, and marine protected areas based on real-time

environmental and stock assessment data to reflect shifting species distributions and ecosystem health.

- **Diversification of Coastal Livelihoods**
  Reduce dependency on wild-capture fisheries by supporting alternative income-generating activities such as aquaculture, marine eco-tourism, and harvesting of non-traditional species.
- **Climate-Resilient Aquaculture**
  Promote the development and dissemination of aquaculture systems and fish species that are tolerant to temperature variability, salinity changes, and disease risks associated with climate change.
- **Coastal Ecosystem Restoration**
  Restore wetlands, dunes, and natural shoreline vegetation to buffer coastal areas from sea-level rise, erosion, and extreme weather impacts.
- **Monitoring and Early Warning Systems**
  Strengthen observation and predictive capabilities to monitor changing ocean conditions, harmful algal blooms, and the migration patterns of commercially important species.

6.2. Implementation Actions

- Establish science-based fisheries co-management plans involving local communities, scientists, and policymakers.
- Update fisheries laws to include adaptive management frameworks allowing flexible responses to climate-related ecological changes.
- Develop pilot projects for climate-smart aquaculture and expand them through public-private partnerships.
- Invest in marine research infrastructure, including temperature, salinity, and oxygen monitoring stations.
- Implement community-based habitat restoration initiatives along the Black Sea coast.
- Establish cross-border cooperation for marine conservation under Black Sea regional agreements.

6.3. Key Institutions Involved

- National Ministries of Agriculture and Fisheries
- General Directorate of Water Management

- Coastal Municipalities
- Universities and Marine Research Institutes
- Fisherfolk Cooperatives and Associations
- Regional Organizations (e.g., Black Sea Commission, FAO regional offices)
- Environmental NGOs

Figure 4. Climate-Resilient Coastal and Marine Adaptation Strategies

Table 5. Adaptation actions and Implementation measures for Sustainable Climate-Resilient Fisheries and Coastal Resource Management

Adaptation Actions	Implementation Actions	Key Institutions Involved
Ecosystem-Based Fisheries Management	Develop science-based co-management plans	Ministries of Agriculture and Fisheries
Flexible Fishing Regulations	Update fisheries laws for adaptive management	Ministries, Research Institutes
Diversification of Livelihoods	Support aquaculture, eco-tourism initiatives	Coastal Municipalities, Cooperatives
Climate-Resilient Aquaculture	Launch climate-smart aquaculture pilot projects	Ministries, Private Sector, Universities
Coastal Ecosystem Restoration	Implement community-based restoration projects	Municipalities, NGOs, Environmental Agencies
Monitoring and Early Warning Systems	Install marine monitoring stations and networks	Universities, Research Institutes, Regional Orgs

7. Climate-Resilient Water Resources and Flood Management

The Black Sea Region's abundant rivers and streams have long supported both communities and ecosystems. However, climate change is increasing the frequency of extreme downpours—triggering flash floods and landslides—while warmer summers threaten to create seasonal water shortages. A resilient water strategy must both mitigate flood risks and secure water supply during dry spells, combining engineering solutions with nature-based approaches and strong coordination across river basins.

7.1. Adaptation Actions

- **Integrated Flood Management**
  Combine grey infrastructure (upgraded drainage, culverts, floodwalls) with green infrastructure (restored floodplains, riparian buffers, retention areas) to slow and absorb runoff.
- **Expanded Water Storage & Efficiency**
  Develop distributed storage (small dams, farm ponds, rainwater harvesting) and promote water-use efficiency (fixing leaks, drip irrigation, wastewater reuse).
- **Early Warning & Community Preparedness**
  Deploy radar, river gauges, and alert systems; train communities on evacuation routes and flood response.

- **Integrated River Basin Management**
  Coordinate upstream/downstream reservoir operations, land-use planning, and water allocation across provinces to balance flood control and drought mitigation.

7.2. Implementation Actions

- **Urban Stormwater System Upgrades**
  Audit and retrofit storm sewers, add detention basins, install permeable pavements and bioswales in towns like Rize and Ordu.
- **Floodplain Restoration & River Training**
  Reclaim and widen historical floodplains, add bypass channels, reinforce banks with willow plantings or gabions, and restore upstream wetlands.
- **Small Dams & Water Storage Optimization**
  Build a network of small to medium reservoirs and check dams in upland streams; update DSİ dam operations using climate forecasts.
- **Rainwater Harvesting & Greywater Reuse**
  Subsidize rooftop collection tanks in villages; require rainwater systems and greywater treatment in new urban developments.
- **Flood Early Warning & Community Response**
  Install high-resolution radar and automated gauges; issue SMS/siren alerts; conduct evacuation drills and train local rescue teams.

7.3. Key Institutions Involved

- **State Hydraulic Works (DSİ)** – dams, river training, flood infrastructure
- **Ministry of Environment, Urbanization & Climate Change** – basin planning, nature-based solutions
- **Municipal Water/Sewerage Authorities & Iller Bank** – urban drainage upgrades
- **AFAD & Turkish State Meteorological Service** – forecasting, early warning, emergency planning
- **Ministry of Agriculture and Forestry & Ministry of Interior** – rural water harvesting programs, building codes
- **Provincial Disaster Directorates & Local Governments** – community drills, evacuation planning
- **Universities & Research Institutes** – hydrological modeling, system design (e.g., ITU, Karadeniz Technical University)

- **Community Organizations & Farmer Associations** – local implementation and maintenance
- **Climate Change Directorate (Environment Ministry)** – cross-sector coordination

Figure 5. Integrated Flood and Water Management: Climate Adaptation Strategies for Resilient Communities

Table 6. Adaptation actions and Implementation measures for Sustainable Climate-Resilient Water Resources and Flood Management

Adaptation Actions	Implementation Actions	Key Institutions Involved
Integrated Flood Management	Urban stormwater upgrades (sewers, basins, bioswales)	DSİ; Municipal Authorities; Ministry of Environment
Expanded Water Storage & Efficiency	Build small dams, farm ponds; rainwater harvesting; leak repairs; drip irrigation	DSİ; Ministry of Agriculture & Forestry; Iller Bank
Early Warning & Community Preparedness	Install radar/gauges; SMS/siren alerts; evacuation drills; rescue-team training	AFAD; Meteorological Service; Provincial Disaster Directorates
Integrated River Basin Management	Coordinate reservoir operations; basin-wide land-use and water allocation planning	Ministry of Environment; Climate Change Directorate; DSİ
Rainwater Harvesting & Greywater Reuse	Subsidies for household tanks; building codes mandating rainwater/greywater systems	Municipalities; Ministry of Interior; Ministry of Environment
Floodplain Restoration & River Training	Reclaim floodplains; bypass channels; eco-bank reinforcement; wetland restoration	DSİ; Ministry of Environment; Local Landowners

8. Biodiversity and Ecosystem Conservation

The Black Sea Region harbors unique coastal wetlands, montane forests, and alpine meadows—home to many endemic and climate-sensitive species. Warming temperatures, altered precipitation patterns, invasive species, and sea-level rise threaten these ecosystems. To safeguard biodiversity, the region needs strategies that enhance connectivity, protect vulnerable species, restore degraded habitats, and engage communities in stewardship.

8.1. Adaptation Actions

- **Ecological Corridors & Protected Area Expansion**
  Connect coastal, lowland, and alpine habitats through linked conservation zones to allow species range shifts.
- **In Situ & Ex Situ Species Conservation**
  Strengthen protections in the wild and maintain backup populations (seed banks, captive breeding) for the most vulnerable endemics.

- **Ecosystem Restoration**
  Reforest degraded lands, re-wet drained wetlands, rehabilitate alpine meadows, and restore riverine habitats.
- **Community-Based Stewardship**
  Empower local committees in villages and towns to monitor, protect, and sustainably manage key biodiversity areas.
- **Climate-Smart Land-Use Planning**
  Integrate ecological and climate projections into spatial plans and EIAs to avoid habitat fragmentation and maladaptive development.
- **Assisted Migration (as needed)**
  Facilitate relocation of species or genotypes when natural dispersal is insufficient and climate refugia exist.

8.2. Implementation Actions

- **Protected Areas & Corridors**
  • Designate new high-elevation refuges and stepping-stone forest patches from coast to peaks.
  • Extend existing parks (e.g., Küre, Kaçkar) and formalize community-managed buffer lands.
- **Targeted Species Programs**
  • Conduct vulnerability assessments; establish seed banks and captive-breeding for endemic plants and animals.
  • Implement habitat management and controlled reintroductions as climates shift.
- **Large-Scale Restoration Projects**
  • Launch reforestation and wetland re-flooding schemes; apply rotational grazing or bans in overused meadows.
  • Install fish ladders, replant riparian vegetation, and add structural habitat for aquatic species.
- **Community Engagement & Incentives**
  • Form “Eco-Guardian” committees; offer payments for ecosystem services to villages preserving wetlands or forests.
  • Train citizen scientists and eco-guides; develop local eco-tourism and youth monitoring programs.

- **Land-Use Policy Integration**

  • Revise regional zoning and EIAs to protect predicted climate refugia and maintain wildlife corridors.

  • Require wildlife crossings on new roads and buffer zones around protected areas.
- **Assisted Migration Trials**

  • Identify candidate species and suitable microrefugia; pilot translocations under research partnerships.

8.3. Key Institutions Involved

- **Ministry of Environment, Urbanization & Climate Change (DKMP)**
  Leads protected area designation, habitat restoration, and policy guidance.
- **Universities & Research Institutes** (e.g., Karadeniz Technical University, TÜBİTAK)
  Provide vulnerability assessments, restoration protocols, and monitoring.
- **Local Governments & Planning Agencies**
  Integrate biodiversity into land-use plans, enforce EIAs, and support community projects.
- **Community Organizations & NGOs** (Doğa Derneği, WWF-Türkiye)
  Facilitate grassroots stewardship, education, and on-the-ground restoration.
- **Ministry of Agriculture and Forestry**
  Manages forest biodiversity, invasive species control, and assisted migration logistics.
- **International & Regional Bodies** (Bucharest Convention's Biodiversity Protocol, Black Sea Commission)
- Coordinate transboundary monitoring and best-practice Exchange

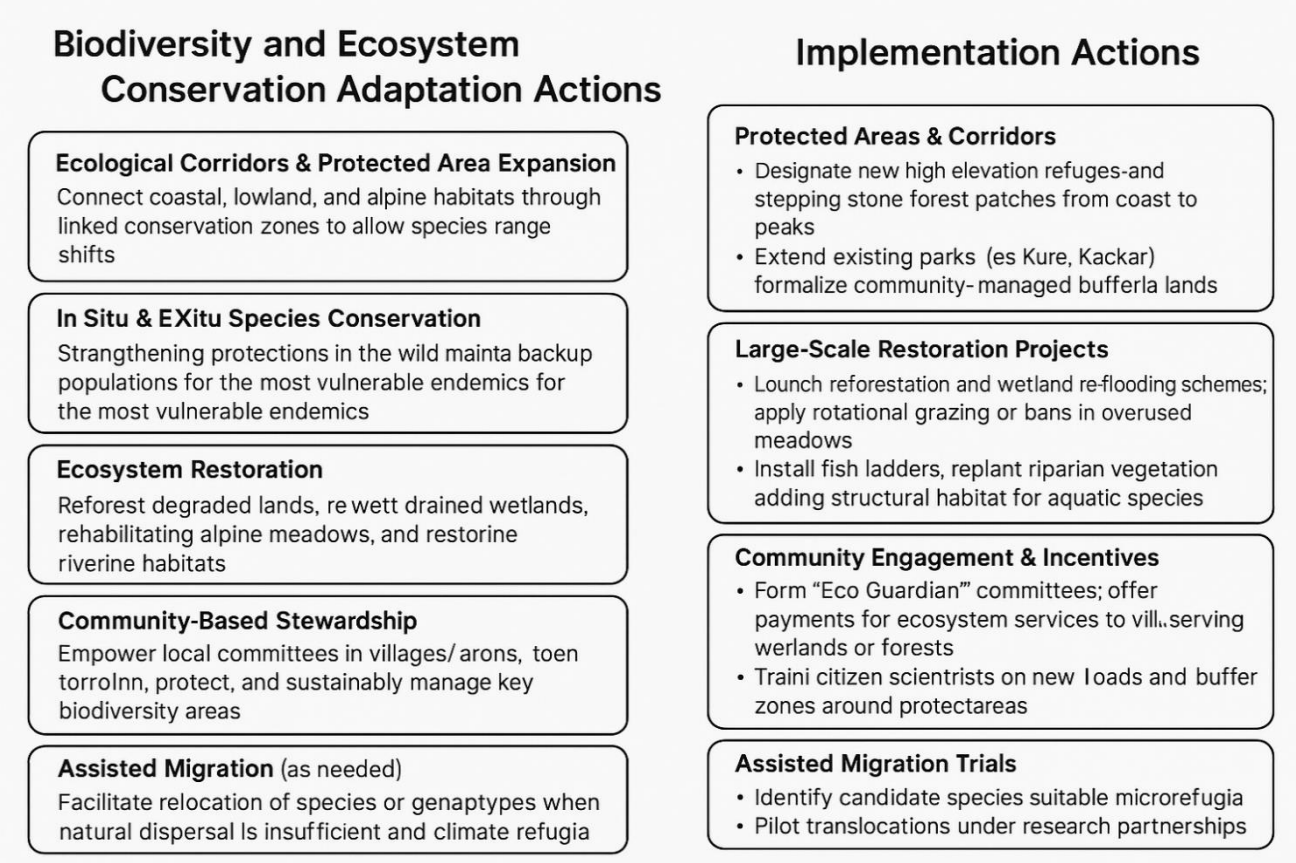

Figure 6. Biodiversity and Ecosystem Conservation: Adaptation and Implementation Actions

Table 7. Adaptation actions and Implementation measures for Sustainable Biodiversity and Ecosystem Conservation

Adaptation Actions	Implementation Actions	Key Institutions Involved
Ecological Corridors & PA Expansion	Designate new refuges, extend parks, formalize community buffers	DKMP; Local Governments; NGOs
In Situ & Ex Situ Species Conservation	Vulnerability assessments; seed banks; captive breeding; controlled reintroductions	DKMP; Universities; Botanical Gardens; Wildlife Departments
Ecosystem Restoration	Reforestation; wetland re-flooding; meadow recovery; riparian and aquatic habitat structures	DKMP; Ministry of Agriculture & Forestry; Local Communities
Community-Based Stewardship	Form Eco-Guardian committees; PES schemes; citizen science and eco-tourism training	Local Governments; NGOs; Community Cooperatives
Climate-Smart Land-Use Planning	Revise zoning/EIAs; mandate wildlife crossings; designate corridor buffers	DKMP; Municipal Planning Agencies; Ministry of Interior

Adaptation Actions	Implementation Actions	Key Institutions Involved
Assisted Migration (As Needed)	Identify candidate species/refugia; pilot translocations	Universities; DKMP; Ministry of Agriculture and Forestry

9. Public Health and Climate Change Preparedness

9.1. Climate-Resilient Public Health

Rising temperatures, more frequent heatwaves, and shifting patterns of vector- and water-borne diseases are creating new health risks in a region unaccustomed to extreme heat or drought. Strengthening health system preparedness, improving early warning mechanisms, and securing clean water and sanitation are critical to protect vulnerable populations.

9.2. Adaptation Actions

- **Heatwave Early Warning & Response**
  Develop a Heat-Health Warning System and designate public cooling centers to prevent heat-related illness.
- **Enhanced Vector Control & Disease Surveillance**
  Monitor and manage mosquitoes, ticks, and other vectors; strengthen laboratory and reporting networks for climate-sensitive diseases.
- **Safe Water & Sanitation Resilience**
  Flood-proof and drought-proof water treatment plants; ensure continuous safe drinking water and functioning sewage systems.
- **Climate-Proof Healthcare Infrastructure**
  Flood- and heat-proof hospitals and clinics; install backup power, water supplies, and mobile health units for emergency access.
- **Community Engagement & Education**
  Inform residents on heat precautions, water safety after floods, vector avoidance, and emergency response procedures.

9.3. Implementation Actions

- **Heatwave Plan Activation**
  • Install meteorological triggers for SMS/TV/radio alerts.
  • Open cooling centers in community venues; run annual drills.

- **Vector & Disease Programs**
  • Map breeding sites; deploy larvicides and community clean-ups.
  • Equip labs for rapid diagnostics; maintain stockpiles of vaccines and treatments.
- **Water & Sanitation Upgrades**
  • Elevate or barrier-proof critical water facilities; install backflow preventers in sewers.
  • Deploy rapid-response water testing and emergency purification kits post-flood.
- **Healthcare Facility Preparedness**
  • Relocate generators and critical equipment to safe floors.
  • Train staff in heatstroke, trauma care, and swift-water rescue; deploy mobile clinics when roads are blocked.
- **Public Education Campaigns**
  • Distribute guidelines on hydration, flood-water safety, and vector bite prevention.
  • Engage community health workers in door-to-door outreach.

9.4. Key Institutions Involved

- **Ministry of Health & Provincial Health Directorates**
  Lead adaptation planning, HHWS operation, and healthcare readiness.
- **State Meteorological Service & AFAD**
  Provide heat/flood forecasts and coordinate emergency alerts.
- **Municipal Water/Sewerage Authorities & Ministry of Environment**
  Upgrade water treatment, distribution, and sanitation systems.
- **Provincial Public Health Laboratories & Refik Saydam Hygiene Center**
  Conduct disease diagnostics and support surveillance.
- **Family Health Centers & Turkish Red Crescent**
  Deliver community outreach, cooling centers, and relief services.
- **Climate Health Working Group**
  Cross-sector coordination among health, meteorology, emergency management, and environment agencies.

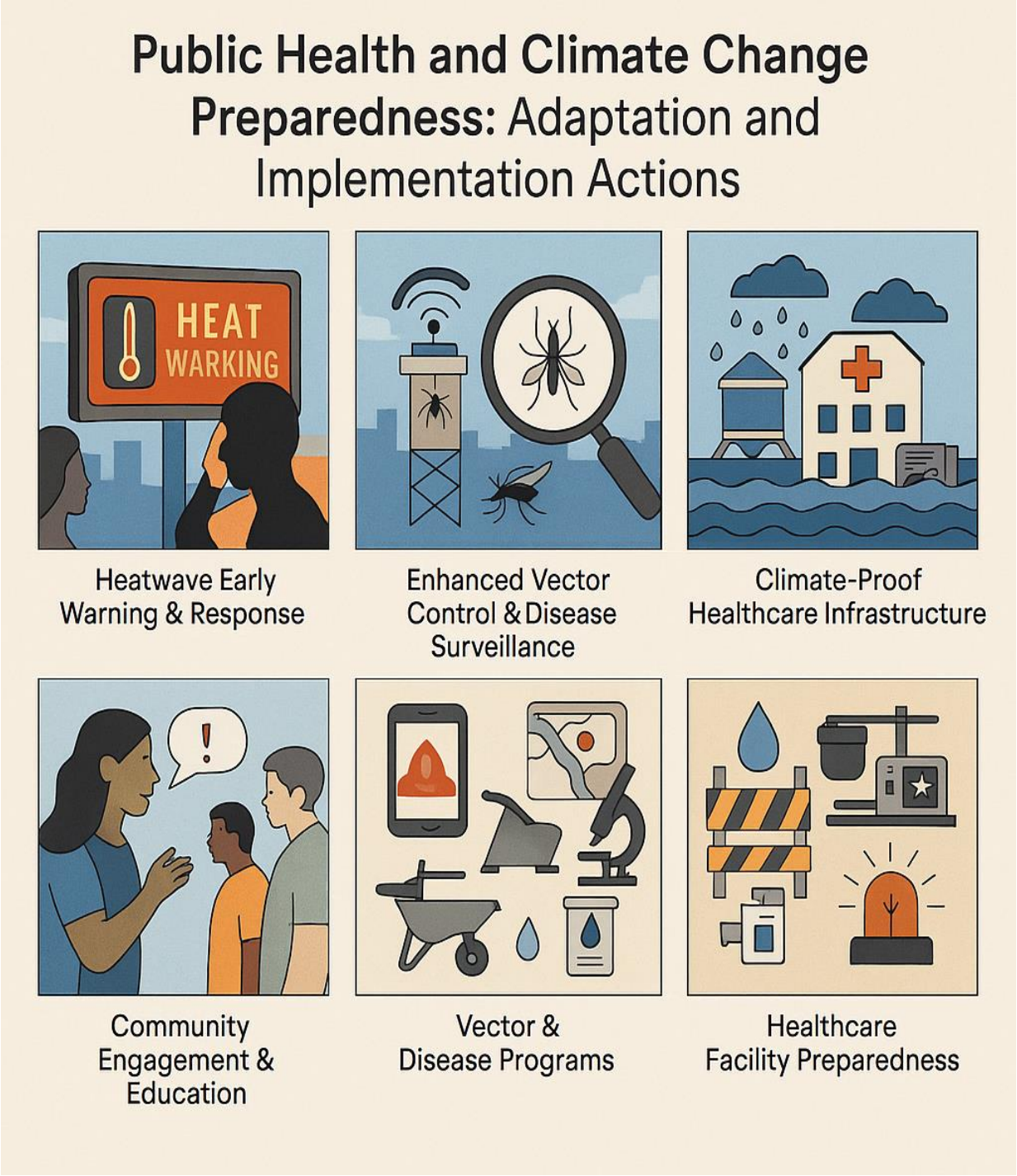

Figure 7. Public Health Resilience in a Changing Climate: Key Adaptation and Implementation Measures

Table 8. Adaptation actions and Implementation measures for Sustainable Public Health and Climate Change Preparedness

Adaptation Actions	Implementation Actions	Key Institutions Involved
Heatwave Early Warning & Response	Install alert triggers; open and staff cooling centers; conduct annual drills	Ministry of Health; Meteorology Service; AFAD
Enhanced Vector Control & Disease Surveillance	Map and treat breeding sites; laboratory diagnostics; maintain vaccine/medicine stockpiles	Provincial Labs; Ministry of Health; Municipalities
Safe Water & Sanitation Resilience	Flood-proof treatment plants; backflow preventers; rapid water testing and purification kits after floods	Municipal Water Authorities; Ministry of Environment; Local Governments
Climate-Proof Healthcare Infrastructure	Relocate critical equipment; backup power/water; train staff in disaster and heatstroke response; deploy mobile clinics	Hospitals & Clinics; Provincial Health Directorates; AFAD
Community Engagement & Education	Distribute health advisories; door-to-door outreach by health workers; public media campaigns on hydration, vector avoidance, safety	Family Health Centers; Turkish Red Crescent; Local NGOs

10. Climate Change and Tourism

The Black Sea Region's tourism sector faces both risks (damage to heritage sites, erosion, disrupted access) and opportunities (a cooler summer alternative, longer shoulder seasons). A resilient approach blends physical protection of sites, sustainable capacity planning, diversified offerings, and industry preparedness.

10.1. Adaptation Actions

- **Climate-Proof Tourist Sites & Routes**
  Reinforce cultural heritage structures, boardwalks, and access roads against rockfalls, floods, and erosion.
- **Sustainable Destination Management**
  Direct new tourism development away from hazard zones; upgrade waste, water, and transport infrastructure to handle changing visitor flows.
- **Diversification of Tourism Products**
  Promote all-season and experiential offerings—eco-tourism, agro-tourism, cultural workshops, off-peak festivals—to reduce weather dependency.
- **Industry Training & Capacity Building**
  Equip hotels, guides, and tour operators with climate adaptation skills: emergency response, resource efficiency, and alternative itineraries.
- **Marketing & Insurance Incentives**
  Brand the Black Sea as a cool-climate refuge; encourage insurance uptake to protect businesses from climate-related losses.

10.2. Implementation Actions

- **Protecting & Adapting Key Sites**
  Conduct risk assessments at Sumela, Uzungöl, Ayder, and beach parks; install rock bolting, drainage upgrades, beach nourishment, and early-warning alerts.
- **Tourism Infrastructure Upgrades**
  Zone and build accommodations, roads, and utilities outside hazard areas; introduce shuttle services; install rainwater harvesting and backup power in hotels.
- **Developing New Tourism Products**
  Create winter bird-watching tours, spring flower festivals, agro-experience workshops, and mapped trekking routes with weather-resistant refuges.
- **Training & Certification Programs**
  Run workshops on heat and flood response, resource-efficient operations, and “green” certifications for tourism businesses; train guides in climate-aware storytelling and safety.

- **Promotion & Risk-Sharing Mechanisms**
  Roll out marketing campaigns ("Türkiye's natural air-conditioner"); establish a regional tourism insurance fund or pooled risk scheme for climate events.

10.3. Key Institutions Involved

- **Ministry of Culture and Tourism & Regional Directorates**
  Lead strategic planning, site risk assessments, and promotional campaigns.
- **Ministry of Transport and Infrastructure**
  Upgrade airports, roads, and shuttle services for safe, climate-resilient access.
- **Ministry of Environment, Urbanization & Climate Change**
  Approve hazard-informed zoning, enforce building codes, and support beach/coastal protection.
- **Local Municipalities & Provincial Administrations**
  Implement site adaptations, manage utilities, and regulate new developments.
- **Tourism Industry Associations & Private Sector**
  Invest in adaptive measures, resource-efficient operations, and insurance schemes.
- **Universities & Hospitality Institutes**
  Research tourism-climate trends, train the workforce, and evaluate adaptation effectiveness.
- **International Partners (UNWTO, BSEC)**
  Share best practices, coordinate cross-border marketing, and support pilot adaptation projects.

Figure 8. Resilient Tourism Development: Adaptation and Implementation Actions

Table 9. Adaptation actions and Implementation measures actions for Sustainable Tourism

Adaptation Actions	Implementation Actions	Key Institutions Involved
Climate-Proof Tourist Sites & Routes	Risk assessments; rock bolting; drainage upgrades; beach nourishment; early-warning systems	Culture & Tourism Ministry; Local Municipalities
Sustainable Destination Management	Hazard-informed zoning; utility upgrades; shuttle services; resource-efficient hotel systems	Transport Ministry; Environment Ministry; Provincial Administrations
Diversification of Tourism Products	Off-season birding, festivals, agro-tours; mapped trekking routes with weather-resistant refuges	Culture & Tourism Ministry; Private Sector; Universities
Industry Training & Capacity Building	Workshops on emergency response, efficiency, and green certification; guide training in climate-aware safety	Regional Tourism Directorates; Hospitality Institutes; Industry Associations

Adaptation Actions	Implementation Actions	Key Institutions Involved
Marketing & Insurance Incentives	"Natural Air-Conditioner" campaigns; regional tourism insurance fund or pooled risk mechanism	Culture & Tourism Ministry; UNWTO; BSEC

11. Disaster Risk Management & Emergency Response

The Black Sea Region's growing exposure to floods, landslides, storms, and heatwaves demands an integrated, anticipatory disaster risk management system. By combining robust risk mapping, community preparedness, technology-driven early warnings, and rapid recovery protocols, the region can minimize loss of life and speed post-disaster rebuilding.

11.1. Adaptation Actions

- **Dynamic Risk Assessment & Mapping**
  Continuously update flood, landslide, and coastal hazard maps using climate projections for planning and public awareness.
- **Community-Based Preparedness**
  Engage schools, businesses, and households in drills, go-bag readiness, and buddy systems for vulnerable neighbors.
- **Strengthened Early Warning Systems**
  Expand radars, river and slope sensors, sirens, and multi-channel alerts (SMS, radio, social media) to reach remote and maritime populations.
- **Enhanced Response Capacity**
  Train and equip local rescue teams in swift-water, mountain, and multi-hazard scenarios; pre-position boats, earthmovers, and medical kits.
- **Build-Back-Better Recovery**
  Reconstruct damaged homes and infrastructure in safer locations or with resilient designs to prevent repeat losses.

11.2. Implementation Actions

- **Regional Emergency Operations Center**
  Establish a 24/7 hub in a central city (e.g., Samsun) that integrates AFAD, meteorology, and sensor networks to coordinate multi-province responses and run regular multi-agency drills.

- **Disaster Education & Drills**
  Hold annual “Disaster Preparedness Week” with community evacuation exercises, school programs, and AKUT-led first-responder trainings.
- **Evacuation Routes & Safe Havens**
  Map and signpost escape paths; outfit designated shelters with power, water, and supplies; organize public transport into evacuation service.
- **Insurance & Relief Funds**
  Promote DASK and a climate-disaster insurance pool; maintain rapid-release relief funds and mobile damage-assessment teams to expedite payouts.
- **After-Action Learning**
  Conduct post-event reviews to capture lessons (e.g., warning failures, shelter shortages) and update plans and hazard scenarios biennially.

11.3. Key Institutions Involved

- **AFAD & Provincial Branches** — lead coordination, center operations, and early warning dissemination.
- **State Meteorological Service** — provide real-time hazard data to the operations center.
- **Local Governorships & Municipalities** — execute community drills, manage shelters, and maintain evacuation routes.
- **Ministry of Interior** — oversee provincial emergency committees and ensure district-level contingency plans.
- **Ministry of Health, Highways, Utilities** — integrate healthcare, transport, and lifeline restoration into disaster committees.
- **Jandarma SAR & Military Engineering Units** — supply aerial and heavy-equipment support for large-scale rescue and infrastructure clearance.
- **Muhtars & Volunteer Networks (e.g., AKUT)** — form Neighborhood Disaster Support Teams for rapid local response.
- **International Mechanisms (EU Civil Protection, BSEC)** — provide supplementary aid and cross-border coordination when events exceed capacity.

Figure 9. Disaster Risk Management and Emergency Response: Adaptation and Implementation Strategies

Table 10. Adaptation Actions and Implementation Measures for Sustainable Disaster Risk Management & Emergency Response

Adaptation Actions	Implementation Actions	Key Institutions Involved
Dynamic Risk Assessment & Mapping	Regional Emergency Operations Center with real-time monitoring and drills	AFAD & Provincial Branches; Meteorological Service
Community-Based Preparedness	Annual preparedness week, school drills, AKUT first-responder training	Local Governorships; Municipalities; Muhtars; Volunteer Networks
Strengthened Early Warning Systems	Deploy additional radars, sensors, sirens; SMS/radio/social-media alerts	AFAD; Meteorological Service; Ministry of Interior
Enhanced Response Capacity	Pre-position boats, earthmovers, medical kits; train rescue teams in multi-hazard scenarios	AFAD; Jandarma SAR; Military Engineering Units

Adaptation Actions	Implementation Actions	Key Institutions Involved
Build-Back-Better Recovery	Insurance promotion (DASK/climate pool); rapid-release relief funds; mobile damage-assessment teams	Ministry of Interior; Ministry of Health; Insurance Authorities; Local Governments
After-Action Learning	Post-disaster reviews; plan updates every two years based on lessons and new climate data	AFAD; Climate Adaptation Board; Local Emergency Committees

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