



Long-Term Climate Adaptation and Mitigation Action Plan for the Marmara Region of Türkiye



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List of Abbreviations

Abbreviation	Full Form
AFAD	Disaster and Emergency Management Authority (Afet ve Acil Durum Yönetimi Başkanlığı)
AKUT	Search and Rescue Association (Arama Kurtarma Derneği)
EV	Electric Vehicle
GIS	Geographic Information System
HVAC	Heating, Ventilation, and Air Conditioning
KEGM	Coastal Safety and Maritime Security Directorate (Kıyı Emniyeti Genel Müdürlüğü)
MENR	Ministry of Energy and Natural Resources
MGM	Turkish State Meteorological Service (Meteoroloji Genel Müdürlüğü)
MMU	Marmara Municipalities Union
MoAF	Ministry of Agriculture and Forestry
MoEUCC	Ministry of Environment, Urbanization and Climate Change
MRF	Material Recovery Facility
NGO	Non-Governmental Organization
PV	Photovoltaic
SECAP	Sustainable Energy and Climate Action Plan
SMS	Short Message Service
TEİAŞ	Turkish Electricity Transmission Corporation (Türkiye Elektrik İletim A.Ş.)
TÜBİTAK	Scientific and Technological Research Council of Türkiye
UHI	Urban Heat Island
UNDP	United Nations Development Programme



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

1. Introduction: Climate Change Impacts in the Marmara Region

Climate change is significantly affecting Türkiye’s Marmara Region, home to the nation’s largest urban centers. Over recent decades, the area has warmed noticeably and experienced shifting precipitation patterns. Average temperatures have risen considerably, with a marked increase in summer heat that is amplified by the urban heat island effect. This has led to higher energy demand for cooling, adverse public health impacts, and deteriorating air quality. Additionally, precipitation patterns have become more erratic. While winter rains have generally declined, rainfall—when it does occur—is often concentrated in intense, short-duration bursts, increasing flood risks through flash floods and overwhelming drainage systems. Rising sea levels further threaten coastal areas with gradual inundation, erosion, and saltwater intrusion, imperiling infrastructure, cultural heritage, and freshwater resources. Beyond these physical hazards, climate change is also challenging urban sustainability by stressing energy, transport, and waste management systems. In response, this Sustainable Energy and Climate Action Plan (SECAP) for the Marmara Region presents a long-term, integrated approach focusing on urban-scale adaptation strategies in key areas including urban heat islands, flood risks, sustainable energy, transport, waste management, and public health. The plan outlines targeted adaptation strategies, concrete implementation steps, and a supportive institutional framework to safeguard communities and infrastructure while advancing Türkiye’s broader climate and sustainable development goals.

2. Urban Heat Island Effect and Extreme Heat

2.1 Introduction

The Marmara Region’s urban districts are grappling with intensifying heat caused by global warming and the urban heat island effect. Rapid urban expansion—characterized by reduced vegetation and increased concrete—has made cities like Istanbul, Bursa, and Kocaeli



significantly hotter than rural areas, particularly during summer nights. This rise in heat poses health risks, increases energy demands for cooling, and worsens air pollution.

2.2 Adaptation Actions

To counteract urban heat islands, the plan prioritizes cooling the cities through urban design and greening interventions. Key strategies include:

- **Expand Urban Green Infrastructure (Parks, Tree Canopies, Green Roofs/Walls):**
 - Increasing vegetative cover lowers ambient temperatures through shade and evaporative cooling, improves air quality, and enhances urban aesthetics.
- **Promote Cool Roofing, High Albedo Surfaces, and Permeable Pavements:**
 - Using reflective and permeable materials reduces heat absorption by buildings and roads, lowering surface temperatures and mitigating the urban heat island (UHI) effect.
- **Improve Urban Planning for Better Ventilation and Shading (Building Spacing, Wind Corridors):**
 - Designing urban layouts to allow natural air circulation reduces heat buildup and improves the microclimate during heatwaves.
- **Enhance Heat-Aware Building Design with Insulation, Reflective Glazing, and Natural Ventilation:**
 - Upgrading building features enhances indoor thermal comfort, reduces reliance on air conditioning, and improves resilience during extreme heat.
- **Incorporate Water Features (Fountains, Ponds) for Local Evaporative Cooling:**
 - Water elements help naturally dissipate heat, creating cooling microenvironments that alleviate urban temperature spikes.
- **Develop Community-Based Heat Action Plans (Warning Systems, Cooling Centers):**
 - Establishing early warning systems and providing cooling centers ensures vulnerable populations receive timely support during heat events.

2.3 Implementation Actions

- **Launch “Cool Marmara” Tree Planting and Urban Greening Campaigns:**
 - Organize initiatives to rapidly increase urban vegetation that provides immediate cooling and long-term benefits for air quality and livability.
- **Provide Incentives (Grants, Tax Rebates) for Green Roofs and Reflective Surface Installations:**
 - Motivate property owners and developers to adopt heat-mitigating technologies by offering financial incentives.
- **Update Zoning and Building Codes to Require Designated Green and Permeable Areas:**
 - Enforce regulatory changes to ensure future developments incorporate features that reduce heat retention and manage stormwater.



- **Establish a Heatwave Early Warning and Response System and Designate Cooling Centers:**
 - Develop proactive alert systems, paired with community cooling centers, to protect residents during extreme heat events.
- **Install Urban Temperature Monitoring Networks to Evaluate UHI Mitigation:**
 - Implement continuous monitoring systems to gather data on the effectiveness of heat reduction strategies and inform future actions.

2.4 Key Institutions for Cooperation in the Marmara Region

- **Municipalities and Local Government Authorities:**
 - Responsible for urban planning, infrastructure implementation, and local policy enforcement.
- **Ministry of Environment and Urbanization:**
 - Oversees urban development, environmental policies, and the integration of climate adaptation measures.
- **Urban Planning and Zoning Departments:**
 - Implement updated building codes and zoning regulations that include green and permeable areas.
- **Regional Environmental Directorates (Marmara Regional Offices):**
 - Coordinate environmental monitoring and oversee urban greening initiatives.
- **Local Universities and Research Institutes:**
 - Provide technical support, climate modeling, and monitoring of urban temperature trends.
- **Civil Society Organizations and NGOs:**
 - Engage communities, raise awareness, and support local adaptation projects.
- **Forestry and Landscaping Agencies:**
 - Support large-scale tree planting and maintenance of green infrastructure.

3 Table 1. Climate Change Adaptation and Implementation Actions for Urban Heat Island Effect and Extreme Heat for Marmara Region

Adaptation Action	Implementation Actions	Key Institutions for Cooperation
Expand Urban Green Infrastructure	- Launch “Cool Marmara” tree planting and urban greening campaigns	Municipalities and Local Government Authorities Marmara Regional Environmental Directorates Forestry Agencies
Promote Cool Roofing, High Albedo Surfaces, and Permeable Pavements	- Provide incentives (grants, tax rebates) for green roofs and reflective surface installations	Ministry of Environment and Urbanization Urban Planning Departments Local Universities
Improve Urban Planning for Better Ventilation and Shading	- Update zoning and building codes to require designated green and permeable areas	Municipalities and Urban Planning Authorities Ministry of Environment and Urbanization



Adaptation Action	Implementation Actions	Key Institutions for Cooperation
Enhance Heat-Aware Building Design	- Encourage use of insulation, reflective glazing, and natural ventilation through revised building standards	Urban Planning Departments Construction and Building Regulation Agencies
Incorporate Water Features for Local Evaporative Cooling	- Integrate fountains, ponds, and other water elements in urban design projects	Municipalities Ministry of Environment and Urbanization Local NGOs
Develop Community-Based Heat Action Plans	- Establish a heatwave early warning and response system - Designate community cooling centers	Municipalities Ministry of Environment and Urbanization Local Civil Defense Groups NGOs
Monitoring and Evaluation of UHI Mitigation	- Install urban temperature monitoring networks to evaluate the effectiveness of adaptation measures	Local Universities and Research Institutes Marmara Regional Environmental Directorates

By aggressively expanding greenery, adapting buildings, and protecting residents during heatwaves, Marmara’s cities can reduce heat stress and improve livability. Many of these measures yield **co-benefits**: more green space improves air quality and stormwater absorption, energy-efficient buildings lower power bills, and a cooler city is also more attractive for tourism and business investment.

3. Flood Risks: Extreme Rainfall and Sea Level Rise

3.1 Introduction

Low-lying and waterfront areas in the Marmara Region face dual flooding threats: intense inland cloudbursts that overwhelm drainage systems and gradual coastal inundation from rising sea levels and storm surges. Extreme precipitation events have already caused deadly flash floods, and future short-duration deluges are expected to become more frequent even as overall rainfall declines. Meanwhile, rising sea levels threaten to erode coastlines and flood coastal neighborhoods, infrastructure, and cultural heritage sites, potentially rendering some areas uninhabitable without proper adaptation measures.

3.2 Adaptation Actions



- **Enhance Stormwater Infrastructure and Drainage Systems to Handle Heavy Rainfall:**
 - Upgrading drainage networks to prevent urban flooding by ensuring excess water is efficiently channeled away from vulnerable areas during intense rainfall.
- **Employ Nature-Based Solutions (Bioswales, Rain Gardens, Restored Wetlands) for Runoff Management:**
 - Use ecological methods to slow down and absorb runoff, reducing flood peaks while enhancing urban biodiversity and green spaces.
- **Build Flood Defenses (Levees, Floodwalls, Sea Walls, or Living Shorelines):**
 - Construct physical barriers to protect critical infrastructure and communities from floodwaters and mitigate the impact of rising sea levels.
- **Reinforce Flood-Resilient Land Use Planning and Restrict New Development in High-Risk Zones:**
 - Restrict construction in flood-prone areas and encourage the use of these spaces for purposes that can tolerate occasional flooding.
- **Develop Coastal Adaptation Measures to Address Sea Level Rise and Saltwater Intrusion:**
 - Implement coastal defenses and protective measures to secure infrastructure against gradual sea level increases and preserve freshwater resources from salinization.
- **Strengthen Early Warning and Emergency Response Systems:**
 - Enhanced forecasting and rapid response plans enable communities to prepare and evacuate when necessary, reducing the overall impact of flood events.

3.3 Implementation Actions

- **Develop and Execute Drainage Master Plans for Major Municipalities by Targeting Identified Bottlenecks:**
 - Comprehensive plans guide systematic upgrades to drainage systems, addressing weak points and increasing overall water management capacity.
- **Initiate Pilot Green Infrastructure Projects (e.g., “Blue Green Boulevard”) and Replicate Successful Models:**
 - Test nature-based solutions in pilot projects to gain practical insights that can be scaled up for broader implementation.
- **Commission Feasibility Studies on Coastal Protection (e.g., Seawalls, Tidal Barriers) and Update Zoning Regulations Accordingly:**
 - Conduct studies to prioritize investments in coastal protection, ensuring that land use policies address evolving risks of coastal flooding.
- **Install Regional Sensor Networks (Rain Gauges, Tide Gauges) and Maintain Drainage Infrastructure with Scheduled Inspections:**
 - Deploy real-time sensor networks to monitor rainfall, tide levels, and water flow, and schedule regular maintenance to ensure the systems function effectively.
- **Organize Community Training and Emergency Drills (Flood Evacuation and Debris Removal):**
 - Conduct preparedness exercises to build local capacity for responding to flood emergencies, ensuring both residents and officials are equipped to handle such events.
- **Revised Zoning Regulations (Effective Immediately):**



- Ban new building permits in high-risk flood zones unless flood defenses are included.
- By 2025, update zoning to convert flood-prone areas into green spaces or low-value use.
- Require flood risk disclosure in property sales.
- Provide incentives for relocating or flood-proofing existing buildings (e.g., subsidies for elevating homes, installing flood gates, or pumps).
- **Community Flood Preparedness:**
 - Install flood warning sirens and SMS alert systems in riverine and coastal towns.
 - Conduct annual flood evacuation drills with AFAD.
 - Equip local teams with boats, pumps, and medical kits.
 - Train volunteer “flood wardens” in vulnerable areas to assist with early warnings and initial response.
- **Monitoring and Maintenance:**
 - Install regional sensor networks (rain, river, tide gauges) linked to the Marmara Disaster Coordination Center.
 - Regularly inspect and maintain flood infrastructure (drains, pumps, levees) with clear municipal schedules and accountability.
 - Allocate budget and staff for year-round upkeep, especially clearing storm drains and servicing pumps before rainy seasons.

3.4 Key Institutions for Cooperation

- **Ministry of Environment and Urbanization (MoEU):**
 - Lead in urban planning, land use regulation, and infrastructure projects, including the implementation of nature-based solutions.
- **AFAD (Disaster and Emergency Management Authority):**
 - Coordinates emergency responses, flood evacuation drills, and public safety initiatives.
- **Municipalities:**
 - Local authorities are responsible for implementing drainage master plans, zoning regulations, and community preparedness actions, such as installation of flood warning systems.
- **Ministry of Agriculture and Forestry (MoAF):**
 - Supports the implementation of green infrastructure projects like bioswales, rain gardens, and restored wetlands.
- **Coastal and Maritime Safety Agency (KEGM):**
 - Oversees coastal adaptation measures and the development of seawalls and tidal barriers.
- **Ministry of Interior (for Local Governance and Emergency Services):**
 - Coordinates community-based preparedness, including training volunteer “flood wardens.”
- **Public and Private Sector Engineering Firms:**



- Provide technical expertise for feasibility studies, infrastructure development, and maintenance.
- **Local Universities and Research Institutes:**
 - Conduct feasibility studies, offer scientific expertise, and support sensor networks and monitoring systems.

Table 2. Climate Change Adaptation and implementation Actions for managing flood risk in the Marmara Region

Adaptation Action	Implementation Actions	Key Institutions for Cooperation
Enhance Stormwater Infrastructure and Drainage Systems	- Develop and execute Drainage Master Plans for major municipalities targeting identified bottlenecks	Municipalities Ministry of Environment and Urbanization AFAD Engineering Firms
Employ Nature-Based Solutions (Bioswales, Rain Gardens, Restored Wetlands)	- Initiate pilot green infrastructure projects (e.g., "Blue Green Boulevard") and replicate successful models	Ministry of Environment and Urbanization Ministry of Agriculture and Forestry Local Municipalities
Build Flood Defenses (Levees, Floodwalls, Sea Walls, Living Shorelines)	- Commission feasibility studies on coastal protection (e.g., seawalls, tidal barriers) and update zoning regulations accordingly	Ministry of Environment and Urbanization KEGM Municipalities Coastal and Maritime Safety Agency
Reinforce Flood-Resilient Land Use Planning	- Implement zoning regulations that restrict construction in flood-prone areas and encourage use of such spaces for compatible uses	Municipalities Ministry of Environment and Urbanization Ministry of Interior Local Development Agencies
Develop Coastal Adaptation Measures	- Implement coastal defenses and protective measures to address sea level rise and saltwater intrusion	Ministry of Environment and Urbanization KEGM Municipalities
Strengthen Early Warning and Emergency Response Systems	- Organize community training and emergency drills (flood evacuation and debris removal) - Install regional sensor networks (rain, river, tide gauges)	AFAD Local Municipalities Ministry of Environment and Urbanization Universities Local Volunteer Groups
Community Flood Preparedness	- Conduct annual flood evacuation drills with AFAD - Train volunteer "flood wardens" in vulnerable areas	AFAD Ministry of Interior Local Municipalities Local Civil Defense Groups
Monitoring and Maintenance	- Regularly inspect and maintain flood infrastructure (drains, pumps, levees) - Allocate budget and staff for year-round upkeep	Municipalities Ministry of Environment and Urbanization Engineering Firms

4 Sustainable Energy and Building Design



4.1 Introduction

Transforming energy use in the Marmara Region is essential for both climate mitigation and adaptation. As Türkiye's most industrialized and populous area, Marmara consumes a large share of national energy, and its cities face rising cooling demands during heatwaves that can stress the power grid. Many older, energy-inefficient buildings worsen this challenge, increasing vulnerability to temperature extremes. This plan focuses on boosting energy efficiency, expanding renewable energy, and strengthening energy infrastructure resilience. Below is a detailed breakdown of the Urban Energy Adaptation and Mitigation Strategies for the Marmara Region.

4.2 Adaptation Actions

- **Retrofit Buildings to Improve Energy Efficiency**
 - Enhance building performance through insulation, efficient HVAC systems, and optimized energy management to reduce energy demand and stabilize indoor conditions.
- **Increase Adoption of Renewable Energy Systems**
 - Transition to solar PV panels, wind energy, and distributed generation to cut emissions, enhance energy security, and reduce fossil fuel reliance.
- **Explore District Energy Systems for Heating and Cooling**
 - Centralize heating/cooling resources among multiple buildings to improve energy efficiency and lower operational costs.
- **Modernize Grids with Smart Meters and Battery Storage**
 - Deploy smart grid technologies and storage solutions to optimize energy distribution, manage peak loads, and enhance grid resilience against extreme weather.
- **Promote Resilient Energy Infrastructure**
 - Strengthen critical assets with flood-proof substations and underground cabling to ensure continuous power supply during climate hazards.
- **Raise Public Awareness and Offer Incentives for Energy Saving Practices**
 - Implement education campaigns and financial incentives to encourage energy efficiency and sustainable consumption among residents and businesses.



4.3 Implementation Actions

- **Building Energy Audits & Retrofits:**
 - Launch regional Building Energy Audit Programs for municipal and private buildings, then implement targeted retrofit plans.
- **Green Building Codes:**
 - Adopt and enforce new Green Building Codes that mandate energy-saving features in all new constructions.
- **Solar City Initiative:**
 - Install rooftop solar panels on public buildings and foster private sector uptake through supportive policies and incentives.
- **Pilot District Energy Projects:**
 - Conduct feasibility studies and pilot projects (including waste heat recovery) in designated zones to explore centralized energy solutions.
- **Smart Grid Deployment & Demand Response:**
 - Deploy smart meters, integrate battery storage solutions, and establish demand response programs through partnerships with utility providers.
- **Energy & Emissions Monitoring Center:**
 - Set up a centralized monitoring center to track energy use and emissions, allowing for continuous evaluation and adjustment of energy policies.

4.4 Key Institutions for Cooperation

- **Ministry of Energy and Natural Resources:**
 - Provides policy direction and oversight for energy transitions and infrastructure improvements.
- **Ministry of Environment and Urbanization:**
 - Integrates energy efficiency and green building initiatives within urban planning and regulatory frameworks.
- **TEİAŞ (Turkish Electricity Transmission Corporation):**
 - Ensures efficient energy transmission and modernizes grid operations.
- **Electricity Distribution Companies:**
 - Implement smart grid technologies, demand response, and support local energy initiatives.
- **Municipalities and Local Governments:**
 - Play a leading role in urban retrofits, renewable installations on public buildings, and district energy project pilots.
- **Urban Planning and Building Regulation Agencies:**
 - Enforce green building codes and update zoning regulations to promote energy-efficient developments.
- **Local Universities and Research Institutes:**
 - Provide technical expertise, conduct feasibility studies, and support monitoring of energy and emissions data.
- **Private Sector Energy Companies and Developers:**
 - Collaborate on renewable energy projects, building retrofits, and deployment of smart grid technologies.

Table 3. Climate Change Adaptation and Implementation Actions for Sustainable Energy in Urban Areas in the Marmara Region



Adaptation Action	Implementation Actions	Key Institutions for Cooperation
Retrofit Buildings to Improve Energy Efficiency	- Launch regional Building Energy Audit Programs - Implement retrofit plans for municipal and private buildings	Ministry of Energy and Natural Resources Municipalities Urban Planning Agencies Private Sector Developers
Increase Adoption of Renewable Energy Systems	- Implement the “Solar City Initiative” by installing rooftop solar on public buildings - Facilitate private sector uptake with incentives	Ministry of Energy and Natural Resources TEİAŞ Electricity Distribution Companies Municipalities
Explore District Energy Systems for Heating and Cooling	- Pilot district energy projects (feasibility studies, waste heat recovery) in designated zones	Municipalities Ministry of Energy and Natural Resources Local Universities and Research Institutes
Modernize Grids with Smart Meters and Battery Storage	- Deploy smart grid technologies (smart meters, battery storage) - Establish demand response programs through utility partnerships	TEİAŞ Electricity Distribution Companies Ministry of Energy and Natural Resources
Promote Resilient Energy Infrastructure	- Retrofit critical infrastructure (flood-proof substations, underground cabling) - Upgrade grids to withstand extreme weather	Ministry of Energy and Natural Resources Municipalities Local Engineering Firms
Raise Public Awareness and Offer Incentives for Energy Saving	- Conduct public education campaigns on energy efficiency - Offer grants and tax rebates to incentivize energy-saving practices	Ministry of Energy and Natural Resources Ministry of Environment and Urbanization Municipalities Private Sector
Monitoring and Evaluation	- Set up an Energy and Emissions Monitoring Center to track progress and adjust targets accordingly	Ministry of Energy and Natural Resources Local Universities and Research Institutes Municipalities

This table organizes the adaptation actions with the corresponding implementation steps and highlights the key institutions needed to effectively achieve sustainable, resilient energy use in the Marmara Region. Through these actions, the Marmara Region can move towards a low-carbon, energy-efficient future. In doing so, it not only contributes to mitigating global climate change but also builds local resilience – efficient buildings and diversified energy sources mean the region can better withstand heatwaves or other disruptions without energy shortages. Additionally, investments in sustainable energy can spur green economic growth, creating jobs in retrofitting, solar installation, and technology maintenance.



5 Sustainable Climate-Smart Transport Systems Adaptation and Implementation Actions

5.1 Introduction

Transportation is both a major emissions source and highly vulnerable to climate impacts in the Marmara Region. Extreme weather threatens roads, railways, tunnels, and ports through flooding, heat damage, and sea level rise. At the same time, reducing transport-related emissions is essential. This plan focuses on sustainable, low-carbon mobility solutions that are built to withstand future climate risks.

Below is a detailed breakdown of a climate-smart transport system for the Marmara Region of Türkiye. First, the adaptation and mitigation actions are listed separately, then the corresponding implementation actions are provided. Next, key institutions for cooperation are identified. Finally, all of these elements are combined into a comprehensive table.

5.2 Adaptation and Mitigation Actions

- **Upgrade Transport Infrastructure Design Standards for Flood, Heat, and Extreme Weather Resilience**
 - Ensure that roads, bridges, railways, and related infrastructure are designed or retrofitted to remain functional during and after extreme events.
- **Expand and Enhance Public Transit and Active Transport Networks**
 - Improve metro, tram, bus rapid transit, and non-motorized transport (cycling, walking) networks to provide resilient and sustainable travel alternatives, reducing emissions and vulnerability during adverse weather.
- **Accelerate the Transition to Low and Zero Emission Vehicles**
 - Shift public and private fleets (e.g., municipal buses, EVs) to cleaner vehicles, lowering air pollution, greenhouse gas emissions, and mitigating urban heat generation.
- **Integrate Transit-Oriented Development (TOD) into Land Use Planning**
 - Promote clustering of development around transit hubs to reduce travel distances and support sustainable urban growth, lowering the community's overall carbon footprint.
- **Implement Transportation Demand Management Measures**

Aim: Encourage reduced reliance on private vehicles through measures such as congestion pricing and low emission zones, decreasing traffic volume and emissions.
- **Strengthen Port and Logistics Resilience Against Climate Hazards**



- Enhance the resilience of critical transport links—such as ports and logistics centers—to ensure the continuity of supply chains during extreme weather events.

5.3 Implementation Actions

- **Conduct Infrastructure Climate Audits**
 - Assess and prioritize vulnerable transport assets using climate risk assessments to guide targeted investments and upgrades.
- **Advance Metro and Rail Expansion Projects with Climate-Resilient Features**
 - Integrate flood proofing, improved drainage, flood gates, and other resilient design elements in both new projects and retrofitting measures.
- **Convert Municipal Bus Fleets to Electric Vehicles and Build EV Charging Networks**
 - Replace significant portions of the fleet with EVs and develop a resilient charging infrastructure to lower operating emissions and support sustainable transit.
- **Develop Protected Bike Lanes, Pedestrian Zones, and Redesigned Urban Streets**
 - Create safe and accessible active travel routes to encourage walking and cycling, reducing dependency on private vehicle use.
- **Enact Policy Incentives (e.g., Congestion Charges and Low Emission Zones)**
 - Implement financial and regulatory measures that discourage private car use and promote sustainable travel behaviors.
- **Establish Emergency Transport and Evacuation Protocols**
 - Develop and maintain procedures backed by real-time sensor data and backup power systems for traffic controls to ensure operational continuity during emergencies.

5.4 Key Institutions for Cooperation in the Marmara Region

- **Ministry of Transport and Infrastructure:**
 - Oversees major transport projects, infrastructure design standards, and national transport policies.
- **Ministry of Environment and Urbanization:**
 - Provides regulatory guidance on environmental standards and urban planning—including transit-oriented development.
- **Municipalities and Local Government Authorities:**
 - Implement local transport infrastructure projects, manage urban planning, and coordinate emergency responses.
- **TEİAŞ (Turkish Electricity Transmission Corporation) and Electricity Distribution Companies:**
 - Support the electrification of transport fleets and smart grid integration for traffic systems.
- **Transport and Infrastructure Planning Agencies:**
 - Conduct infrastructure audits and oversee the integration of resilient design features.
- **Port Authorities and Logistics Organizations:**



- Ensure the resilience of ports and critical logistics centers against climate hazards.
- **Research Institutes and Universities:**
 - Provide technical expertise, conduct feasibility studies, and support the integration of advanced technologies (e.g., sensor networks, backup power systems).
- **Private Sector Stakeholders (Transit Operators, EV Manufacturers, etc.):**
 - Collaborate on fleet conversion, infrastructure projects, and innovation in sustainable transport solutions.

Table 4. Comprehensive Climate-Smart Transport System Adaptation and Implementation Actions for Marmara Region

Adaptation & Mitigation Action	Implementation Actions	Key Institutions for Cooperation
Upgrade Transport Infrastructure Design Standards	- Conduct climate audits of vulnerable transport assets - Retrofit roads, bridges, and railways with flood, heat, and extreme weather resilience features	Ministry of Transport and Infrastructure Municipalities Transport Planning Agencies
Expand and Enhance Public Transit and Active Transport Networks	- Advance metro, tram, and rail expansion projects with climate-proof designs - Develop protected bike lanes and pedestrian zones	Ministry of Transport and Infrastructure Municipalities Local Government Authorities
Accelerate the Transition to Low and Zero Emission Vehicles	- Convert municipal bus fleets to electric vehicles - Build resilient EV charging networks	Ministry of Transport and Infrastructure TEİAŞ Electricity Distribution Companies Municipalities
Integrate Transit-Oriented Development (TOD) into Land Use Planning	- Coordinate land use policies to cluster development around transit hubs, reducing travel distances - Update zoning regulations for TOD	Ministry of Environment and Urbanization Municipalities Urban Planning Agencies
Implement Transportation Demand Management Measures	- Enact congestion charges and establish low emission zones - Develop policy incentives to discourage private car use and encourage public transit	Ministry of Transport and Infrastructure Municipalities Ministry of Environment and Urbanization
Strengthen Port and Logistics Resilience Against Climate Hazards	- Retrofit port facilities with climate-resilient features - Enhance logistics center protections - Conduct vulnerability assessments for critical supply chain transport links	Port Authorities Ministry of Transport and Infrastructure Municipalities Logistics Organizations
Establish Emergency Transport and Evacuation Protocols	- Develop emergency response protocols for transport during crises - Integrate real-time sensor data and backup power for traffic systems	Ministry of Transport and Infrastructure Municipalities AFAD Research Institutes



By redesigning transport systems with climate in mind, Marmara's cities will enjoy safer, cleaner, and more efficient mobility. These efforts yield multiple dividends: less air pollution and GHG emissions, reduced traffic congestion, and infrastructure that continues to function under duress, supporting both everyday life and emergency needs in a changing climate.

6 Sustainable Waste Management Adaptation and Implementation Actions

6.1 Introduction

The Marmara Region, as Türkiye's most densely populated and industrialized area, faces growing environmental and public health challenges linked to rising waste generation. Rapid urbanization, expanding industrial production, and changing consumption patterns have placed significant pressure on the region's waste management systems. To safeguard environmental quality, protect ecosystems, and reduce greenhouse gas emissions, a transition to sustainable waste management practices is essential. This approach prioritizes waste prevention, resource efficiency, circular economy principles, and climate-resilient infrastructure. By integrating modern technologies, strengthening institutional cooperation, and engaging communities in waste reduction, the Marmara Region can not only minimize the environmental footprint of waste but also turn it into an opportunity for innovation, green jobs, and long-term regional sustainability. Below is a structured response that details the adaptation and implementation actions for Sustainable Waste Management in the Marmara Region, along with the key institutions that need to be involved. Finally, a comprehensive table is provided that brings together these lists.

6.2 Adaptation Actions

- **Promote Waste Reduction, Recycling, and Composting Practices**
 - *Objective:* Lower landfill volumes by reducing waste at the source and boosting recycling, thereby decreasing greenhouse gas emissions and conserving resources.
- **Install Methane Capture Systems and Evaluate Waste-to-Energy Processes**



- *Objective:* Capture landfill gas for energy production, reducing methane emissions and transforming waste into a valuable energy resource.
- **Design Waste Collection and Disposal Facilities to Withstand Floods**
 - *Objective:* Upgrade or relocate waste management facilities with flood defenses to ensure continuous operations during extreme weather events and prevent secondary environmental hazards.
- **Enhance Wastewater Treatment and Encourage Reuse**
 - *Objective:* Improve wastewater treatment systems to safeguard water quality and promote water reuse for non-potable applications, which is critical during droughts and floods.
- **Drive Public Engagement and Behavior Change Toward Proper Waste Management**
 - *Objective:* Empower communities through education and outreach to adopt sustainable waste practices, thereby reducing overall environmental impact.
- **Investigate Innovative Waste Management Technologies**
 - *Objective:* Explore advanced solutions such as anaerobic digestion and smart waste bins to optimize waste processing, improve efficiency, reduce costs, and lower environmental impacts.

6.3. Implementation Actions

- **Develop a Regional Waste Management Strategy with Clear Targets**
 - Create comprehensive plans with measurable goals (e.g., increasing recycling rates, reducing landfill waste) that align stakeholders toward common sustainability targets.
- **Invest in New Material Recovery Facilities (MRFs) and Composting Plants**
 - Expand the region's capacity for recycling and composting by establishing modern, efficient infrastructure, while also creating local employment opportunities.
- **Upgrade Landfill Sites with Methane Capture and Improved Leachate Management**
 - Modernize existing landfill operations with methane capture systems, flood defenses, and improved leachate management to mitigate emissions and protect surrounding areas.



- **Modernize Waste Collection Fleets and Optimize Routes**
 - Replace aging vehicles with low-emission alternatives and use digital tools for smart route optimization, thereby reducing fuel consumption and the overall carbon footprint of waste collection.
- **Organize Emergency Debris Removal Protocols and Regular Infrastructure Inspections**
 - Establish routine inspections and emergency plans to ensure that waste infrastructure is maintained and can operate effectively during extreme weather events.
- **Launch Community “Zero Waste Neighborhood” Programs**
 - Implement educational campaigns and incentive programs that encourage residents and businesses to adopt practices focused on reducing, reusing, and recycling waste.

3. Key Institutions for Cooperation in the Marmara Region

- **Ministry of Environment and Urbanization:**
 - Guides policy development and regulatory requirements for sustainable waste management and infrastructure resilience.
- **Municipalities and Local Government Authorities:**
 - Responsible for implementing regional waste management strategies, infrastructure upgrades, and public engagement initiatives.
- **Waste Management Companies and Operators**
 - Execute operational aspects such as collection, recycling, and landfill management.
- **Regional Water and Waste Management Authorities:**
 - Collaborate on upgrading wastewater treatment and ensuring that water reuse meets environmental standards.
- **Private Sector (MRF Operators, Technology Providers):**
 - Invest in and deploy innovative waste processing technologies and modern fleet management systems.
- **Universities and Research Institutes:**
 - Provide technical support, feasibility studies, and data analysis for monitoring and improving waste management practices.
- **Non-Governmental Organizations (NGOs) and Community Groups:**
 - Lead public awareness campaigns and facilitate community-driven “Zero Waste Neighborhood” programs.



Table 5. Climate Change Adaptation and Implementation Actions for Sustainable Waste Management in the Marmara Region

Adaptation Action	Implementation Actions	Key Institutions for Cooperation
Promote Waste Reduction, Recycling, and Composting Practices	- Develop a Regional Waste Management Strategy with clear targets - Launch initiatives that encourage source reduction, recycling, and composting	Ministry of Environment and Urbanization Municipalities NGOs Waste Management Companies
Install Methane Capture Systems and Evaluate Waste-to-Energy Processes	- Upgrade landfill sites with methane capture systems and improved leachate management - Assess and implement waste-to-energy processes	Ministry of Environment and Urbanization Municipalities Waste Management Companies Private Sector (Energy Providers)
Design Waste Collection and Disposal Facilities to Withstand Floods	- Upgrade or relocate facilities with flood defenses - Reinforce infrastructure to ensure continuous operation during floods	Municipalities Ministry of Environment and Urbanization Regional Water and Waste Management Authorities
Enhance Wastewater Treatment and Encourage Reuse	- Invest in advanced wastewater treatment and reuse facilities - Integrate recycled water for non-potable applications in urban settings	Municipalities Regional Water and Waste Management Authorities Ministry of Environment and Urbanization
Drive Public Engagement and Behavior Change Toward Proper Waste Management	- Organize public education and outreach campaigns - Launch community “Zero Waste Neighborhood” programs with incentive rewards	NGOs Municipalities Ministry of Environment and Urbanization Local Community Groups
Investigate Innovative Waste Management Technologies	- Invest in research and pilot projects for technologies such as anaerobic digestion and smart waste bins - Scale up successful innovations	Universities and Research Institutes Private Sector (Technology Providers) Ministry of Environment and Urbanization
Modernize Waste Collection Fleets and Optimize Routes	- Upgrade to low-emission vehicles for waste collection - Implement digital routing tools to reduce fuel consumption	Municipalities Waste Management Companies Ministry of Environment and Urbanization
Organize Emergency Debris Removal Protocols and Regular Infrastructure Inspections	- Schedule routine inspections of waste management infrastructure - Develop and rehearse emergency debris removal protocols to maintain operations during extreme weather events	Municipalities Regional Water and Waste Management Authorities Ministry of Environment and Urbanization AFAD (if applicable)



By managing waste sustainably, Marmara's cities will reduce a source of greenhouse gases and also improve their resilience. Cleaner communities with less waste lying around are less prone to floods and diseases. Moreover, waste management improvements often have quick tangible benefits for citizens (cleaner streets, less odor, new jobs in recycling) which can build public support for broader climate action initiatives.

6. Public Health and Social Resilience

6.1 Introduction

Climate change presents increasing risks to population health and social well-being, making public health adaptation a critical priority for the Marmara Region. With more than 25 million residents, the region is particularly vulnerable to the health effects of extreme heat, shifting patterns of infectious diseases, air pollution, flooding, and disaster-related trauma. Special attention must be given to protecting elderly individuals, children, people with chronic illnesses, and lower-income communities. Strengthening healthcare infrastructure, enhancing disease surveillance, and building community-level resilience will be vital to safeguard the population in the face of future climate conditions.

6.1 Adaptation Actions for Public Health

- **Develop Comprehensive Heat Health Action Plans with Early Warning and Cooling Measures**
 - Plans that integrate medical systems and community response frameworks to reduce heat-related health risks during extreme weather events.
- **Strengthen Disease Surveillance and Vector Control to Counter Emerging Health Threats**
 - Enhance detection and rapid response systems to prevent the spread of climate-sensitive infectious diseases.
- **Enhance Healthcare Facility Resilience (Backup Power, Flood Proofing, Robust Cooling Systems)**
 - Upgrade healthcare infrastructure to ensure continuity of medical services during extreme weather and disaster conditions.
- **Provide Mental Health Support and Community Resilience Programs in Disaster-Prone Areas**
 - Deliver psychosocial support and strengthen social networks to help communities recover from trauma and build long-term resilience.
- **Implement Public Education Campaigns on Health, Water/Food Safety, and Climate Risks**
 - Increase public awareness and self-protection capacity during climate-related events.



- **Ensure Inclusive Planning that Prioritizes Vulnerable Populations and Equity in Health Services**
 - Design health policies and services that specifically address the needs of at-risk groups such as the elderly, children, and those with chronic illnesses.

6.2 Implementation Actions

- **Establish Heatwave Early Warning and Response Systems**
 - Deploy early warning systems and response protocols in collaboration with meteorological and health authorities to protect lives during extreme heat events.
- **Upgrade Disease Surveillance Platforms with Integrated Climate Health Data**
 - Combine climate and health data streams for improved monitoring, prediction, and response to outbreaks.
- **Conduct Climate Resilience Assessments in Hospitals and Retrofit Healthcare Facilities**
 - Identify vulnerabilities in healthcare infrastructure and implement resilience upgrades (flood-proofing, backup power, cooling systems).
- **Prepare EMS for Climate Extremes by Upgrading Equipment and Training Personnel**
 - Equip emergency response teams and provide specialized training for extreme heat and flood-related medical emergencies.
- **Expand Community Health Outreach (e.g., Climate Health Volunteers, School Curricula)**
 - Launch local programs to promote health literacy, climate risk awareness, and proactive health protection behavior.
- **Form Climate and Health Working Groups at Local Levels**
 - Establish coordination platforms at municipal or provincial levels for ongoing dialogue and strategic health planning related to climate adaptation.

6.3 Key Institutions for Cooperation — Marmara Region

- **Ministry of Health (T.C. Sağlık Bakanlığı)**
 - National leadership in health policy, disease surveillance, emergency preparedness, and hospital infrastructure improvements.
- **Ministry of Environment, Urbanization and Climate Change (T.C. Çevre, Şehircilik ve İklim Değişikliği Bakanlığı)**
 - Climate risk analysis, urban heat island mitigation, and integration of climate data into planning.
- **Turkish State Meteorological Service (Meteoroloji Genel Müdürlüğü)**
 - Provision of real-time weather forecasts, heatwave and flood warnings.
- **Provincial Health Directorates (Istanbul, Kocaeli, Bursa, Tekirdağ, Sakarya, Balıkesir, Yalova, Edirne, Çanakkale)**
 - Regional coordination of health services and local implementation of climate-health action plans.
- **Disaster and Emergency Management Authority (AFAD)**
 - Ensuring continuity of emergency medical services during and after extreme events.
- **Municipal Governments**



- Local health campaigns, operation of cooling centers, outreach to vulnerable populations, and implementation of public education initiatives.
- **Universities and Research Centers**
 - Academic research on climate-health risk modeling, vulnerability assessments, and policy recommendations.
- **Civil Society Organizations (Red Crescent, AKUT, TEMA, Yeşilay, and local NGOs)**
 - Community engagement, mental health support, volunteer mobilization, and public education efforts.

Table 6. Climate Change Adaptation and Implementation Actions for Public Health & Social Resilience for Marmara Region

Adaptation Actions	Implementation Actions	Key Institutions for Cooperation
Develop Heat Health Action Plans	Establish Heatwave Early Warning and Response Systems	Ministry of Health, Meteorological Service, Municipalities, Provincial Health Directorates
Strengthen Disease Surveillance and Vector Control	Upgrade Disease Surveillance Platforms with Integrated Climate Health Data	Ministry of Health, Municipalities, Universities, Ministry of Environment and Climate Change
Enhance Healthcare Facility Resilience	Conduct Climate Resilience Assessments and Retrofit Healthcare Facilities	Ministry of Health, AFAD, Municipalities
Provide Mental Health Support and Community Resilience Programs	Expand Community Health Outreach (Volunteers, Schools)	Ministry of Health, Municipalities, NGOs (Red Crescent, Yeşilay), Universities
Implement Public Education Campaigns	Organize Regular Public Education Sessions on Health, Water/Food Safety, and Climate Risks	Municipalities, Provincial Health Directorates, NGOs, Schools
Ensure Inclusive Planning for Vulnerable Groups	Form Climate and Health Working Groups at Local Levels	Municipalities, Ministry of Health, AFAD, NGOs, Universities
Prepare EMS for Climate Extremes	Upgrade EMS Equipment and Train Personnel for Heat and Flood Emergencies	Ministry of Health, AFAD, Municipalities

7. Adaptation and Implementation Actions for Sustainable Biodiversity



7.1 Introduction

The Marmara Region, a unique ecological crossroads between Europe and Asia, is home to a rich diversity of species and habitats, from coastal wetlands and forests to grasslands and freshwater ecosystems. However, the accelerating impacts of climate change — including rising temperatures, altered rainfall patterns, sea-level rise, and extreme weather events — are placing severe pressure on the region’s biodiversity. Healthy and resilient ecosystems are a natural defense against these threats, helping to regulate the climate, safeguard water resources, prevent soil erosion, and support human well-being. Protecting and enhancing biodiversity through sustainable practices is therefore not only essential for preserving the Marmara Region’s natural heritage but also a critical strategy for strengthening the region’s ability to adapt to a changing climate. Investing in biodiversity conservation today ensures ecological balance, food security, and climate resilience for generations to come.

7.2 Adaptation Actions

- **Enhance habitat connectivity and ecological corridors**
 - Restore and maintain natural connections between fragmented habitats to support species migration, genetic exchange, and climate adaptation.
- **Protect and restore native ecosystems**
 - Conserve and rehabilitate forests, wetlands, coastal zones, and grasslands to strengthen biodiversity and enhance natural carbon storage.
- **Implement climate-resilient protected areas**
 - Adjust the size and management plans of existing protected areas, or designate new ones, in light of climate vulnerability assessments.
- **Promote sustainable land use and agroecological practices**
 - Encourage nature-friendly agricultural methods such as agroforestry, organic farming, and low-impact grazing to balance biodiversity conservation with food production.
- **Strengthen invasive species management**
 - Implement proactive monitoring, prevention, and control programs for invasive species that could spread under changing climate conditions.
- **Enhance research and monitoring of species and ecosystems**
 - Develop long-term monitoring programs for species and habitats to ensure early detection of risks and inform adaptive management.

7.3 Implementation Actions

- **Develop a Regional Biodiversity Conservation Strategy**
 - Set measurable goals for habitat restoration, ecological connectivity, and species protection, engaging government, academia, and local stakeholders.
- **Establish ecological corridors linking fragmented habitats**
 - Work with landowners, municipalities, and conservation groups to secure and develop green corridors for wildlife movement and genetic flow.
- **Upgrade and expand protected area networks**



- Revise and expand protected area designations based on climate projections and ecological vulnerability assessments.
- **Provide capacity building and incentives for sustainable land management**
 - Deliver training, technical support, and financial incentives to promote biodiversity-friendly agricultural and land use practices.
- **Implement advanced monitoring systems for invasive species**
 - Deploy technology (remote sensing, citizen science apps, field surveys) to track and manage invasive species early and effectively.
- **Foster collaboration between research institutions and conservation agencies**
 - Facilitate partnerships for joint research, data sharing, and the co-development of locally adapted conservation strategies.

7.4 Institutions for Cooperation

National Level

- Ministry of Environment, Urbanization and Climate Change (MoEUCC)
- Ministry of Agriculture and Forestry
- Ministry of Energy and Natural Resources
- Ministry of Health
- AFAD (Disaster and Emergency Management Authority)
- Iller Bank
- National Meteorological Service (MGM)

Regional Level

- Marmara Municipalities Union (MMU)
- Regional Development Agencies
- TÜBİTAK Marmara Research Center
- Universities and Academic Institutions
- NGOs and Civil Society Organizations

Local Level

- Metropolitan and District Municipalities
- Provincial Governorates
- Community Organizations and Mukhtars
- Private Sector and Public-Private Partnerships (PPPs)

Table 7. Adaptation and Implementation Actions for sustainable Biodiversity Protection for Marmara Region

Adaptation Actions	Implementation Actions	Responsible & Supporting Institutions
Enhance habitat connectivity and ecological corridors	Establish ecological corridors linking fragmented habitats	MoEUCC, Municipalities, Regional Development Agencies, NGOs



Adaptation Actions	Implementation Actions	Responsible & Supporting Institutions
Protect and restore native ecosystems	Develop a Regional Biodiversity Conservation Strategy	MoEUCC, Ministry of Agriculture, Municipalities, Universities, NGOs
Implement climate-resilient protected areas	Upgrade and expand protected area networks	MoEUCC, Ministry of Agriculture and Forestry, Regional Agencies
Promote sustainable land use and agroecological practices	Provide capacity building and incentives for sustainable land management	Ministry of Agriculture, MoEUCC, Municipalities, NGOs, Private Sector
Strengthen invasive species management	Implement advanced monitoring systems for invasive species	MoEUCC, Ministry of Agriculture, Universities, NGOs
Enhance research and monitoring of species and ecosystems	Foster collaboration between research institutions and conservation agencies	Universities, NGOs, MoEUCC, TÜBİTAK Marmara Research Center

8. Conclusion

Through this Sustainable Energy and Climate Action Plan, the Marmara Region is setting a clear course toward climate resilience and low-carbon urban development. The plan translates policy into concrete projects, regulatory reforms, and community initiatives across key sectors such as urban cooling, flood management, energy efficiency, sustainable transport, and public health. Sound methodologies—like risk assessments, stakeholder engagement, and data-driven planning—ensure that actions remain evidence-based and adaptable as new challenges emerge.

By aligning with Türkiye’s national climate vision and local needs, the plan not only addresses threats such as extreme heat, water scarcity, and floods but also delivers significant co-benefits like improved urban aesthetics, increased public health, and economic savings. Continued political commitment, steady financing, and active stakeholder participation will be essential for turning these strategies into lasting, positive change.

In conclusion, by implementing this long-term adaptation plan, Marmara’s municipalities, other state institutions and NGO’s will enhance regional resilience, support national climate goals, and safeguard the prosperity and well-being of their communities for generations to come.

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