MINISTRY OF ENVIRONMENT
AND PHYSICAL PLANNING
REPUBLIC OF MACEDONIA

3 THIRD NATIONAL COMMUNICATION ON CLIMATE CHANGE

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This document provides comprehensive guidelines on the integration of climate change priorities into national policies, development strategies and programmes for relevant sectors. It aims to strengthen dialogue, information exchange and cooperation amongst all the relevant stakeholders, including the governmental and non-governmental, academic and private sectors. This document was produced with the technical and financial support of the United Nations Development Programme (UNDP) and the Global Environmental Facility (GEF).

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ABBREVIATIONS

AR4	Fourth Assessment Report
BAU	Business as Usual
CCPP	Combined Cycle Power Plant
CHP	Combined heat and power
CNG	Compress Natural Gas
COP	Conference of the Parties
CORINAIR	CORe INventory AIR emissions - Emission Inventory Guidebook
CORINE	Coordination of Information on the Environment
CSC	Climate Service Centre
DALY	Disability-Adjusted Life Year
DNA	Designated National Authority
DOC	Degradable Organic Carbon
EE	Energy Efficiency
ETS	Emission Trading System
EU	European Union
FAO	Food and Agriculture Organization
FNC	First National Communication
FOD	First Order Decay
FP	Framework Program
GCM	Global Climate Model/General Circulation Model
GDD	Growing Degree Days
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse gas
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HACCP	Hazard Analysis Critical Control Point System
HPP	Hydro power plant
IBRD	International Bank for Reconstruction and Development
ICEIM-MANU	Informatics and Materials of the Macedonian Academy of Sciences and Arts
IPA	Instrument for Pre-Accession Assistance
IPARD	Instrument for Pre-accession Assistance for Agriculture and Rural Development
IPCC	Inter-governmental Panel on Climate Change
IPPC	Integrated Pollution Prevention Control
IRR	Internal Rate of Return
JICA	Japan International Cooperation Agency
JRC	Joint Research Centre
LPG	Liquefied Petroleum Gas
LULUCF	Land Use, Land-Use Change and Forestry
MAFWE	Ministry of Agriculture, Forestry and Water Economy
MBT	Mechanical and biological treatment
MOEPP	Ministry of Environment and Physical Planning
MSW	Municipal Solid Waste
NAMA	Nationally Appropriate Mitigation Actions
NCCC	National Climate Change Committee
NDE	National Designated Entity
NEAP	National Environmental Action Plan
NGO	Non-governmental organization
NPV	Net Present Value
NWMP	National Waste Management Plan
PP	Power Plant
PV	Photovoltaic
QELRC	Quantified Emission Limitation and Reduction Commitment
R&D	Research and Development
RDF	Refuse Derived Fuel
RES	Renewable energy source
SE	South East
SEEFCCA	South East European Forum on Climate Change Adaptation
SEEVCCC	South East European Virtual Climate Change Centre
SME	Small and Medium Enterprises
SNC	Second National Communication
SoVI	Social Vulnerability Index
SRES	Special Report on Emissions Scenarios
TNA	Technology Need Assessment
TNC	Third National Communication
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
UV	Ultra Violet
WHO	World Health Organisation
WMO	World Meteorological Organisation
WMRs	Waste Management Regions
ZELS	Association of the units of Local Self-Government of The Republic of Macedonia

UNITS

EUR	Euro
GWh	Gigawatt hour
kt	kilo tonne
ktoe	kilo tonne of oil equivalent
m^3	cubic meter
MEUR	Million Euros
MKD	Macedonian Denar
Mt	Mega tonne
MW	Megawatt
Nm^3	Normal cubic meter

GREENHOUSE GASES

CH_4	Methane
CO	Carbon monoxide
CO_2	Carbon dioxide
HFC	Hydrofluorocarbons
NMVOC	Non-Methane Volatile Organic Compounds
NOx	Nitrous Oxides
PFC	Perfluorocarbons
SF_6	Sulphur hexafluoride
SO_x	Sulphur Oxides

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1 EXECUTIVE SUMMARY

1.1. COUNTRY PROFILE

The Republic of Macedonia is a small (25,713 km^2), landlocked country that is located in the middle of the Balkan Peninsula in Southern Europe. It has a diverse **topography** with high mountains and deep valleys surrounded by mountains, picturesque rivers, large and small natural lakes, and spas. **Land use** for agriculture covers almost 50% of the surface area of the country, and forests cover approximately one third of the country. The country is divided into four river basins and has three large natural lakes. Macedonia is a "hotspot" for **biodiversity** in Europe, and over 16,000 species have been recorded in Macedonia, including 854 endemics. Eight of the nine biomes in the Balkan Peninsula can be found in the country.

In spite of the relatively small area of the Republic of Macedonia, the country has a diverse **climate**, with eight climatic regions. With the exception of 2011, the six most recent years (2007-2012) were among the ten warmest years for the period between 1951 and 2012, and a heat wave has been recorded in almost every year since 1987. Two basic pluviometric regimes are present in Macedonia: Mediterranean and continental. The areas with highest **precipitation** are the mountain ranges in Western Macedonia; the driest areas of the country are Ovche Pole, Tikvesh and the surroundings of Gradsko,

According to the most recent census in 2002, Macedonia has a **population** of 2,022,547, with an average density of 78.7 inhabitants per square kilometre. The average household had 3.58 members in 2002, down from 4.68 members in 1971, and the current trend is one of aging. In 2007, **life expectancy** at birth was 73.54 years (76 for females and 71 for males), while disability-adjusted life expectancy was 63 years. The 2005 birth rate was 11.04 per 1,000 population and the mortality rate was 9 per 1,000, resulting in a natural increase of 2 per 1,000 population. Chronic diseases present the biggest burden on public health and high-priority environmental health issues include access to safe drinking-water in rural areas, access to sanitation, waste and waste water management, chemicals and pesticides; and indoor air quality.

The Republic of Macedonia became an independent state on September 8, 1991, following the disintegration of the former Socialist Federal Republic of Yugoslavia, and it became a candidate for membership in the European Union (EU) in December 2005. The **political system** is a parliamentary democracy. As a small country, the Republic of Macedonia has a relatively open **economy** where foreign trade accounts for more than 90% of GDP. The **agriculture** sector, including the value added in the processing industry, contributes 11.5% of the country's GDP and provides employment to 21.7% of the workforce.[1] According to the latest data from the State Statistical Office, in 2012 the GDP decreased for 0.4%. In 2011, the unemployment rate in 2011 was 31.4%.

The Republic of Macedonia is a party to the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I country and party to the Kyoto Protocol without a quantified emissions limits and reduction commitment (QELRC). However, the country has acceded to the Copenhagen Accord, and it submitted a list of non-quantified mitigation actions. The First National Communication on Climate Change (FNC) and the Second National Communication (SNC) were adopted by the Government of Macedonia and submitted to the UNFCCC Secretariat in 2003 and 2008, respectively. In addition, the First Biennial Update Report will be carried out in the coming two years.

In terms of **climate change institutions**, the Ministry of Environment and Physical Planning (MOEPP) is the key governmental body responsible for development of climate change policies, the National Focal Point to the UNFCCC, and the Designated National Authority (DNA) for Kyoto Protocol implementation. MOEPP has a Climate Change Project Office, and most other relevant ministries have appointed Climate Change Focal Points, who are responsible for mainstreaming climate change into respective policies, strategies and programmes; for example, the Ministry of Health established a National Committee for Climate Change and Health in 2009 to serve as the responsible body for surveillance activities and decision-making. At the broadest level, a National Climate Change Committee (NCCC) was established by the Government consisting of representatives of all relevant stakeholders: government bodies, academia,

[1] Source: State Statistical Office

private sector and civil society. Climate change issues are incorporated into **legislation** in the Law on Environment, which details the preparation of GHG emissions inventories (Article 188) and an action plan for mitigation.

A cross-cutting **development priority** for the Republic of Macedonia is accession to the EU. The country has already initiated the process of harmonizing with EU commitments to the UNFCCC and relevant sections of the EU *acquis communautaire*. The Republic of Macedonia is not currently under any obligation to enter the EU emission trading system (ETS), but it may do so voluntarily. National priorities are also expressed in the National Strategy for Sustainable Development (2010) and the Second National Environmental Action Plan.

1.2. NATIONAL GREENHOUSE GAS INVENTORY

The national greenhouse gas (GHG) inventory was calculated for the years 2003-2009. Country-Specific Emission Factors were established for key source categories for the first time in this round of reporting, making possible the use of Tier 2 methodologies for some sectors. The five key source categories that were established for the Republic of Macedonia are as follows: CO_2 emissions from Energy Industries (coal, lignite); CO_2 emissions from Mobile Combustion, including Road Vehicles; N_2O (Direct and Indirect) emissions from Agricultural Soils; CH_4 emissions from Solid Waste Disposal Sites; and CH_4 emissions from Enteric Fermentation in Domestic Livestock.

Total direct GHG emissions in Macedonia for the year 2009 amounted to 10,252 kt CO_2-eq including land-use, land-use change and forestry (LULUCF). National emissions per capita in that year amounted to 5.6 t CO_2-eq. Emissions originated primarily from the Energy sector (73%, ranging mostly between 8,500-9,000 kt CO_2-eq per year), followed by Agriculture (13%, decreasing from year to year due to decreasing numbers of livestock) and Waste (7%, rising due to population growth). The Industry sector produces 7% of the country's emissions. The Land Use, Land-Use Change and Forestry sector accounts for 3–10% of emissions, depending on the amount of forest fires, the management of soils (limestone and fertilizer application) and the conversion of land in the specified year.

Looking at the direct GHGs, CO_2 accounts for 75–80% of emissions for the period covered (mostly from the burning of fuels in the energy sector), CH_4 accounts for 12–14% of emissions (mostly from agriculture and waste), N_2O accounts for 7–9% of emissions (from burning fuels and emissions from soils) and 1–2% are HFCs from the industry sector. For the indirect GHGs, Most of the NO_x (7% of total indirect GHG emissions in the period covered) and CO (32%) emissions come from the energy sector, from the transport and energy industries (coal, lignite), and from burning in agriculture (crop residues) and LULUCF (forest fires). NMVOC emissions (25%) originate from the industry sector, especially from mineral production processes, and a smaller share from the transport sector and from solvent use, while most SO_2 emissions (36%) arise from the energy industries, construction and transport.

A new institutional system was implemented to ensure the sustainability of the process of preparing GHG inventories. In addition to this, the Law on Environment was amended in order to establish a national system for the collection and management of data needed for the development of national GHG inventories. As part of the process, the National Climate Change Committee (NCCC) has been re-formed and was closely involved in the TNC preparation process. The development of country-specific emission factors was made possible due to the provision of data by private sector point-source installations and other national and governmental institutions, including the Chamber of Commerce and the State Statistical Office. This resulted in the introduction of several subsectors for the first time –such as aviation—and the introduction of a higher Tier methodology in many sub-sectors, including the cement industry, aviation, and railway transport.

Recommendations for future improvement of the inventory include:

- Developing local, sub-national inventories;
- Developing fuel-specific and combustion-specific emission factors for road and railway transportation;
- Establishing a national reporting system for GHG emissions by industry;
- Collecting the detailed information needed for estimating CH_4 emissions from enteric fermentation from cattle using a Tier 2 approach;
- Development of a forestry inventory that will enable attaining greater precision in estimates of GHG emissions from land use, land use change and forestry (LULUCF); and
- Undertaking additional measures to enhance the capacity for obtaining data on the waste sector.

1.3. VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

1.3.1. Climate variability

Analysis of the multi-year variation of the mean annual temperature shows that in the most recent 20 years (1994- 2012) the mean annual temperature has been constantly higher than the multi-year average. Differences in the mean annual temperature in comparison with the period from 1961 to 1990 range from 0.2°C to 0.5°C. This is consistent with results from the broader region. The warmest years recorded on the territory for the period between 1951 and 2012 and for which data from all meteorological stations are available are 1952, 1994, 2008, 2007 and 2010. The highest maximum air temperature in the country – an unprecedented 45.7°C – was measured in Demir Kapija on July 24, 2007. A similar analysis of precipitation for different regions of the country by years and by seasons – with a special focus on May and November as the months with the most rainfall throughout the year – indicated a general trend of decrease in rainfall. However, due to the fluctuations in levels of precipitation from year to year, it is difficult to establish the exact amount of this decrease in annual precipitation totals.

Analysis of data on extreme weather events (1961-2012) indicated that the number of summer days has increased significantly in recent years compared to the number at the beginning of the analysed period. Similarly, there has been a significant increase in the number of tropical nights in recent years. An analysis of cold waves and cold weather concluded that cold waves occurred much less frequently than heat waves. While there was a general trend of decline in the number of ice days per year, there was no general change in the number of annual frost days.

1.3.2. Climate change scenarios up to 2100

Climate change projections were carried out with the use of the MAGICC/ SCENGEN software package Version 5.3. Six IPCC SRES/AR4 scenarios were used in the process: A1B-AIM, A1FI-MI, A1T-MES, A2-AS, B1-IMA and B2-MES, and air temperature and precipitation changes were assessed for the period 2025–2100 (reference period: 1961–1990). Data from 18 models were used in the estimation, generating results for two central geographical points. Scenarios were generated for four characteristic years, for each central point, for each of the three values of climate sensitivity, and for each of the six scenarios. Values were produced for air temperature and precipitation changes monthly and seasonally.

The modelling results led to the following conclusions:

1. It is probable that there will be a continuous increase in temperature in the period 2025– 2100;
2. Compared with the period 1961–1990, the predicted changes for the period 2025-2100 will be most intense in the warmest period of the year;
3. It is possible that the average monthly temperatures at the turn of winter into spring will be levelled in this period;
4. A decrease in precipitation is predicted in the period 2025–2100, in all seasons and at the annual level, with the maximum decrease in the summer season;
5. The intensity of changes is greatest in the warm part of the year (in July and August, there may be no precipitation at all); and
6. In the cold period of the year, decreases in precipitation of up to 40% of the average monthly quantities are predicted.

In order to examine the robustness of their findings, the modellers also studied differences between the findings obtained and findings from three previous modelling efforts that produced projections for the Republic of Macedonia. The primary cause for the differences in the results was judged to be the use of different principles when estimating changes.

1.3.3.Sectoral vulnerability and adaptation analyses

An analysis of impacts, vulnerability and adaptive capacity was undertaken for eight sectors (agriculture and livestock, biodiversity, forestry, human health, tourism, cultural heritage, water resources, and socio-economic development) with a special focus on the Southeast (SE) Region, which was identified in both previous National Communications as being especially vulnerable to climate change.

Water resources in the Republic of Macedonia are sensitive to climate change with regard to both quantity and quality. Total average precipitation is expected to decrease by 8% in 2075 and 13% in 2100. Reductions in available surface water for the Vardar River are estimated at 7.6% in 2025 and 18.2% in 2100 and for the Bregalnica River at 10% in 2025 and 23.8% in 2100. Groundwater recharge in the Vardar River Basin will decrease continuously, reaching approximately 57.6% of current recharge levels in 2100. In conclusion, overall water availability in the Republic of Macedonia is expected to decrease by 18% in 2100. The Strumica River Basin (1,649 km^2, or 6.4% of the territory of the Republic of Macedonia), which is relatively poor in water resources, is a vulnerable region in both cases/ scenarios.

Significant barriers to adaptation in the water sector include poorly designed and maintained irrigation systems, unregulated use of surface and groundwater, lack of reliable data on water consumed for irrigation, water pricing practices, and ineffective implementation of the Law on Water. Priority adaptation measures should therefore focus on the development and improvement of water storage and supply infrastructure; coordination of water use; introduction of water-saving measures; improvements in water supply and use techniques in agriculture and industry; pricing and management measures for the energy sector; and measures related to disaster risk reduction.

The negative effect of climate change on **agriculture** in the Republic of Macedonia is increasing. The agricultural sector as whole, and particularly small farms, are expected to be exposed to prolonged heat waves, more severe droughts and floods. The climatic events in 2007/2008 and 2011/2012 with long dry periods and heat waves led to significant production losses. Less than 10% of agricultural land is irrigated, and with the exception of the western parts of the country, water deficiencies occur in summer, resulting in significant moisture stress for summer and annual crops.

The vulnerability assessment for this sector, which used models to analyse the SE Region, found that all crop families with a base temperature of 5.6°C and higher would start growing earlier, and that growing stages would shift dramatically in time. In the SE region, crop modelling for the baseline scenario indicated a reduction in wheat yields of 21% between 2000 and 2025 and 25% between 2040 and 2050 and a reduction in maize 56% in 2025 and by 86% in 2050. At the same time, all scenarios with adaptation measures contributed towards increased yields and a reduction in the negative impacts of climate change compared with the baseline scenario. The simulations presented above indicate that adjustment in sowing dates and depth as well as irrigation could produce substantially improved yields of wheat and maize in the SE region of the country under future climate change. However, these high yield scenarios also placed a great demand on water resources.

The economic analysis of impacts and vulnerability found that economic losses in all scenarios with adaptation measures for wheat were lower than the losses from traditional production practices. For maize, from 2015 to 2025, the proposed scenarios easily counterbalanced the negative climate change effects, but in the second period from 2025 to 2050 most of the scenarios show negative financial results, even with adaptation interventions.

A case study on the influence of the excessive heat on **livestock breeding** found that the yearly number of live born pigs was 2.14% less per litter when taking high temperatures into account. Higher temperature was also associated with prolonged conception of the sows, which increased non-productive days. The economic losses were evident: total annual losses reached 386,928 MKD (~EUR 6,260). Adaptation options identified included the following: genetically heat-tolerant breeding animals; adoption of special feed and feeding techniques in excessive heat; housing conditions with proper ventilation, in-house air conditioning and cooling systems; and continuous productivity monitoring. Clear economic calculations are also needed in order to determine the most appropriate time to invest in adaptation measures.

Additional analysis of **viticulture** showed that table and wine grapes are both vulnerable to increases in temperature – which can be ameliorated by effective irrigation and UV nets.

Adaptive capacity in the agricultural sector is low due to a variety of key factors: (a) small primary producers with low annual income and ability to implement adaptation measures, which in some cases can be costly; (b) small plots, which prevent effective implementation of adaptive measures; (c) insufficient financial support to the farmers to cope with the negative impacts of climate change; (d) low awareness among the key players about climate change and its negative effects in agriculture; (e) weak networking and an insufficient level of cooperation between scientific institutions; (f) lack of effective organizations to disseminate good practice to farmers; (g) lack of modern production technologies and practices and a lack of dissemination of research results to potential users; (h) insufficient experience with implementing modern approaches in assessing impacts and projecting future trends. Proposed adaptation measures for the sector include possible support programs for certain crops, modern irrigation practices, and an increase in organic farming.

The assessment of the **biological diversity** carried out for the TNC consisted of identification of vulnerable habitats and species and an expert assessment of their vulnerability. Besides this possible invasive species, suitability of the national protected area system in relation to climate change and functionality of the bio-corridors in Macedonia were also analysed. Modelling was carried out for the selected habitats and species. The vulnerability assessment identified 18 vulnerable habitats, 58 plant and 224 animal species. The expert assessment made for all habitats and species presented results regarding the distribution changes that may be expected (vertical and horizontal redistribution, phenological changes, especially among some bird species), and even disappearance of some habitats (lowlands wetlands) and species (plant and animal species living in mountains, wetland and riparian habitats).

By using MaxEnt modelling software, the possible changes in two habitats were predicted for two plant species and for one endogean insect, using the A1B emissions scenario. The modelling of species confirmed the expert opinion that in the following 50 years unsuitable climate conditions will occur for the analysed plant and animal species (*Pedicularis ferdinandi, Crocus cvijicii*; *Trechus goebli*) and their vertical redistribution may be expected (towards higher altitude). However the community of kermes oak (*Ouercus Coccifera*) (Pseudomacchia) showed unexpected results according to which this community shall "relocate" to the mountains in Eastern Macedonia, while the expert opinion assumed its relocation from the Southern Povardarje Region towards North, along the River Vardar valley.

Constraints and gaps that are specific to the biodiversity sector in the Republic of Macedonia included a lack of data regarding climate impacts on biodiversity, particularly in mountain ecosystems; lack of a protected areas system that takes climate impacts into consideration; and the absence of *ex situ* conservation efforts. Seven of the actions proposed in the Action Plan within the SNC for biodiversity were partially or fully implemented (most of them within the reports commissioned for the Third National Communication).

The **forestry** sector in the Republic of Macedonia is expected to experience a high level of impact from climate change, especially boreal forests, where those impacts could be dramatic. The major sources of exposure (and associated impacts) for forests in the country are increasing temperatures, increasing frequency of forest fires, and changes in forest productivity. The most significant impact on forest management in the period between the SNC and the TNC has been forest fires: approximately 2,800 forest fires have been recorded in the period 1999-2012 that have burned almost 130,000 ha of forest and forest land, resulting in direct and indirect damage estimated at around EUR 67 million. The following segments of forest management are deemed to be most vulnerable till 2025: forest management planning, forest utilization, forest protection, hunting and tourism, and silviculture.

The results of the International Cooperative Programme (ICP) forest assessment for the Republic of Macedonia indicate that the health of forests in the country for the period (2006-2013) has remained more or less the same. However, around 45% of the trees are in Classes 1 and 2 on the scale of needle/leaf loss (>10<60%), which means that they will be most vulnerable to future climate change. Results for water availability for trees (soil moisture) during the same period indicated that a majority of trees examined have consistently had insufficient water. If there are climate extremes, negative changes in forest health can be expected even in the period up to 2025. While there has been no significant change in forest productivity for the period 2006-2013, it is possible to expect increased productivity of forests due to rising temperatures and CO_2 fertilization in the period up to 2025. However, water deficits could decrease productivity, as could natural disasters. While it appears that forests in the Republic of Macedonia will be able to increase their carbon sink capacity in the period up to 2025 due to increased productivity, the estimation of the forest carbon sequestration will require very complex long-term research.

Adaptation measures unique to the forestry sector include the development of a comprehensive programme for adapting forestry to global climate change; the establishment of 5 monitoring stations in forest regions; the introduction of technologies for efficient biomass usage in forestry; procurement of proper vehicles for fighting forest fires; a thorough biomass stocking exercise (the last one was conducted in 1977); and integration of climate change considerations into forestry management plans.

Research on climate impacts on **human health** for the TNC focused on the (SE) Region. The SE Region is especially sensitive to climate extremes such as floods and droughts. Understanding the health implications of flooding has increased in recent years, but knowledge gaps still remain. While heat waves are also very frequent in the SE Region, cold temperatures are still likely to contribute to the majority of temperature-related health effects over the coming decades. The analysis of the frequency of the emergency calls confirmed that the elderly are more vulnerable to extreme heat and cold than younger people, so future health burdens are likely to be amplified by an aging population. Furthermore, findings in other locations in the country and projections provided in maps of the European Environmental Agency indicate that it is likely that the range, activity and vector potential of many ticks and mosquitoes will increase in the SE Region in the decades to come. Finally, hospitals, health centres and care homes may be adversely affected by high temperatures during heat waves and by flooding.

While most of the goals in the National Climate Change Health Adaptation Strategy have been achieved, areas that require action include: 1) inter-sectoral engagement and coordination, including the involvement of the local governments; 2) follow-up on knowledge of climate health risks (among health workers); 3) improved information and transparency in food safety control and implementation of the Hazard Analysis Critical Control Point System (HACCP system); 4) strengthened vector-borne communicable diseases monitoring system, particularly in the SE Region; 5) more precise meteorological observations and projections in order to take precautionary measures in high-risk periods; and 6) inclusion of the SE Region into the existing national air pollution alert system. Specific measures suggested include ultraviolet (UV) radiation protection and monitoring; an early warning system for flooding; pollen monitoring; and cost-benefit analyses for adaptation measures in the health sector.

A vulnerability assessment of the **tourism** sector was commissioned for the TNC, methodologies included interviews with private and public sector stakeholders on their attitudes and actions concerning climate adaptation, a case study of winter tourism, and a review of regional-level documents. The study found that tourism sector stakeholders seemed to be both unaware and unconcerned about the impact climate change might have on their businesses and are thus taking no mitigation or adaptive measures, and climate change did not figure into Government tourism planning. For example, the tourism sector is to invest in mid to low altitude ski resorts that evidence from other parts of Europe indicate are at risk with a high degree of certainty.

Adaptive policies and measures were identified in four key areas: 1) research (site-specific case studies, vulnerability assessments, and action plans); 2) advocacy (outreach to key stakeholders in the industry and to the general public regarding risks to leisure activities); 3) training (mentoring, awareness-raising in the sector, training for specific climate-related changes); and 4) risk preparedness (planning throughout the tourism supply and value chains, monitoring and reporting site-specific changes).

An assessment of the **cultural heritage** sector was commissioned through the regional project "Climate Change Adaptation in Western Balkans" that developed an impact matrix of risks to be expected by climate change and the relevant parameters describing the composition of the site and the surrounding area. Three cultural heritage sites were selected for study based on a participatory workshop of cultural heritage professionals, and rapid vulnerability assessments were carried out. At the archaeological site of Stobi, severe damage is expected before 2100; at the Skopje Aqueduct, climate-related effects are destabilizing the aqueduct, threatening collapse; and at the Plaosnik archaeological site Ohrid, the threat of frost damage is being countered by mortar repair and surface coverage of the archaeological remains. The assessment recommended the development of a National Action Plan for addressing climate change adaptation in the cultural heritage sector. Key needs include vulnerability assessments of built and archaeological heritage, a monitoring program for damages, the identification of tools and adaptation measures for the main categories of cultural heritage in the Republic of Macedonia, and a long-term management strategy.

Sectoral vulnerability assessments also included an assessment of **socio-economic vulnerability** focusing on the SE Region. Research for this study was closely coordinated with work on disaster risk reduction in the Republic of Macedonia and consisted of a socio–economic vulnerability assessment of the population in the ten municipalities in relation to disaster risk and climate change. Municipalities were then categorized by their score on a social vulnerability index, acknowledging data constraints due to comparability and classification issues and – most importantly – a lack of disaggregated data on household income and employment. Selected populations (the elderly, children, etc.) and municipalities were assessed by their level of social vulnerability.

Several **constraints and gaps** were identified during preparation of the thematic studies on vulnerability assessment within this study. The most common included: data availability, consistency and transparency; institutional structures (particularly coordination); low levels of investment in research; and a shortage of well-qualified and trained personnel, especially in monitoring and data processing technologies and the implementation of adaptation measures. A common problem in the implementation of adaptation measures is a focus on short-term measures over longer-term measures such as risk management. Annex II presents an overview of proposed **priority adaptation measures** with a brief description of their characteristics.

1.4. MITIGATION

The climate change mitigation analysis is built upon the analyses conducted under Second National Communication, but also accounts for other developments particularly for the specific position of the country under the UNFCCC, as an EU candidate and as a member of the European Energy Community. It also includes detailed analysis of a number of Nationally Appropriate Mitigation Actions (NAMAs) which were submitted by the country as a part of its submission for the Copenhagen Accords**.** As a member of the Energy Community, the Republic of Macedonia is already committed to complying with the *acquis communautaire* related to energy – involving, for example, renewable energy usage, energy efficiency standards in buildings and equipment, energy efficiency incorporated into public procurement, and related to the reduction of certain pollutants (e.g. SO_x and NO_x) from power plants. Additionally, if the Republic of Macedonia enters the EU by 2020, it will be required to implement EU mitigation policies and be part of the EU effort-sharing scheme for emissions reductions of 20% by 2020. This will include measures such as those for the Energy Community and additional measures related to, for example, the participation in the EU emissions trading scheme (EU-ETS). If the does not enter the EU, it will probably continue transposition of climate-change related directives but at a slower pace. It would then have choice between joining Annex I and offering Quantified Emission Limitation or Reduction Commitment (QELRC) type of target, or to stay in the position of a developing non-Annex I country and offer a target in the form of baseline deviation. In all cases similar types of policies and measures will likely be implemented, but with different speed and intensity. As part of the development of mitigation actions, NAMAs are also being prepared for the City of Skopje related to transport and energy.

An analysis of mitigation options related to **energy** uses the MARKAL energy system model to Project energy demand, costs, and associated GHG emissions from various development scenarios up through 2050. Under the Baseline scenario, energy consumption is projected to grow by 48% in terms of final energy by 2032, and by 102% by 2050. The most significant share in final energy consumption is related to diesel and electricity use, as well as natural gas, available through import. Under the baseline for new power plants and devices a total investment is expected of around EUR 4,005 million plus an additional EUR 95 million for new transmission and distribution networks. CO_2 emissions would change from ~9.5 Mt in 2011 to ~14 Mt in 2032 - then reducing sharply and increasing again to ~14 Mt in 2050 with power generation making up the largest share.

Three different sets of mitigation scenarios were analysed. Related to energy supply, the most cost-effective areas for mitigation were found to be the following:

- Installing natural gas-fired power plants instead of coal plants;
- Hydropower development;
- Wind power development; and
- Some solar power development.

In addition to power supply, mitigation measures related to reducing or altering energy demand will be important – particularly involving:

- Energy efficiency improvements in the buildings sector;
- Various measures in the transport sector for low carbon fuels, awareness raising for efficient driving, changed travel behaviour, improvement of the vehicle fleet, and advancement of vehicle equipment; and
- Improvements in industrial processes for improving energy efficiency.

In the **waste** sector, emissions are projected to grow in the baseline scenario up until at least 2030 related to population and economic growth. In examining the various scenarios of actions that can be taken for municipal solid waste, the most cost-effective scenario which also yields significant GHG reductions is that of closing and reclamation of existing landfills and burning of landfill gas on flare (which has very low marginal abatement costs), introduction of MBT with composting, and production of RDF.

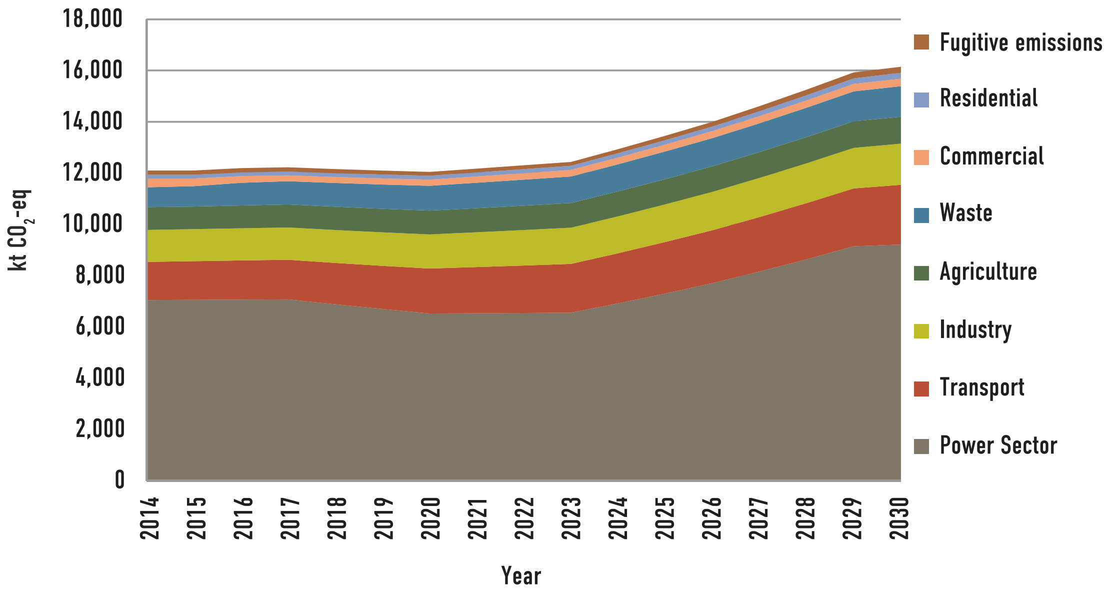
Agricultural activities are expected to increase due to growing demand for food and with that the increase of GHG emissions from this sector is inevitable. Detailed analysis was carried out of the potential for the following mitigation options in agriculture as a part of the TNC:

- Increase in organic agriculture
- Livestock management for less GHG-intensive enteric fermentation
- Improved crop residues management
- Improved sprinkler and drip irrigation
- Altering tillage techniques
- Improved management of fertilizers
- Improved manure management
- Production of biogas from farming

The analysis found that the technical mitigation potential of agriculture is extremely large, especially relative to emissions from the sector. In terms of abatement costs, the sector is particularly attractive, with many abatement options being cost neutral or net-profit-positive (increases in agricultural production, already economically justify the adoption of some mitigation activities), with low capital investment required.

In **summary** the GHG emissions under the baseline scenario are projected to change from around 12,100 kt CO_2-eq to around 16,150 kt CO_2-eq or by 33% (Figure 1-1). In the period 2014-2023 the amount of the emissions is almost the same, but after this period it is expected that there will be significant growth of the emissions in the power sector and the level of the total emissions progressively increases. The highest growth sector is the residential sector with 60% growth, followed by transport with 56% and waste with 54%.

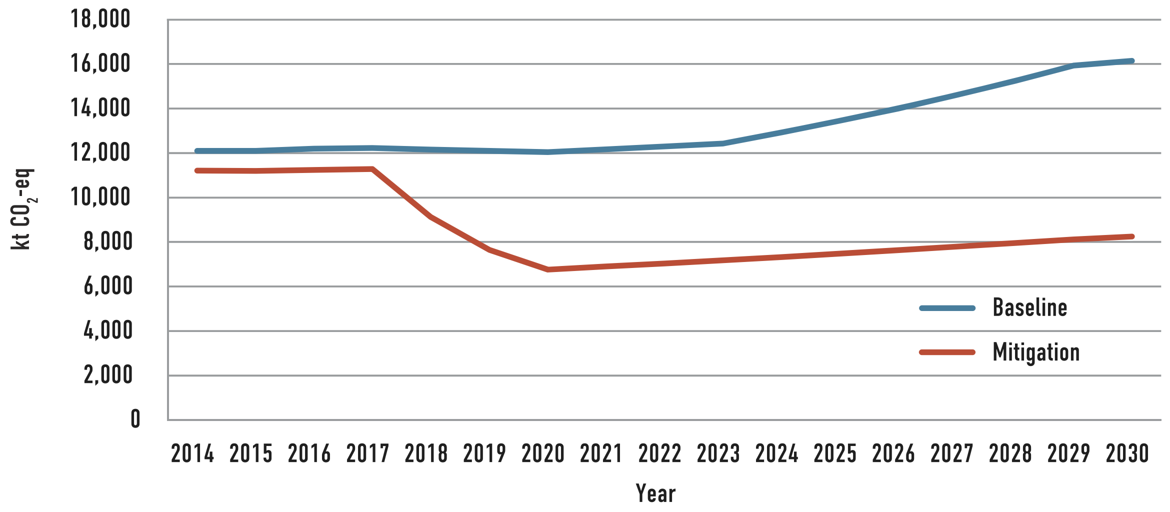
FIGURE 1-1: Emissions Projection under Baseline Scenario (kt CO_2-eq)



The main contributor in the total GHG emissions is projected to be the power sector with around 58% during the whole planning period, followed by the transport sector with 12%-14% share, followed by industry with around 10%.

The combination of the most aggressive mitigations scenarios in energy, waste and agriculture sectors would lead to a significant drop in GHG emissions – from 11,200 kt CO_2-eq to 8,250 kt CO_2-eq. The introduction of a CO_2 price starting from 2020 would cause the closure of the existing lignite power plants and prevents entrance of new coal power plants, which is estimated to decrease the level of the GHG emissions in the power sector by more than 65%. The total GHG emissions in the mitigation scenario in the period 2014-2017 are reduced by around 8%, after this period the reductions become more aggressive and in 2030 emissions would be 50% less than the baseline scenario (Figure 1-2).

FIGURE 1-2: Total emissions under the baseline and mitigation scenarios (kt CO_2-eq)



1.5. OTHER RELEVANT INFORMATION

In the area of **technology transfer**, the Republic of Macedonia submitted its TNA report entitled "Evaluation of Technology Needs for GHG Abatement in the Energy Sector" in 2004. An assessment of the bilateral development assistance projects implemented in Macedonia identified one formal climate technology transfer project, which promoted geothermal energy.

The Government of Macedonia oversees a unified system for **systematic observation** of the climate that consists 19 primary meteorological stations and 2 meteorological radar centres with full-time staffing; 12 climatological stations, 116 rain metering stations, and 24 phenological stations with part-time staffing; and 14 automated meteorological stations. Constraints and gaps in this system include personnel shortages, maintenance difficulties, and lack of field vehicles.

Current **research and development (R&D)** policy is guided by the Programme of the Government of the Republic of Macedonia for the period 2011-2015, and more specific policies and measures including laws, national strategies, and national programs. Key bodies include the Ministry of Economy, the Ministry of Education and Science, MOEPP, and several other agencies and innovation centres. A total of 23 climate change-related R&D projects have been supported by EU Framework Programmes and other EU financing mechanisms.

Climate change **education** is still not adequately incorporated into the national educational system. Currently, there are three faculties in the state university system that have graduate, post-graduate level and/or PhD programs connected to climate change and sustainable development. A 2009 EU **public awareness** survey showed that climate change was perceived by Macedonians as the third most serious problem currently facing the world. On a scale of 1 to 10 with 10 indicating that climate change was an "extremely serious problem" and 1 indicating that climate change was "not a serious problem at all", the average response given by Macedonians was 7.4. In terms of knowledge, a little less than half (46%) of Macedonians surveyed in 2009 felt generally well-informed about the causes of climate change.

Government **public outreach** efforts have been conducted by the public relations office of MOEPP and municipalities; bilateral and multilateral donor-funded projects have included public outreach in broader programs; and several NGOs have also been involved in outreach. A 2012 assessment of climate change communications identified a lack of activities targeted at specific stakeholder groups, and a Climate Change Communications Strategy and Action Plan has been developed in response. Within Macedonia, MOEPP provides **information and networking** related to climate change on its website. The Hydrometeorological Service also participates in information exchange and networking at the regional level (in meteorology and in disaster and risk reduction) and globally through the WMO.

Capacity strengthening activities range from specific capacity to implement emissions trading and greenhouse gas inventories to more general capacity related to climate policy and management. For the TNC, a new institutional system was implemented to ensure the sustainability of the process of preparing GHG inventories. A number of trainings and networking events have occurred in the period since the SNC in which Macedonian experts, government officials, and citizens have been involved. General capacity needs in climate change include broad support for the National Hydrometeorological Service, support for a National Climate Technology Centre and Network, and expanded cooperation with EU initiatives.

Financial resources for climate change activities come primarily from two sources: 1) bilateral and multilateral donors; and 2) the Global Environmental Facility (GEF). Since joining the GEF, the Republic of Macedonia has received five country-level grants and two regional/global grants related to climate change.

2 NATIONAL CIRCUMSTANCES

2.1. COUNTRY PROFILE

2.1.1. Geography

The Republic of Macedonia is a small, landlocked country that is located in the middle of the Balkan Peninsula in Southern Europe, with a total surface area of 25,713 km^2, out of which hills and mountainous terrain cover 79%, plains 19.1%, and water surfaces approximately 1.9%. Macedonia's 246-km southern border is with Greece, a Member State of the European Union (EU), its 148-km eastern border is with Bulgaria (also an EU member state), its 221 km border to the north is with Serbia (Kosovo), and its 151 km border to the west is with Albania.

The Republic of Macedonia has a diverse topography with high mountains and deep valleys surrounded by mountains, picturesque rivers, large and small natural lakes, and spas. The highest point is the peak of Mount Korab, with a height of 2,764 m. Macedonian cultural sites and resources occupy an important place in world cultural heritage. Land used for agriculture in the form of cropland and pastures is substantial in Macedonia and occupies almost 50% of the surface area of the country. Forested land covers approximately one third of the territory of Macedonia.

The territory of the Republic of Macedonia is divided into four river basins: Vardar, Strumica, Crn Drim and Juzna Morava. The Vardar river basin is the largest (20,546 km^2 or 79.9% of the country's land area) and drains to the Aegean Sea. The Strumica river basin in the South East part of the country (1,520 km^2 or 5.9% of the country's land area) also drains to the Aegean Sea. The Crn Drim river basin is in the western part of the country (3.355 km^2 or 13% of the country's land area) and gravitates towards Adriatic Sea. The smallest river basin, the Juzna (South) Morava river basin (44 km^2 or 0.2% of the country's land area), is in the northern part of the country and drains to the Black Sea. This river basin has no significant impact on the availability of the water resources in the country. Water discharge in Macedonia is performed through the following rivers: Vardar at Gevgelija, Crn Drim at Debar and Strumica at Novo Selo. The largest river, the Vardar, divides the country roughly from north to south into two parts. Macedonia has three large natural lakes in the south of the country: Ohrid, Prespa and Dojran. Lake Ohrid is the deepest lake in the Balkans (286 m).

Several major transport routes connect Macedonia with Central and Eastern Europe, and with Southern and South East Europe and beyond. The basic infrastructure of the country is relatively well established and can be seen as a good foundation for further extension.

2.1.2. Biodiversity

The biodiversity of the Republic of Macedonia has been relatively well studied and documented in both previous national communications. Macedonia is noted for its species richness and level of endemism, underlining the country's importance of a "hotspot" for biodiversity in Europe. This situation is a result of Macedonia's specific geographic position, climate, geology, geomorphology, hydrography, pedology and other characteristics, such as the changes that occurred during previous geologic periods (e.g., from the end of the Triassic period through the Ice Age, with its glacial and interglacial phases).

To date over 16,000 species have been recorded in Macedonia, including 854 endemics (Petkovski 2010). According to Petkovski (2010), there are more than 10,000 species of animals in Macedonia; Fauna Europaea - lists 10,586 species (although similar, these numbers are based on the elaboration of different groups). With a total of almost 700 endemic animal species, Macedonia represents one of the most important centres in Europe in spite of its small land area (MOEPP 2004; Petkovski 2010). The centres of endemism in Macedonia are the natural lakes (Ohrid and Prespa in particular) and high-mountain areas, and possibly the Macedonian caves. In terms of climate change analysis, special attention should be paid to high-mountain endemic species, because some of them are restricted only to the subalpine and alpine zones of the mountains. The European Red Data List includes 113 of the vertebrate species present within Macedonia (30 species of fish, 66 birds, 16 mammals and one reptile species). Seventeen of the 20 endemic fish species are globally threatened. The flora of higher plant groups is represented by 210 families (with 67 families of mosses), 920 genera and approximately 3700 species. The most numerous group is flowering (Angiosperm) plants, with about 3200 species, followed by mosses (about 350) and ferns (42). According to the National Biodiversity Strategy (MOEPP 2004) there were about 1600 species of algae and 1250 species of fungi. Karadelev (2000) proposed a preliminary Red Data List of Fungi of the Republic of Macedonia that includes 67 species.

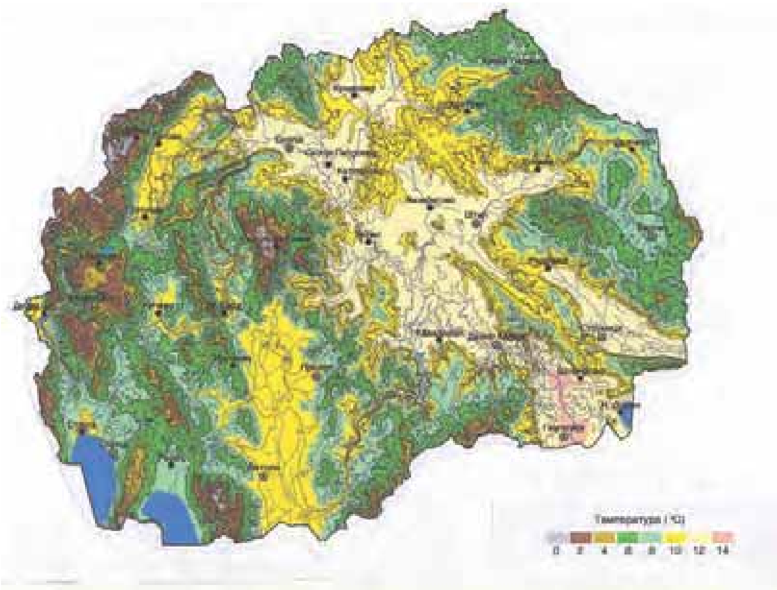
Of the nine biomes in the Balkan Peninsula, eight can be found in the Republic of Macedonia (Lopatin and Mavejev 1995; Filipovski et al. 1996). The diversity of ecosystems has been documented in the National Biodiversity Strategy (MOEPP 2004). Major ecosystems include forest ecosystems, dryland/grassland ecosystems, mountain ecosystems, and aquatic/wetland ecosystems. At present, anthropogenic impacts have affected a range of species and habitats; in particular, aquatic and wetland ecosystems are considered the most endangered, and surviving lowland marsh communities are now only found in fragments (including six sites that are at risk). Within grassland communities, wet meadow communities are considered threatened. Other specific threats affect certain halophytic (saline) communities, and specific forest types. The direct causes of biodiversity loss are many and varied, and they include loss or modification of habitats, fragmentation of habitats, pollution, and unsustainable exploitation.

Three national parks have been recognized in the Republic of Macedonia: Mavrovo (731 km^2), Galičica (227 km^2) and Pelister (125 km^2). All three national parks are heritage sites of nature and culture. They offer great possibilities for the development of tourism, the preservation of natural resources, and scientific research.

2.1.3. Climate

In spite of the relatively small area of the Republic of Macedonia, the climate is diverse. The climate is influenced by the Mediterranean Sea and by the European continent to a varying extent. The country can be divided into the following eight climatic regions: sub-Mediterranean climate region (50 - 500 m, only in the area of Gevgeija and Valandovo); moderate-continental-sub-Mediterranean climate region (to 600 m); warm continental climate region (600 - 900 m); cold continental climate region (900 – 1,100 m); sub-forest-continental-mountainous climate region (1,100 -1,300 m); forest-continental mountainous climate region (1,300 – 1,650 m); sub-alpine mountainous climate region (1,650 – 2,250 m); and alpine mountainous climate region (> 2,250 m). Figure 2-1 depicts mean annual air temperature in Macedonia.

FIGURE 2-1: Mean annual air temperature in Republic of Macedonia



Source: Hydrometeorological Service 2013

The highest values of annual air temperatures in the Republic of Macedonia are recorded in the Gevgelija and Valandovo Region, where the mean annual air temperature is higher than 14°C. The coldest month in Macedonia is January, and on average July is the hottest month. With the exception of 2011, the six most recent years (2007-2012) were among the ten warmest years for the period between 1951 and 2012. The frequency of heat waves[2] has also increased from 1987 onwards. And in contrast to the first half of the period, a heat wave has been recorded in almost every year since 1987. It should also be noted that the greatest frequency of heat waves has occurred in the last ten years, with maximum occurrences at the greatest number of stations in 2012 and 2007 (Hydrometeorological Service 2013).

Precipitation in the Republic of Macedonia is unequally distributed. Two basic pluviometric regimes are present in Macedonia: Mediterranean and continental. In the area with the Mediterranean precipitation regime, November, October and December are the months with highest level of precipitation; in the area with a continental climate, the highest amount of rainfall occurs in May and June. The areas with highest precipitation are the mountain ranges in Western Macedonia; the area around the Shar Planina, Bistra and Stogovo mountains; and the mountain ranges of Jakupica, with the summit of Solunska Glava, and Baba, with the summit of Pelister, where annual precipitation totals about 1000 mm. The driest areas of the country are Ovche Pole, Tikvesh and the surrounding of Gradsko, where annual precipitation totals about 400 mm.

2.1.4. Population

According to the most recent census in 2002, Macedonia has a population of 2,022,547, with an average density of 78.7 inhabitants per square kilometre, 58% of whom live in urban areas. The western part of the country is the most heavily populated. Most of the population is concentrated in the urban areas. The average household had 3.58 members in 2002, down from 4.68 members in 1971. The fertility rate has declined from 1.9 births per woman in 1990 to 1.46 in 2008 and is now lower than the European average of 1.6 (WHO 2009). The current trend is one of aging.

As in many other countries, people have migrated into the cities, looking for employment. Approximately 25% of the population lives in the capital city of Skopje, which is located in the northern part of the country. Other major cities are Bitola, Kumanovo, Prilep and Tetovo. The country is administratively divided into 84 municipalities and the City of Skopje is a separate entity made up of ten municipalities. Macedonia has also experienced sustained high rates of permanent and seasonal emigration.

TABLE 2-1: Enumerated and estimated population

Year	Population (thousands)
1921	809
1931	950
1948	1,153
1953	1,305
1961	1,406
1971	1,647
1981	1,909
1991	2,034
1994	1,946
2003	2,027
2004	2,032
2005	2,037
2006	2,040
2007	2,044
2008	2,045
2009	2,051
2010	2,055
2011	2,058
2012	2,062

Source: State Statistical Office

2.1.5. Health

Life expectancy at birth was 73.54 years (76 for females and 71 for males) in 2007 in the Republic of Macedonia, while disability-adjusted life expectancy was 63 years. The 2005 birth rate was 11.04 per 1,000 population and the mortality rate was 9 per 1,000, resulting in a natural increase of 2 per 1,000 population. The distribution of deaths by age shows the highest proportion of total deaths for age 75 at 43.6 per cent.

[2] In accordance with the recommendations of the World Meteorological Organization (WMO) Working Group for Climate Change Detection and Indices (CCI/CLIVAR), the Heat Wave Duration Index (HWDI) has been used for the analysis of heat waves. This index determines a heat wave as a period of at least 6 successive days with a maximum air temperature (T_x) of 5°C higher than the average maximum temperature (T_{xavg}) for the period 1961–1990.

Chronic diseases present the biggest burden to public health analysed by direct cost to society as well as to the Government based on the disability-adjusted life years (DALYs). The total burden of the most common diseases in the Republic of Macedonia (circulatory, cancer and respiratory) is estimated as 67% of DALY from all causes of mortality. The most common diseases – cardiovascular diseases, cancer, respiratory diseases, injuries and non-specific symptoms – have many causes which are often interconnected, including genetics, lifestyle (diet, exercise, etc.), and the environment.

Health care in Republic of Macedonia is delivered through a system of health care institutions that cover the country's territory relatively evenly. This makes it possible for around 90% of the population to obtain health services in less than 30 minutes. Health care facilities range from primary care stations and centres and specialty-consultative and inpatient departments (including three secondary hospitals), to universities and tertiary-care institutes, whose functions also include research and teaching. The Ministry of Health and the Public Health Institute have introduced an early warning system for communicable diseases surveillance (Early Warning and Response Network – EWARN) based on clinical descriptions in order to detect epidemics. General practitioners from all health care institutions at the primary health care level take part in this system. While there is currently no integrated health information system, the main sources of health-related information include the State Bureau of Statistics (for mortality data); the Institute of Public Health (for morbidity data), the Health Insurance Fund, and regional public health centres and health care facilities.

High-priority environmental health issues in the Republic of Macedonia include the following: access to safe drinking-water in rural areas, access to sanitation in almost the entire country; inadequate waste and waste water management at the state level; uncontrolled use of chemicals and pesticides; and inadequate air quality indoors and housing generally (in particular associated with poverty and children's exposure to environmental tobacco smoke).

2.1.6.Politics

The Republic of Macedonia became an independent state on September 8, 1991, following the disintegration of the former Socialist Federal Republic of Yugoslavia. The country became a candidate for EU membership in December 2005.

The political system is a parliamentary democracy. Government is organized on the principle of distribution of powers among the legislative (Parliament), executive (the President of the Republic, the Government), and judicial branches of government. The Parliament consists of 120 members with a four-year mandate. Members are elected by popular vote from party lists, based on the percentage that parties gain of the overall vote in each of six election districts, each district having 20 seats. The Prime Minister is the head of Government and is selected by the party or coalition that gains a majority of seats in parliament. The Prime Minister and other ministers must not be members of parliament. The Government consists of 15 ministries. The General Secretariat of the Government provides logistic and expert support to the government, to the President of the Government, Vice-Presidents of the Government, ministers (members of the government).

The President is elected by general, direct ballot for a term of five years and can serve for a maximum of two terms. The President exercises his/her rights and duties on the basis and within the framework of the Constitution and laws.

The court system consists of a Supreme Court, Constitutional Court, Administrative court, and appeal courts. The Judicial Council of the Republic of Macedonia governs the ethical conduct of judges and recommends the election of judges to parliament. The Supreme Court is the highest court in the country and is responsible for the equal administration of laws by all courts. Its judges are appointed by parliament without a time limit. The Constitutional Court is responsible for the protection of constitutional and legal rights and for resolving conflicts of power between the three branches of government. An independent public prosecutor with a six-year mandate is appointed by parliament.

2.1.7. Economy

As a small country, the Republic of Macedonia has a relatively open economy where foreign trade accounts for more than 90% of GDP, making it vulnerable to external events, and since the independence of the country, it has repeatedly suffered the negative impacts of these events. Currently, the country is stabilized and has made good progress in its economic reform agenda. However, more work needs to be done in building a favourable business climate in order to attract private investors and to create more jobs through private sector growth.

The Macedonian economy was relatively well insulated from the 2011 debt crisis in the Eurozone due to the absence of large macroeconomic imbalances and a stable financial system relying mainly on domestic sources of financing. Hence, the Republic of Macedonia realized a 2.8% growth rate in 2011, due primarily to strong performance in the first half of the year, when the domestic economy experienced real growth of 4.8% as a result of increased demand for exports.

In 2012, effects from unfavourable external conditions intensified as a result of the reduced demand for Macedonian exports and lower inflows of capital, causing economic activity to slow down. Reduced demand for Macedonian products caused industrial production and exports to decline. According to the latest data from the State Statistical Office, in 2012 the GDP decreased for 0.4%.

In 2011, the labour force in the Republic of Macedonia amounted to 937,326 persons, 639,340 of which were employed and 297,986 of which were unemployed. The unemployment rate in 2011 was 31.4%.

TABLE 2-2: Selected macroeconomic indicators, 2003-2012

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
GDP (million MKD)	258,369	272,462	295,052	320,059	364,989	411,728	410,734	434,112	459,789	458,621
Real GDP growth rate (%)	2.8	4.6	4.4	5	6.1	5	-0.9	2.9	2.8	-0.4
GDP per capita (MKD)	127,478	134,050	144,857	156,874	178,605	201,147	200,292	211,246	224,300	224,439
GDP per capita (EUR)	2,081	2,185	2,363	2,564	2,919	3,283	3,269	3,434	3,645	3,648
Inflation (CPI, average) (%)	1.2	-0.4	0.5	3.2	2.3	8.3	-0.8	1.6	3.9	3.3
Exports f.o.b (million EUR)	1,203	1,345	1,643	1,914	2,472	2,693	1,933	2,530	3,179	3,093
Imports f.o.b (million EUR)	1,956	2,259	2,501	2,915	3,653	4,455	3,492	3,978	4,861	4,877
Current account deficit (% of GDP)	-4	-8.1	-2.5	-0.4	-7.1	-12.8	-6.8	-2	-3	-3.9
Unemployment rate (ILO)	36.7	37.2	37.3	36	34.9	33.8	32.2	32	31.4	31
Employment growth	-2.9	-4.1	4.3	4.6	3.5	3.2	3.4	1.3	1.1	0.8

Source: Ministry of Finance of the Republic of Macedonia, National Bank of the Republic of Macedonia

2.1.8. Energy

The energy sector in the Republic of Macedonia has the following main characteristics.

- The production of electricity from older coal-fired power plants (approximately 66% of power generation) and hydropower (approximately 34% of power generation).[3]
- The transport sector accounts for almost 25% of energy demand which is almost entirely from imported oil products as there is no domestic production (see Table 2-3).
- The Residential and Commercial sectors comprise almost 70% of electricity demand whereas Industry only accounts for ~30% of the demand.
- There are currently plans to expand the natural gas supply as the Republic of Macedonia would be a part of the "South Stream" gas pipeline for import of gas from Russia.

3 World Bank. 2013. 10 Facts about FYR Macedonia's energy sector. http://www.worldbank.org/en/news/video/2013/07/23/macedonia-energy. Accessed 27 Nov. 2013

The breakdown of the sectors for final consumption of energy (in thousands of tonnes of oil equivalent) is provided below.

TABLE 2-3: Energy consumption in the Republic of Macedonia for 2010

	Coal and peat	Crude oil	Oil products	Natural gas	Nuclear	Hydro	Geo-thermal, solar, etc.	Bio-fuels and waste	Electricity	Heat	Total
Total	**114**	**0**	**818**	**41**	**0**	**0**	**10**	**199**	**584**	**54**	**1820**
Industry	110	0	204	39	0	0	0	5	173	7	538
Transport	0	0	448	0	0	0	0	0	2	0	450
Other	4	0	132	2	0	0	10	194	409	47	798
Residential	*2*	*0*	*43*	*0*	*0*	*0*	*0*	*179*	*278*	*34*	*536*
Commercial and public services	*2*	*0*	*73*	*2*	*0*	*0*	*1*	*14*	*130*	*13*	*234*
Agriculture/ forestry	*0*	*0*	*16*	*0*	*0*	*0*	*8*	*1*	*1*	*0*	*27*
Non-specified	*0*	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*0*	*0*	*1*
Non-energy use	0	0	34	0	0	0	0	0	0	0	34
-of which petrochemical feedstocks	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

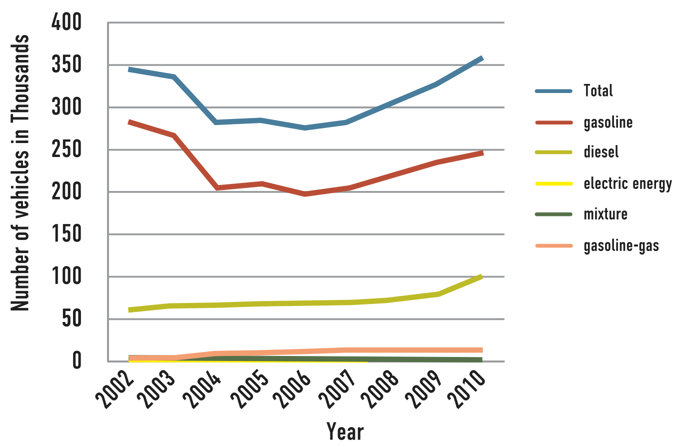
Source: International Energy Agency (2013)

2.1.9. Transport

Within the transport sector, the road transport has the highest share in the energy consumption (98%) and is dominant in the transport sector in general. The Republic of Macedonia has relatively well-developed road transport infrastructure though the energy consumption in the sector is small comparing to the EU on a per-capita basis: 650 toe per 1000 inhabitants in the EU-27 compared to 200 toe per 1000 inhabitants in the Republic of Macedonia. In the last five years there has been a slight increase, but still national figures considerably lag behind European ones.

As to the energy mix, gasoline and diesel have a dominant role in the road transport sector. Since 2000, there has been a significant drop in gasoline consumption and a significant increase in diesel consumption, since diesel vehicles have become more attractive. LPG was introduced after 2000. The total number of the vehicles in the country according to fuel type for the period 2002-2010 is shown in Figure 2-2.

FIGURE 2-2: Total number of vehicles in the road transport



In 2010 there were 170 passenger cars per 1000 inhabitants. The vehicle fleet is generally very old with the average age of the passenger cars of about 15 years.[4] The same is true of buses and goods vehicles: 62% of the buses, 74% of the goods vehicles are older than 15 years in 2010 – though only 27% of special vehicles in 2010 were older than fifteen years.[5]

[4] For the sake of comparison, in 2011 in Slovenia, the number of passenger cars per 1000 inhabitants was 519, with the average age of the passenger cars of 8.4 years.

[5] State Statistical Office (2011), State Statistical Office (2010), State Statistical Office (2009), and State Statistical Office (2008)

In the last four years there has been quite a big change when it comes to fleet renewal. In 2007 and 2008 a significant renewal of the fleet occurred, but during 2009 and 2010 the fleet size has increased via imported used vehicles (older than 2000). This is characteristic for cars and buses, while the number of goods vehicles older than 1997 was dramatically reduced in 2010. There has been an increase in new vehicles only among special vehicles.

2.1.10. Industry

Industry is important in the development of the Macedonian economy. Industrial activities comprise 18% of (GDP). According to the value added data for 2010, industrial production was dominated by the following divisions (State Statistical office of the Republic of Macedonia 2013):

- Manufacture of food products (11.7%);
- Electricity, gas, steam and air conditioning supply (14.6%);
- Manufacture of basic metals - steel, lead, zinc, ferro-alloys (9.34%);
- Manufacture of wearing apparel (textiles) (10.2%);
- Manufacture of other non-metallic products (5.9%);
- Manufacture of tobacco products (4.5%); and
- Manufacture of beverages (6.2%).

2.1.11. Agriculture

The agriculture sector, including the value added in the processing industry, contributes 16% of the country's GDP and provides employment to 36% of the workforce. The most recent national census recorded 192,675 family farms (in a country of 2.1 million inhabitants). Consequently, given the fact that about 42% of country's population live in rural areas where off farm employment opportunities are rather limited (active workforce unemployment rate in Macedonia is as high as 32%), a more realistic conclusion would be that the agriculture sector is of critical importance for the wellbeing of about half of country's population. Agriculture and natural resource-based rural economies are particularly vulnerable to various anthropogenic stressors, including climatic hazards, variability, and long-term climate change.

2.1.12. Forestry

The Republic of Macedonia's forests cover around 1,095,000 ha of forested land, of which around 940,000 ha is recognized as forests (State Statistical Office 2009). The total wood stock is estimated at around 75,000,000 m^3, and the annual increment is around 1,830,000 m^3. The most dominant species are beech (Fagus moesiaca), and several oak species (Quercus spp.), which make up to 90% of all native forest types. Forests are mostly covered with deciduous tree species, and conifers comprise around 11% of all forests. Around 550,000 ha are categorized as low-quality coppice forests, and around 390,000 ha are categorized as high forests, out of which around 140,000 ha are plantations (artificially planted), mostly with coniferous tree species (Pinus nigra, Cupressus arizonica, and others).

Regionally, the richest forest region is Southwest Macedonia, with around 180,000 ha, and the poorest is the Skopje region, with around 125,000 ha. Distribution of forest cover throughout the country is uneven in terms of quantity and quality. High forests with good quality are located along state borders, far from the industrial and inhabited places and human influence. Low-quality coppice forests are located in the central parts of the country, and their condition has resulted partly from climate conditions and partly from human activities.

Around 90% of the forests are in state ownership, and state-owned forests with commercial value are managed by the special public enterprise "Makedonski sumi." State-owned protected forests are managed by the national parks (public enterprise) or by local government offices. The remaining 10% of forests are in private or other forms of ownership (e.g. church lands). There are more than 200,000 parcels of forests owned by around 65,000 households, averaging 0.6 ha.

In the terms of assignation, around 92% of total forest area has an economical character, and around 8% are protective and protected forests. Annual allowed logging volume, according to approved management plans, is set at around 1,200,000 m^3, and is around 2/3 of the annual increment that is totally acceptable in terms of its sustainability. Most of this cut comes from the state-owned economic forests, and a very small part comes from protective and protected areas. Annual actual logging volume is between 550,000 m^3 and 750,000 m^3, and is mostly firewood (80- 85%), which is used by households. Logs are used mostly by domestic industry, and only a small part is exported.

2.1.13. Tourism

Macedonia has an interesting mix of tourism products ranging from history and culture to modern winter adventure sports and skiing. Tourism has not traditionally played a significant part in Macedonia's economy and as such was somewhat neglected. However, recent government actions (starting with a revision to the 2009-2011 tourism strategy and subsequent attention to rural tourism) have given the sector a higher priority. However, Macedonia's tourism is not seen as particularly competitive by global standards and underperforms in comparison to its regional competitors.

Tourism in the 2009-2013 Strategy was identified as comprising the following sub-sectors:

- **Wine tourism** taking advantage of high quality viticulture in the Tikveš region of central Macedonia.
- **Nature based tourism (summer)** primarily hiking found mainly in Branjo with emerging developments in Zrnovci, Pehcevo, Berovo, Kolesino, Bansko, Mokrino, Smolare, Vevcani and Galichnik
- **Nature based tourism (winter)** primarily skiing with a nascent snowboarding sector. The largest is Popova Sapka and is also present in Krusevo, Mavrovo/ Zare Lazarevski, Mount Kozuf, Oteshevo, Pelister, and Ponikve
- **Cultural tourism (tangible)** comprising handicrafts, the built heritage (especially Skopje) archaeological, monasteries, churches and religious monuments found throughout the country
- **Cultural tourism (intangible)** comprising museums, arts, drama, cultural heritage, and festivals

2.2. CLIMATE CHANGE-RELATED INSTITUTIONAL AND POLICY FRAMEWORK

The Republic of Macedonia is a party to the United Nations Framework Convention on Climate Change (UNFCCC) as a non-Annex I country and party to the Kyoto Protocol without a quantified emissions limits and reduction commitment (QELRC). However, the country has acceded to the Copenhagen Accord, and it submitted a list of mitigation actions (without quantifying the associated emission reductions) based on these actions.

The **Ministry of Environment and Physical Planning (MOEPP)** is the key governmental body responsible for development of climate change policies. MOEPP has been designated as the National Focal Point to the UNFCCC and as Designated National Authority (DNA) for Kyoto Protocol implementation and is therefore the key governmental body responsible for coordinating implementation of the provisions of the Convention and the Protocol. Other ministries that have responsibilities related to climate change are: Ministry of Agriculture, Forestry and Water Management, Ministry of Economy, Ministry of Transport and Communication, and Ministry of Finance. Most of these ministries have appointed Climate Change Focal Points, who are responsible for mainstreaming climate change into respective policies, strategies and programmes. In addition, the Ministry of Health established a National Committee for Climate Change and Health in 2009 to serve as the responsible body for surveillance activities and decision-making in that area.

In January 2000, the **Climate Change Project Office** was set up within MOEPP. In addition, a **National Climate Change Committee** (NCCC) was established by the Government consisting of representatives of all relevant stakeholders: government bodies, academia, private sector and civil society. The NCCC is a participatory platform aimed at providing high-level support and guidance for overall climate change policies in the country. Moreover, a **National Council for Sustainable Development** has also been established under the auspices of the Deputy Prime Minister in charge of economic affairs.

At the legislative level, climate change issues are incorporated into the Law on Environment, including details on the preparation of GHG emissions inventories as well as an action plan on measures and activities to abate the increase of GHG emissions and to mitigate the adverse impacts of climate change. The **Law on Environment** stipulates that a National Plan for climate change is to be adopted for the purpose of stabilizing GHG concentrations at a level that would prevent any dangerous anthropogenic impact on the climate system within a timeframe sufficient to allow ecosystems to naturally adapt to climate change, in accordance with the principle of international cooperation and the goals of the national social and economic development. In July 2013, changes in the Law on Environment were adopted, and a new article (188) has been added regarding the national system of GHG emissions inventories. This article foresees that a national system of inventories of GHG emissions will be established and that this system will provide a database of relevant information for the preparation of GHG inventories as well as monitoring of the implementation of agreements regarding climate change. This system incorporates collection, processing, assessment, verification and quality assurance and management of uncertainty, as well as storage, use, distribution and presentation of data and information derived from entities holding data for anthropogenic emissions by sources and sinks of greenhouse gases in the atmosphere.

Recognizing the important steps forward in the institutionalization of climate change issues and the mainstreaming of climate change in the national and sectorial development policies, the development of three National Communications to the UNFCCC has contributed to strengthening these integration processes as well as to informing the international community on the actions taken by the country to address climate change issues. The First National Communication on Climate Change (FNC) and the Second National Communication

(SNC) were adopted by the Government of Macedonia and submitted to the UNFCCC Secretariat in 2003 and 2008, respectively. This Third National Communication (TNC) represents a further step forward in the process.

In addition, the First Biennial Update Report which will be carried out in the coming two years will build on the findings and recommendations of Third National Communication, as well as the outcomes of the ongoing complementary projects in the country. In order to fulfil the obligations arising from Cancun and Durban Conference of Parties (COP) decisions related to the submission of national communications and biennial update reports, further support is needed to continue to develop and consolidate the existing technical and institutional capacity and to continue the efforts of integrating climate change into national policies, plans and programs.

It should also be noted that in the context of the EU accession process, the Republic of Macedonia has already initiated the process of harmonizing of its approach towards EU commitments to the UNFCCC and sections of the EU *acquis communautaire* related to climate change. While Macedonia is not currently under any obligation to enter the EU emission trading system (ETS) or have a national ETS, it may do so voluntarily. Additional details related to the EU accession process are included below.

2.3. NATIONAL AND REGIONAL DEVELOPMENT PRIORITIES AND OBJECTIVES

The driving forces for creation and implementation of environmental policy in the Republic of Macedonia can be grouped into two major categories: national and international, which includes regional cooperation, bilateral activities, and multilateral activities.

2.3.1. National context of climate change policy

At the national level, the Republic of Macedonia focuses on several types of objectives in the areas of environment and climate: strategic, legislative, and institutional/organizational. A cross-cutting priority is accession to the EU, which is at the core of the development goals of Macedonia and a main driving force behind its objectives. The EU integration agenda has generated momentum for political, economic and social reforms and contributed to building consensus on important policy issues across sectors. While EU accession poses great challenges in terms of human capacity at the national and local level and identifying financial means for investments in key sectors, it also provides opportunities for the creation of more integrated, cross-cutting policies and better utilization of available resources.

At the strategic level, environmental policy (as a component of sustainable development policy and in and of itself) is covered by the National Strategy for Sustainable Development (in which the energy sector and climate change are identified as the main contributors towards national sustainable development, adopted in 2010) and the Second National Environmental Action Plan. In the past decade, a number of relevant laws, regulations and strategies that incorporate climate change considerations have been adopted, such as the Strategy for Energy Development in the Republic of Macedonia for the Period 2008-2020 with a Vision to 2030 (2010); Renewable Energy Sources Strategy of Macedonia till 2020 (2010); the National Strategy for Energy Efficiency in the Republic of Macedonia till 2020 (2010); National Environmental Investments Strategy (2009); National Environmental Approximation Strategy (2008); National Health Strategy for Adaptation in Health Sector (2010); a National CDM Strategy, 2008-2012 (2007); the National Agriculture and Rural Development Strategy 2007-2013; and the National Strategy for Climate Change Adaptation in Agriculture (under development).

The Strategy for Energy Development offers a set of ambitious and specific numerical targets for 2020 following the EU climate change policy track, e.g. reducing the energy intensity of the economy by 30% relative to 2006 or increasing the share of renewables (including hydropower and wood heat) to more than 20% of total final energy. However, half of the country's electricity is still projected to come from lignite-fired plants, both in 2020 and in 2030, and the overall total electricity demand is projected to grow by around 52% by 2030.

The Government has also adopted 5 Laws on Ratification of 5 Protocols under the United Nations Economic Commission for Europe (UNECE) Convention for Trans-boundary Effects of Air Pollution and they are in parliamentary procedure at the moment (National Programme for Adoption of the *Acquis Communautaire* 2012). In previous years, work was aimed at increasing the reliability of data in order to enable a gradual transition to a more sophisticated inventory with a higher tier of analysis. The differences in terms of data collection have been analysed, and a proposal for a legal solution has been submitted.

2.3.2. International context of climate change policy

As previously stated, accession to the European Union is a priority for Macedonia. It was the first country in the region to sign a Stabilization and Association Agreement (SAA) with the EU in April 2001, and in December 2005 the Presidency of the European Council granted Macedonia candidate status for the EU. Legislative and regulatory activities related to the accession process include the Ohrid Framework Agreement, the Law on Local Self-Government, the Action Plan on Accession Partnership, and the National Programme for Adoption of the *acquis communautaire* in the environment sector.

As a member of the EU, Macedonia would be obligated to participate in the EU Emissions Trading System (EU ETS). In 2012, there were a series of coordinated activities with stakeholders to develop a roadmap for implementation of the Directive on Emissions Trading and EU decision for monitoring, reporting and verification, using the experience of the Republic of Bulgaria for monitoring, reporting and verification of greenhouse gases required for participation in European scheme for emissions trading.

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3 NATIONAL GREENHOUSE GAS INVENTORY

This chapter is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=246

3.1. INTRODUCTION: NATIONAL GREENHOUSE GAS INVENTORY

The Republic of Macedonia ratified the UN Framework Convention on Climate Change (UNFCCC) in December 1997 and the Kyoto Protocol in 2004. Responding to the obligations incurred by signing the Framework Convention as a non-Annex I Party, the country prepared and submitted the First National Communication on Climate Change in 2003 and the Second National Communication in 2008. Within these National Communications, GHG inventories were developed for the period 1990–2002, applying the Tier 1 method (i.e., the simplest method) for most sectors. Tier 2 methods were partially applied in the Energy sector as being a key source of GHGs, accounting for over 70% of all emissions.

3.1.1. Scope

The inventory takes into account the following six direct gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride(SF_6). The following four indirect gases are taken into account: carbon monoxide (CO), nitrous oxides (NOx), non-methane volatile organic compounds (NMVOC) and sulphur dioxide (SO_2). Inventory years are 2003-2009.

Country-Specific Emission Factors were established for *key source categories* for the first time in this round of reporting, making possible the use of Tier 2 methodologies for some sectors. Key source categories refer to the sources that together contribute more than 95% of the total GHG emissions identified in the inventory. The five key source categories that were established for the Republic of Macedonia are as follows: CO_2 emissions from Energy Industries (coal, lignite); CO_2 emissions from Mobile Combustion, including Road Vehicles; N_2O (Direct and Indirect) emissions from Agricultural Soils; CH_4 emissions from Solid Waste Disposal Sites; and CH_4 emissions from Enteric Fermentation in Domestic Livestock.

3.1.2. Institutional arrangements

A new institutional system was implemented to ensure the sustainability of the process of preparing GHG inventories. Three professionals were engaged to form the GHG Inventory Team in order to ensure continuous and regular updating of the national GHG inventories and the establishment of a Monitoring, Reporting and Verification (MRV) system. Training materials were prepared for each sector, including a step-by-step process for completing inventory tables, explanations of good practices and sources of data and emission factors.

Data for each activity rate, emission and conversion factor were documented directly in the sectoral and sub-sectoral MS Excel worksheets in the IPCC software (version 1.3.2 of 1996 IPCC Software for National Greenhouse Gas Inventories). This documentation procedure increases the **long-term sustainability and transparency of the inventory process**.

Each member of the GHG Inventory team was responsible for one or more sectors. An **Enterer** was responsible for identifying/verifying data sources, entering and documenting the input data (activity data and emission factors), while a **Checker** was responsible for checking and validating the input data and emission estimates. In this way, each team member focused on a specific part of the inventory preparation. This approach was introduced in the Second National Communication and was implemented again as a good practice in the Third National Communication, avoiding possible mistakes in data entry.

The possibilities for establishing a legally binding national system for the collection of data needed for developing a more detailed inventory of greenhouse gas emissions were explored in a separate document on the 'Preparation of Legal Provisions for the GHG Inventory'. This activity resulted in an amendment to the Law on Environment in order to establish a national system for the collection and management of data needed for the development of national GHG inventories.

As part of the process, the **National Climate Change Committee** (NCCC) has been re-formed and was closely involved in the TNC preparation process, providing information and policy guidance as well as making use of the results and recommendations from the National Communication in sectoral plans and national strategies. Regular consultations were held with relevant members of the NCCC on various issues. Bringing together representatives from all relevant institutions encouraged networking, knowledge transfer and sharing of experiences related to climate change between the members of the NCCC. The NCCC was closely involved in providing recommendations for resolving identified data gaps, thus setting a baseline for the establishment of a national system for GHG inventory data collection.

Involving all relevant stakeholders from both the public and the **private sector** in the development of the GHG inventory increased access to information, thus providing data necessary for introducing a more detailed methodology and making possible the development of components such as country-specific emission factors, particularly since major emitters of greenhouse gasses are point-source installations. Establishing **direct contact with these installations** and other national and governmental institutions, including the Chamber of Commerce and the State Statistical Office, proved essential in obtaining unpublished data collected only for internal purposes. This resulted in the introduction of several subsectors for the first time –such as aviation—and the introduction of a higher Tier methodology in many sub-sectors, including the cement industry, aviation, and railway transport.

The long-term agreement for cooperation and data exchange between the Macedonian Air Navigation Services Provider (M-NAV) and the Ministry of Environment and Physical Planning also added value. This cooperation made it possible to disaggregate the data on domestic and international aviation and allowed the application of a higher Tier methodology in calculating emissions from the aviation subsector–a methodology that only eight other countries in the world use at this time.

3.1.3. Sources of information and the inventory process

GHG inventories were prepared for the period 2003–2009 using the methodology prescribed in the 1996 Revised IPCC Guidelines for National Greenhouse Gas Inventories, the 2000 IPCC report on Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the updated 1.3.2 version of the 1996 IPCC Software for National Greenhouse Gas Inventories.

During the planning phase of the inventory process, a detailed gap analysis of GHG data was performed and solutions were proposed to fill identified gaps. These recommendations served as input for amending the Law on Environment, to facilitate access to the data necessary for the preparation of future national inventories.

Activity data were obtained from the following sources:

- The State Statistical Office (MAKSTAT)
- National Energy Balances
- National Reports from the Ministry of Agriculture, Forestry and Water Economy (MAFWE), the Ministry of Environment and Physical Planning (MOEPP) and other relevant institutions
- Industry
- The Food and Agriculture Organization (FAO) database.
- Emissions from aviation have been included in the TNC for the first time thanks to collaboration with the Macedonian Navigation Company
- Data on agriculture and land-use change and forestry were provided by various institutions.

The MOEPP was supported by the development of a new software solution for the industry sector: Emissions Monitoring in Industry (EMI). EMI is a web-based platform that gathers data directly from industrial installations about annual production, feedstock usage, and details about specific production processes in a distributed manner.

Furthermore, over the course of development of the GHG inventory, a new software solution was purchased for modelling GHG emissions, BREEZE AERMOD v.7 (EPA), which simulates the impacts of GHG emissions from a variety of sources.

3.2. SUMMARY OF GHG EMISSIONS

Total direct GHG emissions in Macedonia for the year 2009 amount to 10,252 kt CO_2-eq including land-use, land-use change and forestry (LULUCF). National emissions per capita in that year amounted to 5.6 tCO_2-eq., which is ~62% of the EU-28 average, or ~25% of the average emissions per capita of the USA.

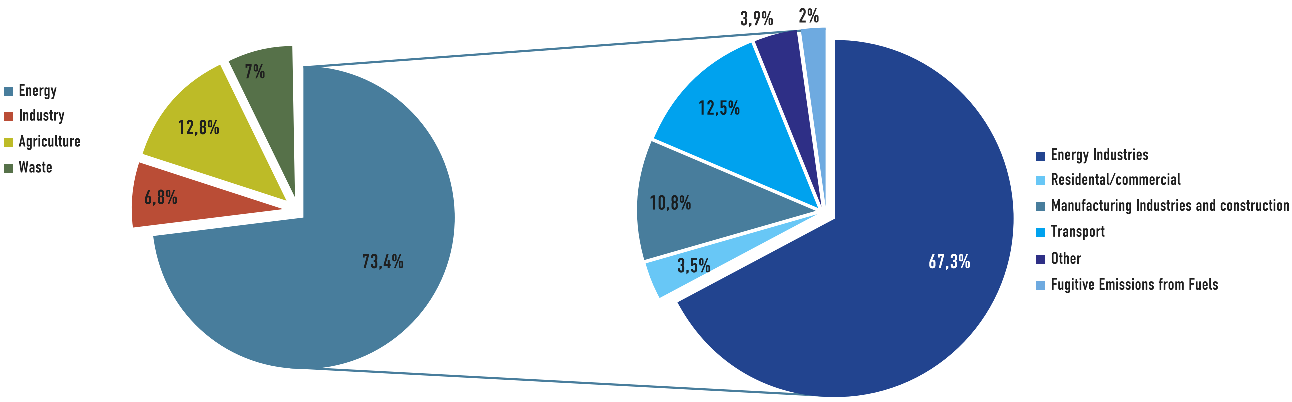
The time series of emissions per sector for the period 1990-2009 are presented in Table 3-1.

TABLE 3-1: Direct GHG emissions/removals by sectors in the period 1990–2009 [kt CO_2-eq]

	1990	2000	2003	2004	2005	2006	2007	2008	2009
Energy	9,940	9,227	9,059	8,732	9,456	8,543	9,035	9,146	8,761
Industry	889	886	598	971	1,076	784	944	975	434
Agriculture	1,908	1,380	1,734	1,788	1,581	1,677	1,496	1,403	1,321
Waste	786	844	833	839	840	852	862	872	881
LULUCF	-33	-1,450	-977	-989	-1,093	-927	8	-718	-1,146
Total CO_2-eq excluding LULUCF[5]	13,524	12,336	12,231	12,330	12,953	11,857	12,337	12,397	11,399
Total CO_2-eq including LULUCF	13,193	10,886	11,255	11,341	11,861	10,929	12,344	11,680	10,252

This report focuses on the inventory for the period 2003-2009. In this period, emissions originated primarily from the Energy sector (73.41%, ranging mostly between 8,500-9,000 kt CO_2-eq per year), followed by Agriculture (12.87%, decreasing from year to year due to decreasing numbers of livestock) and Waste (7%, rising due to population growth) (see Figure 3-1). The Industry sector produces 6.72% of the country's emissions. The Land Use, Land-Use Change and Forestry sector accounts for 3–10% of emissions, depending on the amount of forest fires, the management of soils (limestone and fertilizer application) and the conversion of land in the specified year.

FIGURE 3-1: Sectoral shares of total direct greenhouse gas emissions in the period 2003–2009



Looking at the direct greenhouse gases, CO_2 accounts for 75–80% of emissions for the period covered (mostly from the burning of fuels in the energy sector), 12–14% are CH_4 emissions (mostly from agriculture and waste), 7–9% are N_2O emissions (from burning fuels and emissions from soils) and 1–2% are HFCs from the industry sector (see Figure 3-2 and Table 3-2).

6 Emissions / removals from Land Use, Land-Use Change and Forestry are not included in national totals. CO_2-eq figures for emissions in this category are presented with a minus symbol (-) since these figures represent removals of GHGs, or carbon sink, through the process of carbon sequestration.

FIGURE 3-2: Share of the direct GHGs in total emissions in the period 2003–2009

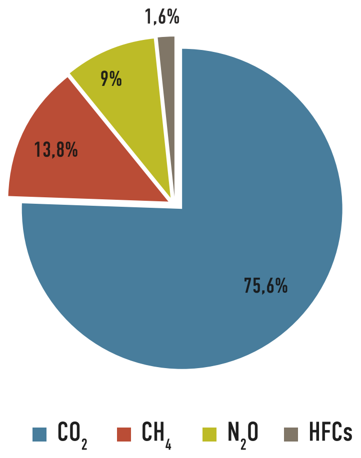


TABLE 3-2: Direct GHG emissions by gas [kt CO2-eq]

	2003	2004	2005	2006	2007	2008	2009
CO_2	9,302	9,049	9,852	8,912	9,446	9,493	8,851
CH_4	1,681	1,692	1,648	1,688	1,764	1,719	1,649
N_2O	1,223	1,262	1,089	1,162	1,135	971	907
HFC	22	331	372	101	227	274	0
Total CO_2-eq [kt] excluding LULUCF	12,231	12,330	12,953	11,857	12,337	12,397	11,398
Total CO_2-eq [kt] including LULUCF	11,255	11,341	11,861	10,929	12,344	11,680	10,252

Indirect GHGs are those that have an impact on climate change through indirect radiative effects. Therefore, it is good practice to report these gases separately in national inventories. Figure 3-3 shows the share of each gas in total emissions of indirect GHGs and Table 3-3 presents the amounts emitted in the period 2003-2009. Most of the NO_x and CO emissions come from the energy sector, from the transport and energy industries (coal, lignite), and from burning in agriculture (crop residues) and LULUCF (forest fires). NMVOC emissions originate from the industry sector, especially from mineral production processes, and a smaller share from the transport sector and from solvent use, while most SO_2 emissions arise from the energy industries, construction and transport.

FIGURE 3-3: Share of each gas in total indirect GHG emissions in the period 2003-2009

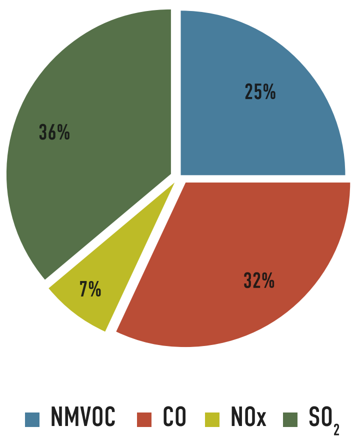


TABLE 3-3: Indirect GHG emissions by gas [kt CO_2-eq]

	2003	2004	2005	2006	2007	2008	2009
NO_x	35.22	32.13	32.54	33.41	35.86	36.63	34.50
CO	145.56	137.32	128.38	129.87	195.29	154.40	149.01
NMVOC	102.53	228.75	181.98	74.56	52.48	90.21	85.70
SO_2	172.62	168.38	175.33	162.91	161.76	181.05	176.26

3.3. SECTORAL INVENTORIES

3.3.1. Energy sector

The Energy sector is the main source of GHG emissions in Republic of Macedonia, accounting for an average of 73.22 % of overall direct GHG emissions for the period 1990–2009. Energy production in Macedonia is predominantly based on domestic lignite, imported fuels, natural gas, hydropower and wood, all of which are used for electricity production, heat production, and mechanical energy in the transport sector.

To produce the inventory, both the Sectoral and Reference approach were applied, allowing for the verification of the reported emissions and taking into account the carbon flow in the country. The deviation between the two approaches was satisfactory even by the standards applied to Annex I Reporting Countries.

To enable the application of higher Tier methodologies and improve the accuracy of the estimation of GHG emissions, country-specific emission factors[7] for key sources of GHG emissions were developed. In the energy sector, country-specific emission factors were used for the carbon/carbon dioxide emissions factors for lignite, natural gas and residual fuel oil; the sulphur dioxide emission factors for lignite and residual fuel oil; the nitrogen dioxide emission factor for lignite; and the methane emission factor for coal mining and handling.

TABLE 3-4: Energy subsectors

Fossil fuel consumption	Energy industries
	Manufacturing industries and construction
	Transport
	Commercial/ institutional secto
	Residential sector
	Agriculture/ forestry/ fishing
	Other sectors
Fugitive emissions	Coal mining and handling
Memo item[1]: international bunkers	International aviation
Memo item[1]: biomass	Biomass emissions

[1] Memo items emissions are excluded from the Energy sector totals. Emissions from these subsectors are given for information purposes only.

Emissions from the Energy sector are divided into a number of subsectors (see Table 3-4). Table 3-5 present the contribution of individual GHGs to the sector's emissions, with CO_2 being by far the most dominant contributor.

The Energy Industries subsector was the main contributor to overall emissions from the Energy sector for the TNC inventory period of 2003–2009, accounting for an average of 73.4% of emissions from the Energy sector (see Table 3-6). This is primarily because the country's energy production is based on the exploitation of domestic lignite, which is inefficient in terms of energy delivery and has high emission factors.

The Transport sector consists of Road, Rail and Civil Aviation, amongst which the majority of emissions (99%) originate from Road Transportation. The Road Transportation subsector is the second biggest emitter of GHGs in the country, accounting for an average of 12.55% of emissions from the Energy sector. Emissions from Road Transportation have a significant negative impact on human health and represent a major environmental problem, especially in densely populated cities.

The Manufacturing Industries and Construction subsector accounts for an average of 10.85% of total emissions from the Energy sector. This subsector is the fifth biggest emitter of GHGs in the country.

[7] Technolab (2013)

TABLE3-5: Contribution of individual direct and indirect GHGs to emissions in the energy sector [kt]

	2003	2004	2005	2006	2007	2008	2009
CO_2	8,726.56	8,408.33	9,148.49	8,228.19	8,729.15	8,792.57	8,416.22
CH_4	13.46	13.14	12.43	12.66	12.31	14.34	14.02
N_2O	0.16	0.15	0.15	0.16	0.15	0.17	0.16
NO_x	33.42	30.56	31.38	32.30	34.00	35.43	33.65
CO	136.50	126.24	116.36	118.52	111.99	126.16	137.54
NMVOC	21.33	19.34	18.01	18.13	17.62	19.46	21.01
SO_2	172.10	168.06	174.98	162.54	161.44	180.75	175.95

TABLE3-6: Contribution of individual subsectors to emissions in the energy sector [kt CO_2-eq]

	2003	2004	2005	2006	2007	2008	2009
Energy Industries	6,288	6,222	6,417	5,588	5,754	6,040	5,922
Manufacturing Industry and Construction	632	549	1,136	1,133	1,369	1,205	805
Transport	1,168	1,012	1,018	1,018	1,165	1,200	1,294
Commercial / Institutional / Residential / Agriculture / Forestry / Fishing	342	348	320	318	282	286	287
Other sectors	455	431	408	332	310	230	279
Fugitive emissions from fuels	183	177	171	168	173	201	184
Total	9,068	8,739	9,471	8,557	9,052	9,161	8,770

3.3.1.1.International aviation bunkers and CO_2 emissions from biomass

In the framework of the TNC, emissions from the Civil Aviation Subsector were calculated for the first time using the Tier 2 approach (see Figure 3-4 and Figure 3-5). In accordance with IPCC methodology, emissions from domestic flights – i.e., emissions arising from flights between the country's two domestic airports – have been introduced and reported in the national totals, while emissions from international traffic are reported separately as Memo Items and are excluded from the national totals.

FIGURE 3-4: Fuel combustion by international aviation, 2003-2009 [TJ]

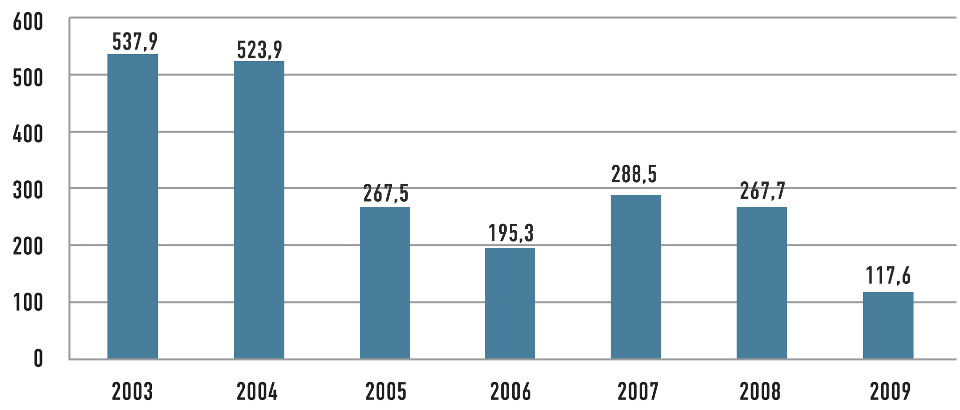
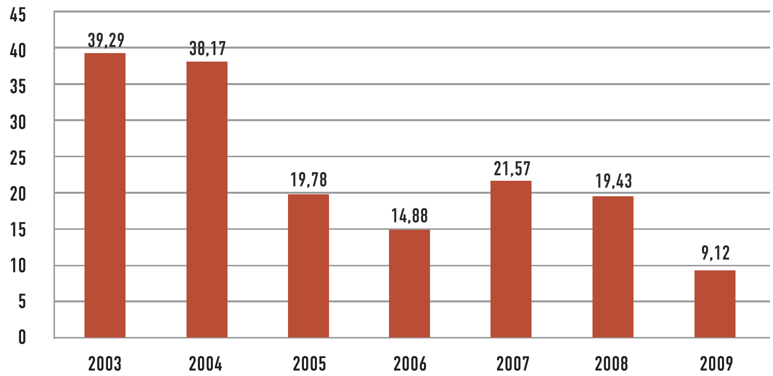


FIGURE 3-5: Direct GHG emissions from international aviation, 2003-2009 [kt CO_2-eq]



CO_2 emissions from biomass in the Republic of Macedonia arise from the combustion of wood biomass. This energy source is generally used by households and usage is very difficult to quantify precisely due to widespread illegal logging. See Figure 3-6 and Figure 3-7 for estimates of the energy use and CO_2 emissions from biomass.

FIGURE 3-6: Total biomass consumption by the energy sector, 2003-2009 [TJ]

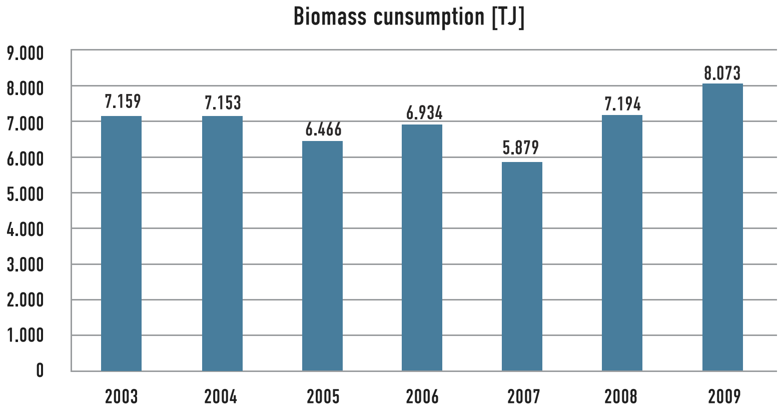
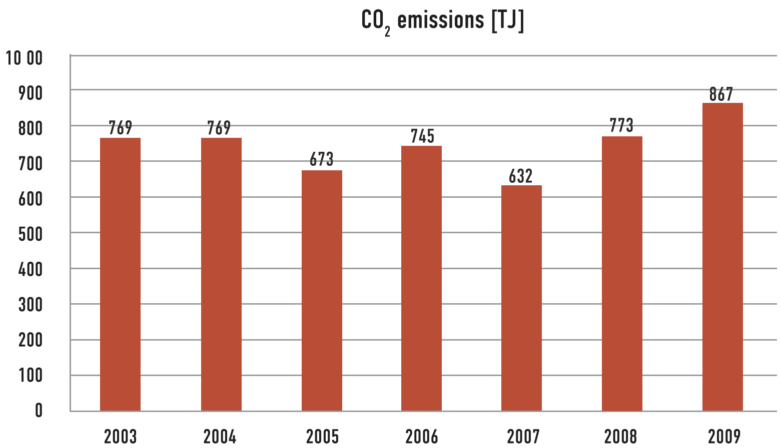


FIGURE 3-7: CO_2 emissions from biomass consumption by the energy sector, 2003-2009 [kt]



3.3.2.Industrial processes

Rapid industrial development is one of the most important drivers of economic growth, with the potential to have a transformative effect on socio-economic relationships, standards and ways of living. GHG emissions are generated by a wide variety of industrial activities. The main emission sources are those industrial processes that chemically or physically transform materials. Most emissions from Industrial Processes in Macedonia originate from mineral and metal product processes, with the cement industry and ferroalloys production accounting for over 77% of total emissions. In addition, greenhouse gases are often used in products such as refrigerators, foams and aerosol cans. HFCs are responsible for 23% of GHG emissions from the industrial processes in the country.

For the purposes of the Third National Communication, country-specific emission factors were developed in close collaboration with industrial plants. In the Metal Production sub-category, emissions were calculated using country-specific emission factors that take into account the amount of feedstock used and its carbon content data. The plant-specific data for Iron and Steel Production was taken from the integrated environmental permit, in accordance with the recommendation of the Second National Communication, while the data on ferroalloys production was gathered directly from industrial plants.

Country-specific emission factors were also developed for the cement industry, with data collected directly from the single cement production plant in the country. Data on annual clinker production were not available for the period 2003–2009 and clinker production was therefore calculated from the cement production data. This means that GHG emissions from cement production were calculated using a Tier 1 methodology.

Industrial production in the period 2003–2009 was stable in some sectors but fluctuated in others. Cement Production and Commodities Production were stable throughout the whole period. The highest fluctuations occurred in the Metal Production category. Ferroalloy production increased in 2007 and 2008 due to the production of Ferro-silico-manganese, which was absent in the previous years, but then experienced a sudden downturn as a result of the world economic crisis. Iron and steel production also increased until 2007 before declining as a result of the global crisis. Limestone use was calculated on the basis of steel production data. The calculated emissions for the whole time series 1990–2009 are presented in Figure 3-8.

In the Key Category analysis, Cement Production and Ferroalloy Production were identified as key categories. HFC consumption in refrigeration and air-conditioning was identified as a key category in the period 2004–2008 because of the high global warming potential (GWP) of HFCs. This category does not appear as a key category in 2009 due to a lack of data. Emissions from the industrial processes subcategories are presented in Table 3-7.

Emissions of indirect GHGs are calculated for each subcategory. The highest emitters of SO_2 are the Mineral Industry and the Metal Industry, while NMVOCs are mostly emitted during the road-paving process and the production of food and beverages. The aggregated direct and indirect GHG emissions are provided in Table 3-7.

FIGURE 3-8: Greenhouse gas emissions from the industrial processes sector in the period 1990–2009 [kt CO_2-eq]

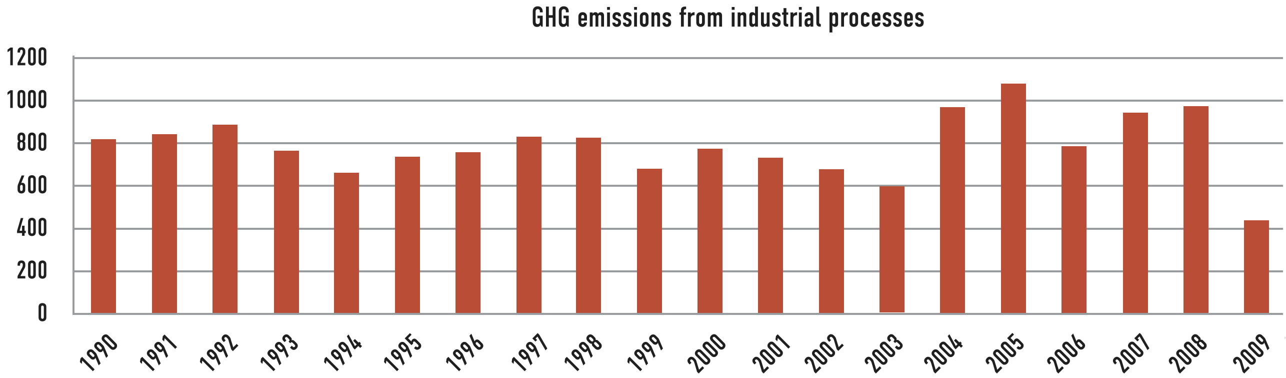


TABLE 3-7: Contribution of individual direct and indirect GHGs to emissions in the industry sector [kt]

	2003	2004	2005	2006	2007	2008	2009
CO_2	575.86	640.91	703.45	683.39	716.65	700.53	434.44
NO_x	1.46	1.14	0.74	0.71	0.3	0.51	0.43
CO	0.51	0.03	0	0.03	0.01	0	0.05
NMVOC	81.2	209.41	163.97	56.43	34.87	70.75	64.69
SO_2	0.51	0.31	0.35	0.37	0.32	0.3	0.31
HFCs	0.02	0.25	0.28	0.07	0.17	0.21	n/a

TABLE 3-8: Contribution of individual subsectors to emissions in the industrial sector

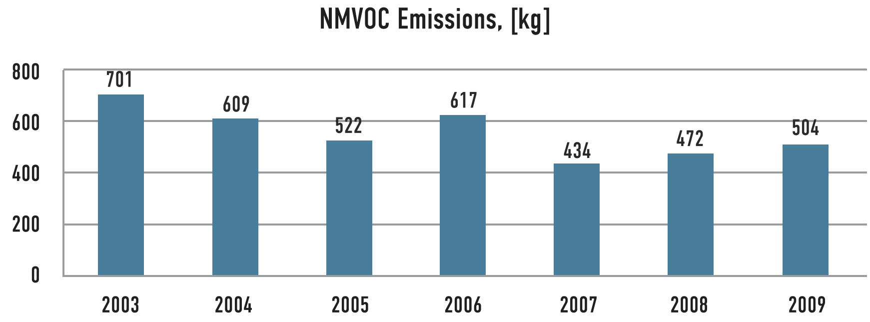
Industrial Processes and Product Use	CO_2-eq [%]						
	2003	2004	2005	2006	2007	2008	2009
Mineral Industry	47.8%	29.2%	29.3%	41.8%	35.6%	32.1%	70.7%
Metal Industry	48.5%	36.8%	36.2%	45.3%	40.4%	39.7%	29.3%
Consumption of halocarbons and sulphur hexafluoride	3.8%	34.0%	34.6%	12.9%	24.0%	28.1%	0.0%
TOTAL	100%	100%	100%	100%	100%	100%	100%

3.3.3. Solvent and other product use

The use of solvents, which are manufactured using fossil fuels as feedstock, can lead to evaporative emissions of various non-methane volatile organic compounds (NMVOCs) that are subsequently further oxidized in the atmosphere.

Methodologies for estimating these NMVOC emissions can be found in the CORe INventory AIR emissions (CORINAIR) Emission Inventory Guidebook from the European Environmental Agency, 2005. For the purposes of the Third National Communication, data on imports and exports of solvents, paint, varnish-remover, etc., were derived from the United Nations Commodity Trade Statistics Database (UN Comtrade), which stores annual international trade statistics detailed by commodities and partner countries. An emission factor of 1 has been used for all organic solvents and other volatile organic compounds, while NMVOC emissions from paints have been calculated using an emission factor of 0.5, in accordance with the CORINAIR Guidelines, though there was no data to distinguish paints from the other substances. Figure 3-9 shows the estimated NMVOC emissions from solvent use.

FIGURE 3-9: NMVOC emissions from solvent use, [kg]



3.3.4.Agriculture

The agriculture sector is the second biggest source of GHG emissions in the country. The GHG Inventory for the Agriculture sector details emissions from the following source categories:

- CH_4 emissions from *enteric fermentation* in domestic livestock;
- CH_4 emissions and N_2O emissions from *manure management*;
- CH_4 emissions from *rice production*;
- CH_4 and N_2O emissions from the burning of agricultural residues;
- Direct N_2O emissions and indirect N_2O emissions from *agricultural soils.*

Eighty-nine per cent (89%) of CH_4 emissions in the agriculture sector are generated by enteric fermentation from domestic livestock, and these emissions have been continuously decreasing in line with a reduction in livestock populations. Emissions from manure management account for 8% of methane emissions, while the remaining emissions come from rice fields and the burning of residues.

With regard to nitrous oxide (N_2O) emissions, 89% arise from the management of agricultural soils, including the use of fertilizers, the amount and type of manure applied, leaching, nitrogen-fixing crops and atmospheric deposition, while remaining emissions are generated by manure management and, to a lesser extent, from the burning of crop residues. Values for the production of the most important crops were entered in the TNC for the first time. In the Key Category Analysis, Enteric Fermentation, Manure Management and Agricultural Soils were identified as key categories. Default emission factors for Enteric Fermentation and Manure Management for Eastern Europe from the IPCC Guidelines were set as country-specific. The values for CH_4 emissions (kt) from rice fields in the revised inventory for agriculture in the period 2003–2009 showed a decrease compared to the previous inventory, mostly due to the abandonment of rice cultivation because of very low purchase prices and conversion to more profitable crops.

The 40% decrease in emissions in this sector was mainly due to a reduction in livestock population and associated emissions. Time series for the individual greenhouse gases are given in Table 3-9 and the subsectors are shown in Table 3-10.

TABLE 3-9: Contribution of individual direct and indirect GHGs to emissions in the agriculture sector [kt]

	2003	2004	2005	2006	2007	2008	2009
CH_4	28.86	29.47	27.84	29.05	26.24	26.37	24.45
N_2O	3.64	3.77	3.21	3.44	3.05	2.74	2.61
NOx	0.32	0.41	0.39	0.37	0.32	0.37	0.38
CO	5.83	8.84	8.31	7.66	5.97	7.87	7.63

TABLE 3-10: Contribution of individual subsectors to emissions in the agriculture sector [kt CO_2-eq]

	2003	2004	2005	2006	2007	2008	2009
Enteric fermentation	549.16	561.62	529.65	553.97	490.64	492.25	458.02
Manure management	170.17	168.87	162.14	167.92	166.27	166	149.33
Rice fields	4.11	3.88	3.56	3.45	3.45	3.62	4.27
Agricultural soils	1,002.68	1,042.91	875.85	941.35	828.03	732.16	700.22
Agricultural residue burning	7.37	10.58	10	9.31	10.48	10.9	10.43
Total Agriculture	1,733.51	1,787.87	1,581.21	1,676.00	1,498.88	1,404.94	1,322.27

3.3.5. Land use, land use change and forestry (LULUCF)

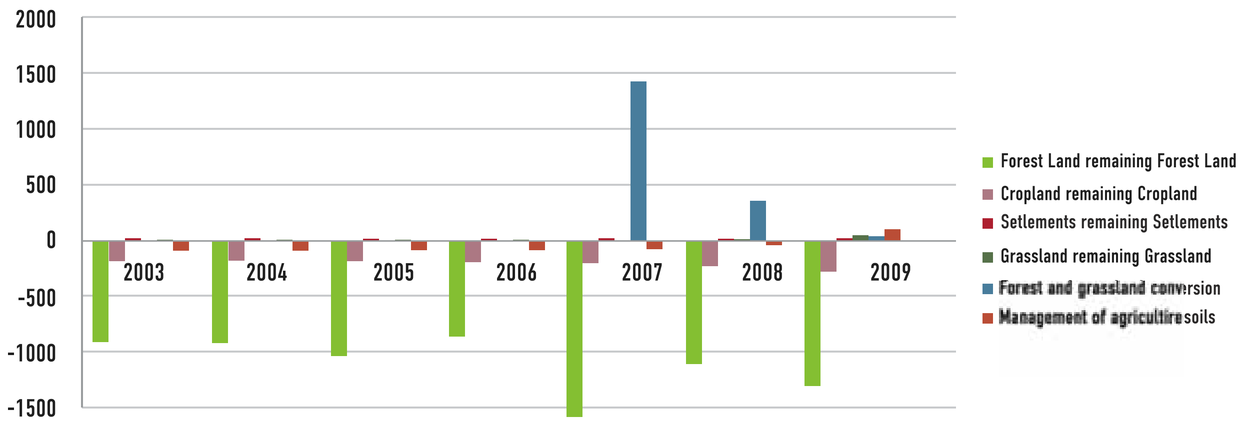
Land Use, Land-Use Change and Forestry (LULUCF) is a very important sector when investigating the overall balance of GHG gases, both globally and in specific countries, because it is the only sector that removes GHGs from the atmosphere – as is the case in the Republic of Macedonia. Changes in carbon stocks in the living biomass in forests and croplands have the greatest effect on carbon sinks, followed by biomass conversion from one category to another. The main positive emissions (releases) from this sector arise from the annual loss of biomass by commercial harvesting, from burning of biomass, wood decay and changes in land use.

The GHG inventory for this sector consists of data for CO_2 absorption – i.e., carbon sinks, as well as data on other gases (CH_4, CO, N_2O and NO_x) generated during biomass burning. The inventories were compiled using Tier 1 methodology due to the unavailability of accurate activity data required to apply a more detailed methodology. Activity data were mainly taken from the State Statistical Office of the Republic of Macedonia and the Forestry Inspectorate within the Ministry of Agriculture, Forestry and Water Economy, and default emission factors were taken from the revised IPCC Guidelines for GHG inventories and Good Practice Guidelines in LULUCF. Table 3-11 and Figure 3-10 present the emissions and removals of GHGs from this sector. Major forest fires in 2007 resulted in a significantly lower absorption of emissions in that year.

TABLE 3-11: Contribution of individual direct and indirect GHGs to emissions/removals in the LULUCF sector [kt]

	2003	2004	2005	2006	2007	2008	2009
CO_2 removal	-981.81	-993.21	-1,099.55	-934.1	-227.15	-778.73	-1,155.37
CH_4	0.18	0.15	0.25	0.24	6.63	1.73	0.29
N_2O	0	0	0.01	0	0.31	0.08	0.01
NO_x	0.02	0.02	0.03	0.02	1.23	0.32	0.04
CO	2.73	2.21	3.71	3.66	77.31	20.37	3.78

FIGURE 3-10: GHG Emissions/removals by different land use categories in the period 2003-2009 [kt CO_2-eq]



The *Forest land* category was responsible for most carbon removals, followed by *Cropland remaining Cropland* and the intensive management of agriculture soils *(liming)*. Emissions from managed organic soils are continuously increasing since the area of organic production is expanding, mainly because of favourable subsidies from the Government's agricultural policy, awareness-raising campaigns and growing demand on the market for healthy organic produce. Most of the GHG emissions are generated by on-site and off-site burning and forest and grassland conversion (in 2000 and 2007 because of land destruction by fires).

3.3.6.Waste

There are a number of sources of GHG emissions in the waste sector:

- CH_4 emissions from Solid Waste Disposal Sites (SWDS);
- CH_4 emissions from residential/commercial wastewater and sludge;
- CO_2 emissions from waste incineration; and
- N_2O emission from human sewage and domestic/industrial wastewaters.

The Waste sector has become a significant source of emissions, accounting for 7% of total GHG emissions in the country, and this sector should be analysed more thoroughly in the future.

Some 89% of emissions from the Waste sector are CH_4 emissions, 5% are N_2O and 6% are CO_2 emissions from waste incineration (see Table 3-12). Most of the GHG emissions in the Waste sector originate from solid waste disposal sites (methane emissions), while emissions from incineration and wastewater handling have an equal importance in total emissions. Emissions from this sector show a slight *increase* during the inventory period, since a larger population produces higher emissions through the disposal and incineration of municipal solid waste.

In the Third National Communication a higher Tier methodology (i.e. First Order Decay (FOD) for the calculation of emissions from Solid Waste Disposal Sites) has been used for the first time, whereas the previous Inventories for the period 1990–2002 applied the default mass-balance method. The FOD method requires data on the amounts and composition of solid waste disposal over a 50-year period. Historical data was taken from official censuses from 1950, 1962, 1971, 1981, 1991, 2002 and current population estimations from the State Statistical Office. Data for the missing years were obtained by extrapolation. The same method was applied to waste generation per capita. The Degradable organic carbon (DOC) value was set as a *country-specific value of 0.19,* based on the different fractions of waste disposed in landfills in the country.

Most wastewater produced in rural areas of the country is managed without formal handling and/or treatment systems and only the proportion of the country's population living in urban areas *(59.9%)* was taken into consideration when calculating methane emissions because only this population is connected to sewage networks with some form of treatment prior to release into rivers. For industrial wastewater, the highest emissions come from the non-ferrous industries, followed by the pulp and paper industries, canneries and wine production. Since total industrial production declined during the inventory period, organic industrial wastewater also decreased significantly, falling by 50% from 1990 to 2009.

Like other types of combustion, incineration and the open burning of waste are sources of greenhouse gas emissions. The gases emitted include CO_2, methane (CH_4) and nitrous oxide (N_2O). In the TNC, these GHGs are reported for the first time. The total amount of municipal solid waste burned in the open was estimated using Tier 1 methodology from the IPCC Guidelines using data from the only incinerator in the country (Drisla Landfill) covering hazardous and clinical waste from the whole country as well as municipal solid waste from the Skopje Region.

TABLE 3-12: Contribution of individual GHGs to emissions in the waste sector [kt]

	2003	2004	2005	2006	2007	2008	2009
CO_2	64.91	65.07	65.18	65.28	63.95	65.65	65.99
CH_4	37.56	37.81	37.94	38.44	38.83	39.42	39.79
N_2O	0.14	0.14	0.14	0.14	0.15	0.14	0.15

TABLE 3-13: Summary of emissions from subsectors of the waste sector [kt CO_2-eq]

Година	2003	2004	2005	2006	2007	2008	2009
CH_4 emissions [kt CO_2-eq] Solid Waste Disposal Sites	726.78	728.53	732.69	745.30	755.45	767.44	778.70
CH_4 emissions [kt CO_2-eq] Wastewater Handling	46.44	49.77	48.43	46.32	44.29	44.54	40.96
CH_4 Emissions from Waste Incineration [kt CO_2-eq]	15.61	15.60	15.65	15.67	15.66	15.75	15.76
Total CH_4 emissions (kt CO_2-eq)	**788.83**	**793.90**	**796.77**	**807.29**	**815.40**	**827.73**	**835.42**
N_2O emissions [kt CO_2-eq] Wastewater Handling	43.02	44.16	42.74	43.85	46.13	43.77	44.67
N_2O Emissions from Waste Incineration [kt CO_2-eq]	0.71	0.71	0.71	0.71	0.71	0.72	0.77
Total N_2O emissions (kt CO_2-eq)	**43.73**	**44.87**	**43.45**	**44.56**	**46.84**	**44.49**	**45.44**
CO_2 emissions from waste incineration [kt]*	64.91	65.07	65.18	65.28	63.95	65.65	65.99
Total emissions (kt CO_2-eq)	*832.56*	*838.77*	*840.22*	*851.85*	*862.24*	*872.22*	*880.86*

*According to IPCC's Good Practice Guidance (IPCC-GPG, 2000), CO_2 emissions from the incineration of biogenic waste should not be included in total GHG emission calculations and reporting.

3.4. KEY SOURCE ANALYSIS

The identification of key source categories is described in Chapter 7 of the IPCC's Good Practice Guidance (IPCC-GPG, 2000), which defines a key source category as one that has a significant influence on a country's total inventory of GHGs in terms of the absolute level of emissions (tonnes CO_2-eq), the trend in emissions, or both. In practice the key sources are the largest sources which – added together – reach 95% of the total GHG emissions level in a certain year.

Following the IPCC Good Practice Guidance (IPCC-GPG, 2000), and IPCC Good Practice Guidance for LULUCF (IPCC-GPG, 2003), key category analysis was performed for the period 2003–2009, first excluding LULUCF categories and then repeated including the LULUCF categories. Table 3-14 summarizes the results of the analysis, presenting the Key Source Categories from both the analysis excluding LULUCF and the analysis including LULUCF.

TABLE3-14: Key source analysis - summary results

IPCC Source Category	Sector	Source Categories to be Assessed in Key Source Category Analysis	Applicable GHG	Number of years being a key category
1.A.1	Energy	CO_2 Emissions from Energy Industries - Coal - Lignite	CO_2	7
1.A.3	Energy	CO_2 Mobile Combustion: Road Vehicles	CO_2	7
4.D	Agriculture	N_2O (Direct and Indirect) Emissions from Agricultural Soils	N_2O	7
6.A	Waste	CH_4 Emissions from Solid Waste Disposal Sites	CH_4	7
1.A.2	Energy	CO_2 Emissions from Manufacturing Industries and Construction	CO_2	7
4.A	Agriculture	CH_4 Emissions from Enteric Fermentation in Domestic Livestock	CH_4	7
1.A.5	Energy	Other (Energy)	CO_2	7
1.A.1	Energy	CO_2 Emissions from Energy Industries - Oil - Residual Fuel Oil	CO_2	7
2.A	Industrial Processes	CO_2 Emissions from Cement Production	CO_2	7
1.B.1	Energy	CH_4 Fugitive Emissions from Coal Mining and Handling	CH_4	7
1.A.4	Energy	Other Sectors: Residential CO_2	CO_2	7
5.A	LULUCF	Forest Land remaining Forest Land	CO_2	7
5.B	LULUCF	Cropland remaining Cropland	CO_2	7
2.C	Industrial Processes	CO_2 Emissions from Ferroalloy production	CO_2	6
4.B	Agriculture	N_2O Emissions from Manure Management	N_2O	6
2.E	Industrial Processes	HFCs Emissions from HFC Consumption	HFCs	5
1.A.4	Energy	Other Sectors: Residential CH_4	CH_4	3
1.A.1	Energy	CO_2 Emissions from Energy Industries - Gas - Natural Gas	CO_2	2

From Table 3-14 it can be seen that 18 categories were considered key sources at some point in the seven examined years. The key source with the highest contribution to national total emissions is 1.A.1: CO_2 Emissions from Energy Industries - Coal - Lignite. The contribution of emissions from the Energy Industries to total national emissions in the last analysed year (2009) was 47.17%.

3.5. UNCERTAINTY ESTIMATION

The degree of uncertainty of data in the Third National Communication to the UNFCCC was estimated only for the Industrial Processes sector. The Industrial Processes sector was particularly interesting as a subject of uncertainty assessment because the cumulative result for this sector depends on many variables with high uncertainty. Within the Industrial Processes sector there were inter-annual fluctuations as well as significant changes from one year to the next due to the introduction of new industrial production or temporary or permanent plant closures. Changes in processes, production intensity and technology can also cause significant fluctuations. Emission trends for each category and/or sub-category can be explained in terms of some type of economic or technological change. This is why this sector is so sensitive to change and why it is important to conduct an uncertainty analysis to confirm whether the results are within the confidence range. Uncertainty analysis was performed for each CO_2-emitting sub-category in the Industrial Processes category for every year in the period 2003–2009.

The Monte Carlo algorithm was used for estimating uncertainty as it is suitable for detailed category-by-category assessment of uncertainty, particularly where uncertainties are significant. For every variable, random values were generated for each input used in the methodology formula to calculate the desired output. This process was repeated for over 40,000 iterations in order to compute multiple estimates of the model output. The results of the Monte Carlo Simulation are given in Table 3-15.

TABLE 3-15: Summary Results of the Monte Carlo simulation of CO_2 emissions from the Industrial processes sector for the period 2003–2009

	CO_2-eq Emission [kt]				
YEAR	MAX	MIN	MEAN	ST.DEV	DEV/MEAN
2003	727.69	452.26	579.39	63.04	10.88%
2004	797.36	499.91	640.72	64.01	9.99%
2005	891.55	552.17	705.72	73.09	10.36%
2006	908.02	512.59	682.02	76.31	11.19%
2007	824.65	521.13	662.85	65.74	9.92%
2008	880.3	548.07	682.28	66.23	9.71%
2009	609.4	295.51	424.24	68.39	16.12%

The results obtained from the Monte Carlo simulation are as expected. It can be seen that there is high uncertainty in the Industrial Processes emission estimates due to lack of data, though in most years the results fall within the confidence-range accepted in the IPCC Good Practice Guidance (±10%). An uncertainty outlier can be noticed in 2009 due to lower data availability for this year than for earlier ones, especially in the HFCs consumption category.

3.6. PROBLEMS ENCOUNTERED AND SOLUTIONS IMPLEMENTED

A detailed gap analysis of GHG data was performed a number of applicable solutions were proposed and in close collaboration with members of the NCCC. These recommendations served as input for amending the Law on Environment, to facilitate access to the data necessary for the preparation of future national inventories.

3.6.1.Energy sector

Data on the Energy sector are mainly generated from the Energy Balances of the Republic of Macedonia. The data provided in the State Statistical Database 2005–2009 are adequate and fully meet the requirements for the IPCC methodology. A significant data gap was identified in the inventory preparation for the period 2003–2004, since there is no officially published Energy Balance for this period. The Inventory for these two years was developed with data from the Energy Balances of the Ministry of Economy and the International Energy Database of the International Energy Agency (IEA).

The data on biomass given in the statistical yearbook was aggregated for Wood Fuel, Wood Waste and Other Solid Waste. Each type has its own level of carbon content and a different emission factor and should ideally be treated separately. Wood Fuel should also be divided according to the type of wood used because of the different net calorific value and carbon content. The exact amount of biomass used as an energy source differs from the statistical database because of illegal tree felling. As mentioned in the recommendations section, a detailed forest inventory for the country needs to be developed and monitored every year to allow for better estimates as to the illegal use of wood as an energy source.

3.6.2.Industrial processes

Several problems were encountered during the process of inventory construction. In the inception stage there was a lack of previous relevant documentation for the Macedonian inventory from the First and Second National Communications. Although some documentation was provided for one year, this did not explicitly state the activity rate collection processes or include calculations for more complex subsectors.

A second problem was encountered during the data collection process. The data was provided by the State Statistical Office but was not collected under the necessary nomenclature. This led to the unintentional discounting of some products as well as some uncertainty as to whether some products belong under the IPCC requirements. The biggest problem occurred in the collection of data on feedstock usage rather than product production (e.g. Soda Ash Use) since the State Statistical Office does not report this kind of data in its Statistical Yearbooks and Statistical Reviews. Furthermore, these data were not well segregated, which is a primary requirement for selecting adequate emission factors. In order to overcome this issue, most of the bigger industrial installations were contacted and asked to provide relevant information about emission factors and ongoing processes in the plants. This communication was conducted via the Macedonian Chamber of Commerce and did not bring the desired results. Only a few installations reported the required data within the given timeframe.

3.6.3.Agriculture

Generally comprehensive data is provided on the Agriculture sector by the State Statistical Office in its Statistical Yearbooks and Statistical Reviews on livestock numbers, livestock balance, growth rate, and milk and wool production. Using the Tier 1 approach, default values can be obtained for the Republic of Macedonia on animal weight, emission and conversion factors in the calculation of CH_4 from enteric fermentation and both CH_4 and N_2O emissions from manure management.

However, a gap was found in data on the country's goat and buffalo populations. In addition, poultry were not divided into sub-categories as broilers, ducks, chicks and hens, or turkeys, making it difficult to determine the methane emission factor CH_4 (kg CH_4/head year) and excretion rate for manure management. The same sub-categorization is required for cattle, swine, sheep and goats. A number of other livestock were not included in previous inventories. Although rabbits were registered in the 2007 census of agriculture of the State Statistical Office, they were not registered in statistical yearbooks in the examined period (2003–2009). Mules and asses were not considered, since their numbers are relatively low. These additional data on livestock population were obtained from the FAO stat database.

The manure management system for poultry was not adequately defined, resulting in incorrect values for emissions. The total amount of synthetic fertilizers applied in agriculture is very difficult to define, and the statistical data used in this inventory refers to the quantities used by agricultural companies and cooperatives. The amount of fertilizers used in the private sector is also very difficult to define since there is no instrument for auditing the amount and type of fertilizers used in this sector. Data on synthetic fertilizers were obtained from Statistical yearbooks.

3.6.4.LULUCF

Since the last forest stocktaking undertaken in the Republic of Macedonia in 1979, a difficulty has appeared with regard to annual forest growth and yield. Activity data is very uncertain and needs updating in the following areas:

- total forest area;
- stock and annual forest growth;
- changes in land use;
- loss of biomass due to commercial harvesting;
- illegal harvesting;
- wood decay in forests; and
- the processed wood industry.

In previous inventories, organic production was not taken into consideration as a separate cropland category. Since 2005, the Ministry of Agriculture, Forestry and Water Economy (MAFWE) has undertaken registers of organic farming, giving precise data on land converted to organic farming and data on annual changes in carbon stocks in organic soils. For the changes in land use, no official data was used in previous inventories. *Conversion of forest land to cropland, grassland or settlements and vice-versa was not taken into account.* Additional data on conversion needs to be obtained from the private enterprise Macedonian Forests. No data were provided in previous inventories on the burning of biomass in terms of the area burned on croplands and grasslands.

Data on fires and other disturbances in forests (pests, diseases, illegal logging), until 2008 was given only on the total annual forest land (in hectares), but not divided into sub-categories. Land conversion data were not obtained. Accurate and official data on illegal tree felling was obtained from the yearly reports of the Public Enterprise 'Macedonian Forests', as well as the Forestry Inspectorate. The *Forestry Inspectorate* provided a comprehensive database for forest disturbances for the years 2008 and 2009, divided into forest sub-categories. These data were used in the TNC Inventory, giving more accurate calculations for carbon sink in forests. Data on flooded forest areas in the period 2005–2009 are available from the Centre for Crisis Management.

3.6.5.Waste

Data on the waste sector were obtained from yearly reports on the state of the environment published by the Ministry of Environment and Physical Planning. Data on generated municipal solid waste (MSW) and its composition (fractions: paper, textile, garden waste, food waste, wood and straw) are highly uncertain, since such information is gathered from municipalities (which need to submit annual reports to the MOEPP) and only 60–80% of municipalities reported in the previous period. In addition, there are no exact data for the years 2006 and 2008. Another problem is that the fraction of MSW disposed of in Solid Waste Disposal Sites (SWDS) remains unknown, although the MOEPP estimates that 76% of municipal waste is landfilled in the country.

A new *country-specific* default value was thus used in the GHG Inventory within the Third National Communication. The FOD method used in the TNC requires more precise calculation of DOC from different fractions of waste, as well as historical data on waste generation (from 1950), which can be obtained directly from municipal landfills in combination with relevant research studies.

Sludge from both domestic and industrial wastewaters is not considered (value = 0). For domestic wastewater treatment and discharge, data on protein content per person was obtained from the FAOSTAT database on daily protein intake.[8]

3.7. RECOMMENDATIONS FOR FUTURE IMPROVEMENT

Proposals are given below for inventory improvement in each sector. It is further recommended that local inventories be compiled, which will help local governments to assess the impact of mitigation actions undertaken within municipalities.

3.7.1.Energy sector

Transport sub-sector: The following measures would improve the estimation of emissions from Transport and enable the application of higher Tier Methodologies to this sector:

Road transport: Fuel-specific and combustion-specific emission factors should be developed. The establishment of a register of the country's vehicle fleet according to fuel type, specific EURO classification, average consumption and annual average mileage per vehicle would make possible the use of a higher Tier methodology.

Railway transportation: Fuel-specific and combustion-specific emission factors should be developed. The establishment of a database of the average annual mileage per locomotive type and the exact amount of fuel combusted would enable a more accurate determination of the specific emission factor.

3.7.2.Industrial processes and solvent use

The key to successfully developing a GHG inventory for industry is the collection of relevant data of good quality. In order to establish sustainable data collection in this sector, it is important to develop national systems of transparent, comparable, coherent, complete and accurate Measurement, Reporting and Verification (MRV). A set of recommendations for such a system has been developed. Key recommendations are as follows:

- The reporting system should be robust, flexible, transparent and, most importantly, country driven so it can respond to national circumstances.
- Institutional arrangements should be based where possible on existing institutions and make efficient use of already existing staff.
- Deeper and stronger relations and collaboration with industry installations should be developed (a possible linkage could be made with the ongoing projects for introducing ETS in the country).
- The reporting system must be in line with the most recently adopted IPCC Guidelines (i.e. moving from the 1996 IPCC Guidelines to the 2006 IPCC Guidelines.
- The system must be based on the most cost-effective solutions at all stages and structural levels.
- The system should be multifunctional, making it possible to report under different conventions (e.g. CORINAIR and European Pollutant Release and Transfer Register – PRTR) with a single centralized data collection.
- New reporting tools should be developed and used. In this project an online software tool was developed for the Emission Monitoring Inventory as a centralized database that collects the data in a distributed manner directly from industry installations. This data should be used to apply higher tier methodologies.
- An attempt should be made to incorporate GHG emissions in the reporting scheme of the A and BIPPC installations. This may involve a separate project to train the responsible staff within the industry on the IPCC methodology.

3.7.3.Agriculture

The Tier 2 approach is recommended for estimating methane (CH_4) emissions from enteric fermentation from cattle in developing countries, including the Republic of Macedonia, where agriculture plays a significant role in the domestic economy. In contrast to the Tier 1 method, this approach requires much more detailed information on the livestock population, including at least three sub-

[8] The FAO database can be accessed at: http://faostat.fao.org/site/609/DesktopDefault.aspx?PageID=609#ancor).

categories. Using this detailed information will enable the development of more precise estimates of cattle emission factors.[9] For instance, data on crop patterns, land use and agricultural management (animal waste treatment, quantities of mineral fertilizers applied, etc.) are needed in order to apply improved methodology in estimating emissions from the Agriculture sector. Additional recommendations are as follows:

- There is an urgent need to establish a farm register and an Integrated Administration & Control System (IACS), which is a sophisticated and accurate system for gathering all this data into one database.
- An instrument should be developed for auditing the amount and type of fertilizers used in the Agriculture sector.
- Data on crop production and data on soil types (i.e. mineral, high activity clay mineral, low activity mineral) should be further disaggregated at the level of the strategic planning regions in order to obtain a more precise picture of GHG emissions from each region.

3.7.4.Land use, land use change and forestry (LULUCF)

Very limited activity data is available at present for this sector, making the implementation of a higher Tier approach practically impossible. Tier 1 is thus still considered the only appropriate approach. Key recommendations for this sector are as follows:

- A new forestry Inventory should be developed that will determine the area, stock, density, annual growth, tree species, commercial and illegal logging, fires and other disturbances, and flooding, as well as land conversion in forests, croplands, grasslands and settlements. This is needed to attain greater precision in estimates of GHG emissions. Data could be obtained from Public Enterprise Macedonian Forests, the Ministry of Agriculture, Forestry and Water Economy, the Forestry Inspectorate, the Crisis Management Centre and Public Enterprise Macedonian Pastures.
- IDRISI Selva software (Clark Labs, http://www.clarklabs.org/) could be used for modelling. This is a revolutionary tool for integrated modelling environments, including the Earth Trends Modeler (ETM) for image time series of environmental trends and the Land Change Modeler (LCM) for land change analysis and prediction. With ETM, users can rapidly assess long-term climate trends, measure seasonal trends in phenology, and decompose image-time series to seek recurrent spatio-temporal patterns.
- The 2006 CORINE LAND COVER Map should be used in modelling and needs to be updated.

3.7.5.Waste

Good data on current and historic annual quantities of waste are available only for the Drisla landfill. Additional measures should therefore be undertaken to enhance the capacity for obtaining data on other landfills in order to apply a more complex estimation method. A study should be undertaken on the average composition of waste (at least in a sample of rural and urban municipalities) in order to obtain reliable information on degradable organic content (DOC). DOC depends on the composition of waste and is an important parameter in the application of the theoretical gas yield methodology. More detailed analyses should be undertaken of wastewater discharge systems in all regions. Analysis of the compost facility opened in Resen municipality (Prespa region) would provide insight into weight, quantities and composition of waste, allowing for the estimation of possible GHG reductions from the implementation of anaerobic treatment.

[9] Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories: Reference Manual, Sector 4: Agriculture, pp. 4.15–4.16).

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4 VULNERABILITY AND ADAPTATION TO CLIMATE CHANGE

4.1. NATIONAL CLIMATE AND CLIMATE CHANGE SCENARIOS

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=207

The last decade of the 20th century and the beginning of the 21st century are considered as some of the warmest periods globally. At the same time, these have also been unique weather and climate periods in the Republic of Macedonia as well. The climate in the Republic of Macedonia is influenced by several factors. In the last hundred years (more specifically in the last 20 years) under the influence of fossil fuels and physical and chemical components in the composition and the structure of the atmosphere, the influence of anthropogenic factors has become a dominant influence.

4.1.1. Climate variability

In the last 25 years, changes in the global climate have been observed influenced by natural conditions and human activities. These changes have also been evident in the Republic of Macedonia. In order to document these changes, an analysis was made of the variability of key climate elements (air temperature, precipitation, solar radiation, cloud cover, snow and snow cover) in the country for the period from 1926 to 2012. Data for this period were collected at the meteorological stations in Skopje, Shtip, Bitola, Prilep and Demir Kapija. These metering stations have the longest data series in the country. Experts also analysed the period from 1951 to 2012 with data collected at metering stations with shorter data series in Lazaropole, Ohrid, Prilep, Berovo, Kriva Palanka, Gevgelija and Strumica. These stations cover all specific climate regions in the country. The analysis was made by year and by season, and extreme months (January, July, May and November) were also analysed individually.

Comparisons were based on three 30-year series, and the periods from 1971 to 2000 and from 1981 to 2010 were compared with the period from 1961 to 1990. Decade values for the periods from 1931 to 2010 and from 1961 to 2010 were also compared with the period from 1961 to 1990.

4.1.1.1. Temperature Analysis

Analysis of the multi-year variation of the mean annual temperature shows that in the 1950s, relatively higher air temperatures were measured in all meteorological stations on the whole territory of the Republic of Macedonia. After this period, there was a relatively colder 20-year period (1971-1993), while in the most recent 20 years (1994- 2012) the mean annual temperature has been constantly higher than the multi-year average. The multi-year variation of the average annual air temperature during this 87-year period ranges between:

TABLE 4-1: Information about temperatures at various meteorological stations

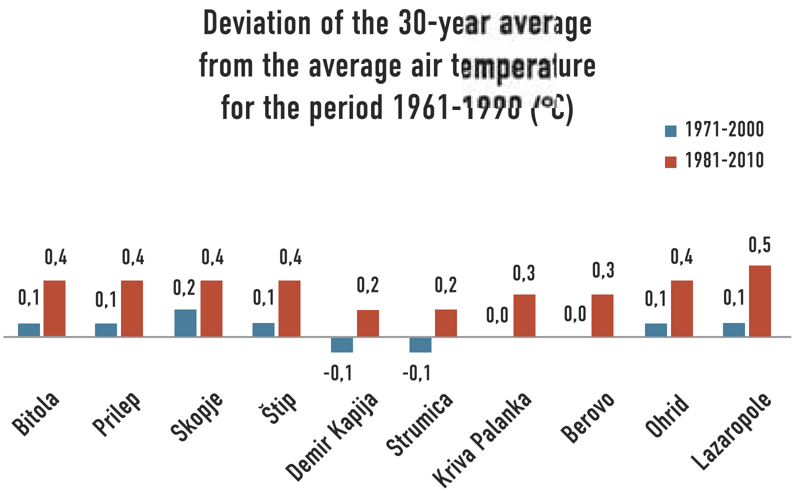
Station	Multi-year variation of average annual air temperature for the period 1926 to 2012	Average mean annual temperature for the period 1961-1990	The difference in the average annual air temperature for the whole period (1926-2012) compared to the average annual temperature for the period between 1961 and 1990
Bitola	10.1°C and 13.2°C	11.0°C	0.4°C
Skopje	10.8°C to 14.3°C	12.1°C	0.3°C
Shtip	11.2°C to 14.3° C	12.6°C	0.4°C
Prilep	10.1°C to 14.3° C	11.1°C	0.3°C

The warmest years recorded on the territory of the Republic of Macedonia for the period between 1951 and 2012 and for which data from all meteorological stations are available are 1952, 1994, 2008, 2007 and 2010. Among the ten warmest years for the period 1951-2012, five of the last six most recent years are included (2007, 2008, 2009, 2010 and 2012). The highest maximum air temperatures in the country in most of the meteorological stations were measured on July 24, 2007. At the meteorological station in Demir Kapija, unprecedented 45.7°C was measured, which is the highest air temperature ever measured on the territory of the country since the beginning of meteorological measurement. The highest mean monthly temperatures in July were measured in 2012, 2007 and in 1988.

The five coldest years measured in almost all meteorological stations are 1991, 1976, 1973, 1983 and 1980. The lowest value of the minimum air temperature on the territory of the Republic of Macedonia is -30.4°C and it was measured on January 7, 1993 in Bitola.

A general conclusion that can be reached based on the analysis is that the periods from 1971 to 2000 and from 1981 to 2010 are warmer compared to the period from 1961 to 1990. As the data in Figure 4-1 indicate, the most recent 30-year period (1981-2010) is the warmest, and the differences in the average mean annual temperature in comparison with the period from 1961 to 1990 range from 0.2°C to 0.5°C. This increase in the temperature is consistent with the results from reports from the broader region.

FIGURE 4-1: Average Air Temperature: Deviation of the 30-Year Average in Two Periods (1971-2000 and 1981-2010) from the 1961-1990 Period



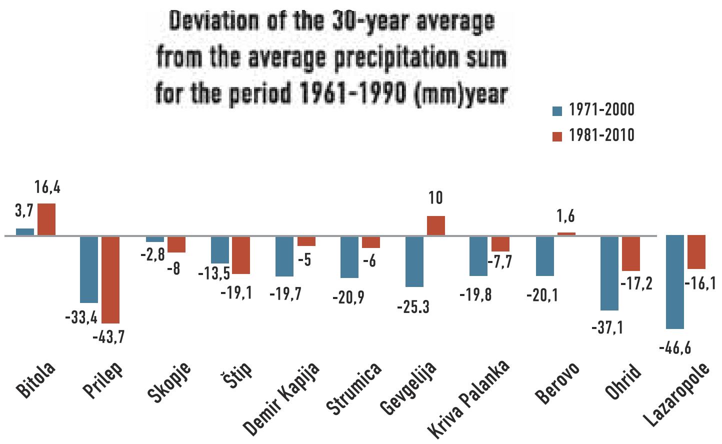
Source: Hydrometeorological Service 2013

4.1.1.2.Precipitation analysis

A similar analysis of precipitation for different regions of the country by years and by seasons – with a special focus on May and November as the months with the most rainfall throughout the year – indicated a general trend of decrease in rainfall. However, due to the fluctuations in levels of precipitation from year to year, it is difficult to establish the exact amount of this decrease in annual precipitation totals.

The quantity of total annual precipitation for the period 1971-2000 and the period 1981-2010 at all meteorological stations in the country is lower than for the period 1961-1990, with the exception of the meteorological station in Bitola. As Figure 4-2 indicates, there was less precipitation at most meteorological stations during the 1971-2000 period compared to the other two periods.

FIGURE 4-2: Total Average Precipitation: Deviation of the 30-Year Average in Two Periods (1971-2000 and 1981-2010) from the 1961-1990 Period



Source: Hydrometeorological Service 2013

Annual reductions in precipitation are expressed most strongly at the meteorological stations in Prilep, Ohrid and Lazaropole. Changes in precipitation by months and by seasons vary. A higher decrease in precipitation across the country has been observed in spring. In all stations in autumn and in some stations in summer there is an increase in the precipitation in the two periods from 1971 to 2000 and from 1981 to 2010.

4.1.1.3.Extreme temperatures

This section presents analysis of extreme air temperature conditions recorded in the Republic of Macedonia, including the occurrence of heat waves and cold waves, tropical and summer days, and frost and ice days. Daily maximum and minimum air temperatures were taken from statistics from 11 main meteorological stations[10] for period from 1961 to 2012. Researchers paid special attention to Skopje, Stip and Bitola (as the most representative stations for the main climate regions) and at (Strumica, Demir Kapija and Gevgelija (as representative stations for the southeast region, the region most vulnerable to climate change).[11]

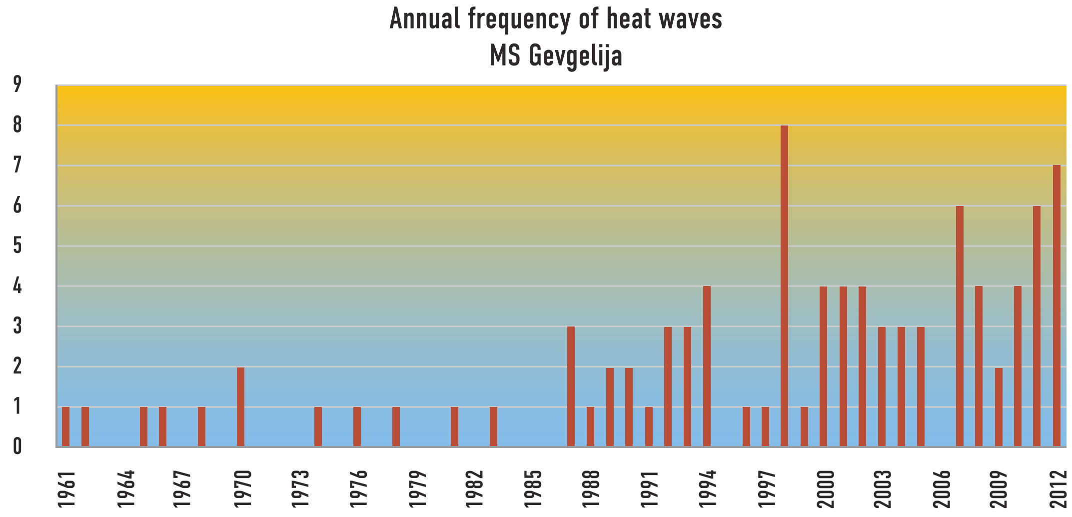
On the basis of maximum daily air temperature values, it was concluded that the frequency of heat waves decreases in correlation to the length of their duration, with the most frequently occurring heat waves being those of the shortest duration – i.e., no more than 6 days in succession.

Researchers also found that the total number of recorded waves was unevenly distributed over time. Increases in frequency were also observed in various cities; i.e. the frequency of heat waves increased from 1987 onwards. In contrast to the period 1961-1987, a heat wave is recorded almost every year starting in 1987. It can also be noted that the greatest frequency of heat waves has occurred in the last ten years, with maximum occurrences at the greatest number of stations in 2012 and 2007. Figure 4-3 shows an increase in the annual frequency of heat waves increases in the second half of the analysed period for the city of Gevgelija. During 2012, 10 heat waves were recorded in Kriva Palanka, 8 in Skopje, Stip, Lazaropole and Demir Kapija, 7 in Gevgelija and Berovo, 6 in Bitola, 5 in Strumica and Prilep and 3 in Ohrid.

[10] Skopje, Bitola, Prilep, Stip, Demir Kapija, Gevgelija, Strumica, Kriva Palanka, Berovo, Ohrid and Lazaropole.

[11] The analysis of heat waves and warm weather during this period was based on the following climate parameters: (1) Heat Wave Duration Index (HWDI): maximum duration of heat waves, interval of at least 6 successive days with Tx>Txavg+ 5°C; (2) The number of heat waves; (3) Monthly and annual frequency of heat waves; (4) Frequency of heat wave occurrences in the warm and cold parts of the year; (5) Summer days: days with a maximum air temperature of Tx >25°C; and (6) Tropical nights: days with minimum air temperature of Tn >20°C

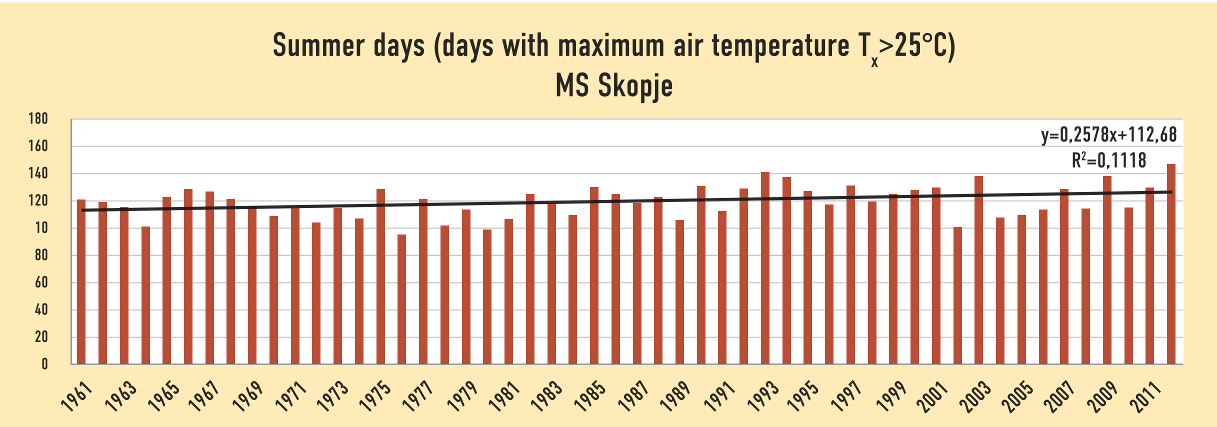
FIGURE 4-3: Annual Frequency of Heat waves in the Period 1961–2012

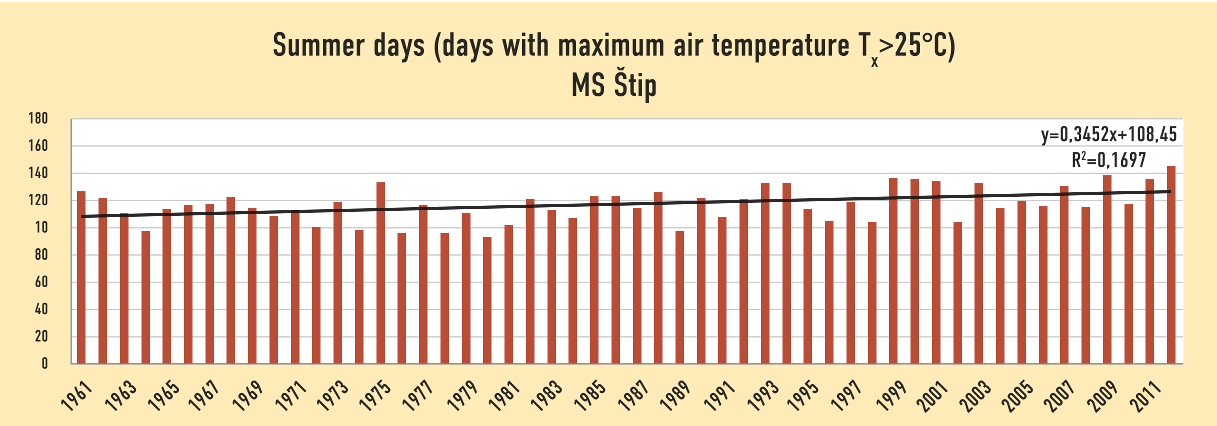


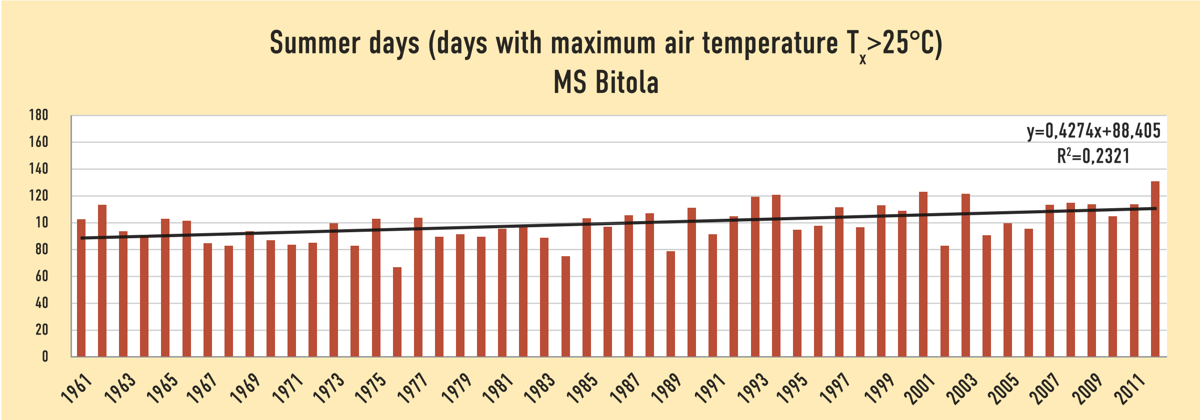
One characteristic of heat waves is a number of days with a maximum air temperature of Tx >25°C (summer days), as shown in Figure 4-4, which was developed with GIS-technology for the period 1971–2000. It can be seen that the greatest number of summer days occurred in the lower region of the River Vardar and the region of Gevgelija-Valandovo.

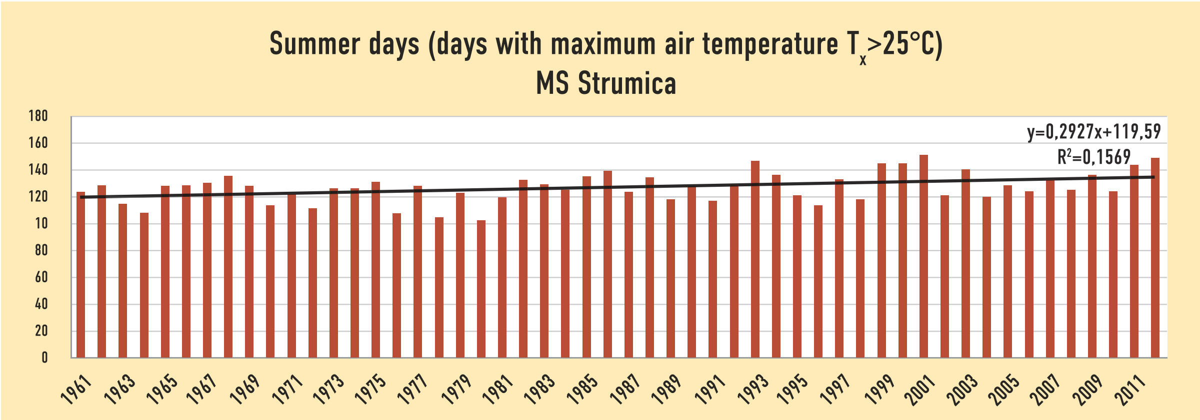
Figure 4-4 shows the number of summer days by years recorded at the five main meteorological stations for the period 1961 to 2012, illustrating that the number of summer days has significantly increased in recent years as compared to the number at the beginning of the analysed period. Similarly, there has been a significant increase in the number of tropical nights in recent years.

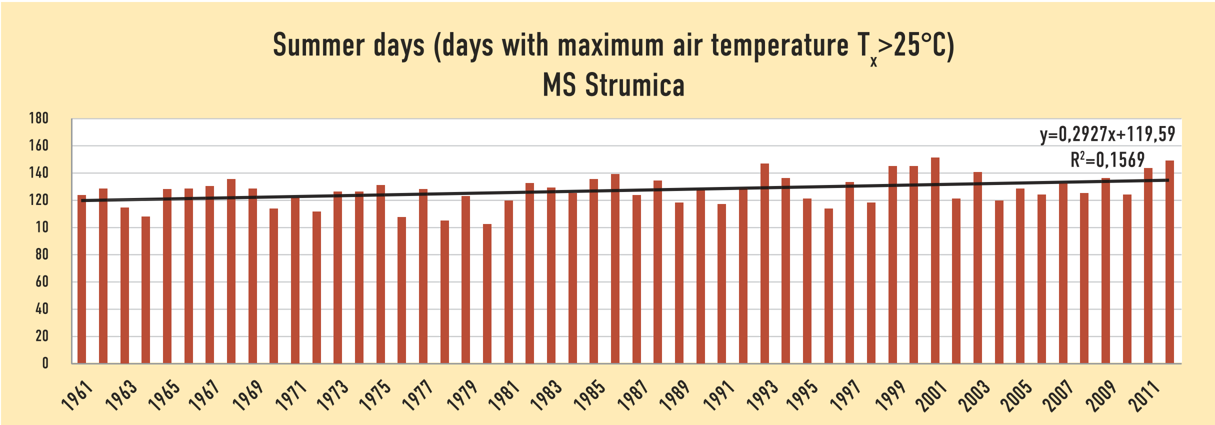
FIGURE 4-4: Summer days (days with a maximum air temperature of Tx >25°C) in Selected Areas for the period 1961–2012

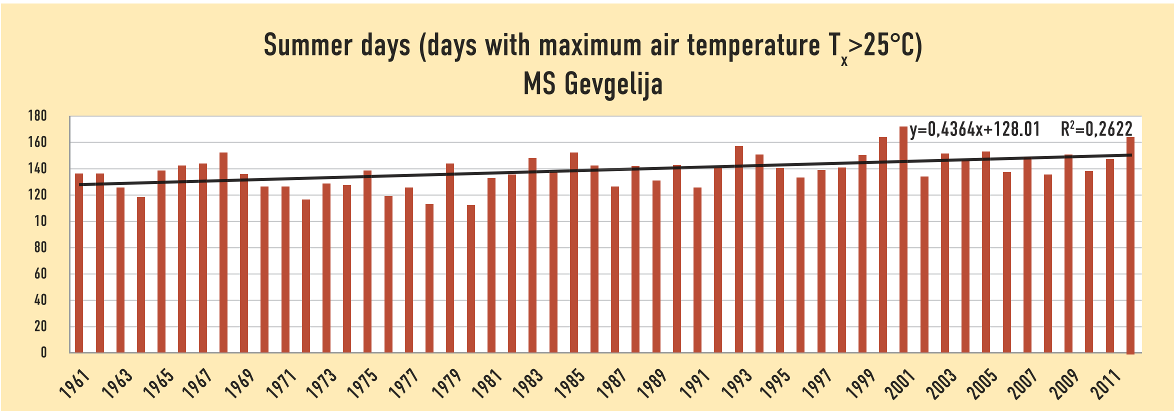












Source: Hydrometeorological Service 2013

Analysis of **cold waves and cold weather** was made based on statistical processing of daily minimum air temperature values for the period 1961–2012 from the eleven primary meteorological stations used in the analysis of heat waves.[12]

From the analysis, it can be concluded that cold waves occurred much less frequently than heat waves. For example, a total number of 27 cold waves were recorded in Skopje in the period 1961–2012, while 38 were recorded in Stip and 49 in Bitola, compared to a total number of 87 heat waves recorded in the same period in Skopje, 105 heat waves in Stip and 113 in Bitola.

The least average number of **frost days** on the territory of the Republic of Macedonia occurs along the river Vardar, where there are 20 to 60 frost days per year. The average number is 80 to 125 days on the highest mountain regions.

The average number of cold days on the territory of the Republic of Macedonia varies from 5 to 60 days, depending on height above sea level. Analysis of climate data showed a general trend of decline in the number of ice days per year; however, there was no general change in the number of annual frost days.

Absolute minimum air temperatures for the period 1961–2012 from 11 measuring sites on the territory of the Republic of Macedonia. The lowest air temperature was recorded on 7 January 1993, when the lowest air temperatures were recorded as follows: in Bitola -30.4°C, in Demir Kapija -23.2°C, in Berovo -27.4°C and in Strumica -27.3°C.

4.1.2. Climate change scenarios up to 2100

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=207

4.1.2.1.Introduction to the scenarios

The climate change projections developed for the Republic of Macedonia as a part of the preparation of the Third National Communication were carried out with the help of the MAGICC/ SCENGEN software package (Version 5.3.). In accordance with IPCC recommendations and findings from the Fourth Assessment Report (AR4), the projections have the following features: 1) no favoured ("best") scenario is adopted, with preference instead given to the application of several scenarios producing a spectrum of probable results rather than single values; the three most probable values (optimal and limit values) for climate sensitivity (2.0°C, 3.0°C and 4.5°C) were used; and scenarios were selected based on their validity for the region.

Six scenarios[13] were used in the process: A1B-AIM, A1FI-MI, A1T-MES, A2-AS, B1-IMA and B2-MES. Furthermore, an assessment of air temperature and precipitation changes has been made for the period 2025–2100, comparing these changes to those in the period 1961–1990, which was chosen as a point of reference. In accordance with the recommendations of the MAGICC/ SCENGEN software for removing inter-annual fluctuations and indeterminacies, the results obtained represent a mean state for the thirty-year period, with the central year selected to represent the period. (For example, 2025 is taken as representative of the period 2011–2040). Assessments were made for four characteristic years:

- 2025, the central year for the period 2011–2040;
- 2050, the central year for the period 2036–2065;
- 2075, the central year for the period 2061–2090;
- 2100, representing the central year for the period 2086–2100[14].

Data from 18 models were used in the estimation, generating complete results suitable for further use. Results were generated for two central points: A (41.25° N, 21.25° E) and B (41.25° N, 23.75° E). Data generated at point A are valid for the largest part of our territory while the data generated at point B are only valid for the eastern part. Scenarios were generated for the four characteristic years, for each central point, for each of the three values of climate sensitivity and for each of the six scenarios. Values were produced for air temperature and precipitation changes as follows: for twelve months from January to December and for four seasonal periods. The values obtained for changes in air temperature and precipitation for each year are averaged for the three values of climate sensitivity and for each scenario.

[12] Analysis was made on the basis of the following climate parameters: (1) The Cold Wave Duration Index (CWDI): (maximum length of cold wave with an interval of at least 6 successive days with Tn < Tnavg - 5°C); (2) Number of heat wave occurrences; (3) Monthly and annual frequency of cold wave occurrences; (4) Frost days: days with a minimum air temperature of Tn <0°C; (5) Ice days: days with a maximum air temperature of Tx <0°C

[13] Based on the IPCC Special Report on Emissions Scenarios (SRES) and AR4.

[14] Selecting 2100 for scenario generating involves a minor inconsistency: since the scenarios defined in SRES describe the state of GHG emissions up to 2100, the results for changes in air temperature and precipitation for 2100 would be representative of the period 2086–2100.

4.1.2.2.Findings – Air temperature

Table 4-2 shows the mean air temperature changes at central point A. All of the values presented are positive, meaning that an increase in air temperature is predicted in the period 2025–2100. Temperature changes are given below. The data indicate an increase in air temperature throughout the whole period 2025–2100. These changes are greatest in the summer period. The changes marked with “high” and “medium high” have the highest gradient of increase (for the period between 2025 and 2100). The changes marked with “low” are develop more moderately.

An examination of the highest, medium and lowest changes predicted for the mean monthly air temperature for central point A, per month and per year for 2025, 2050, 2075, and 2100 revealed the following:

- For all the selected years, all changes in air temperature are positive, meaning an increase in mean monthly temperatures.
- The intensity of changes is greatest in the warmest period of the year from May to October, when a significant difference appears in temperature changes between adjacent months.
- Inter-monthly changes in air temperature are more moderate in the coldest period of the year from November to April.
- In July there is a primary and in February a secondary (almost twice as small) maximum of changes.
- In April there is a primary and in December a secondary (almost twice as small) minimum of changes.
- The greater changes in temperature predicted in February in comparison to the changes in March and April indicate a possible levelling of the average monthly temperatures in this period.

An analysis of quarterly changes shown in the model for point A led to the following additional conclusions:

- It is probable that there will be a continuous increase in temperature in the period 2025– 2100.
- Compared with the period 1961–1990, the predicted changes for the period 2025-2100 will be most intense in the warmest period of the year. Thus summers will be warmer and warmer, and the rise in temperature greater. The air temperature is also expected to increase, though with less intensity, in the coldest period of the year.
- It is possible that the average monthly temperatures at the turn of winter into spring will be levelled in this period.

A similar process was used to determine results for central point B in order to describe changes in air temperature and precipitation in the easternmost part of the country. The analysis made for the results at point A were also valid for the results at point B, with the exception of minor differences in the change values. Although these differences between predicted air temperature changes at central point A and central point B appear slight, they range from -0.3°C to 0.2°C. The differences indicate the influence of local geographic situations on climate conditions and changes. Nevertheless, these differences are not so dramatic to require significantly different measures to be taken for adaptation to climate change and mitigation related to increased average air temperature in the future for points A and B. For the whole territory of the Republic of Macedonia, only the results generated from central point A (which is representative of almost three quarters of the country) could be used with a great certainty.

TABLE 4-2: Predicted changes in air temperature for central point A (41.25°N, 21.25°E) for the years 2025, 2050, 2075 and 2100, presented both separately for the four annual seasons and annually (Year/A)

	DJF /A				MAM /A				JJA /A				SON /A				Yeat/A			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
High	1.1	2.4	3.8	5.0	1.4	3.0	4.6	6.2	2.4	4.8	7.9	10.0	1.5	3.0	5.0	6.7	1.6	3.3	5.3	7.1
Medium high	0.9	1.9	3.0	3.9	1.1	2.4	3.6	4.8	1.9	3.8	6.2	8.2	1.2	2.4	3.9	5.2	1.3	2.6	4.2	5.5
Medium	0.8	1.5	2.2	2.7	1.0	1.8	2.7	3.3	1.7	3.0	4.6	5.8	1.1	1.9	3.0	3.7	1.2	2.0	3.1	3.9
Medium low	0.7	1.0	1.5	1.7	0.9	1.3	1.9	2.1	1.6	2.1	3.4	3.9	1.0	1.3	2.2	2.5	1.1	1.4	2.2	2.5
Low	0.5	0.8	1.1	1.1	0.7	0.9	1.4	1.4	1.2	1.5	2.4	2.7	0.7	1.0	1.6	1.8	0.8	1.0	1.6	1.7

DJF=winter, MAM=spring, JJA=summer, SON=autumn

TABLE 4-3: Overview of projected changes in precipitation at Central Point A for the 4 central years selected

	DJF /A				MAM /A				JJA /A				SON/A				Yeat/A			
	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100	2025	2050	2075	2100
Low	-1	-3	-2	-1	-2	-5	-7	-9	-4	-12	-29	-36	-1	-5	-8	-9	-2	-6	-8	-8
Medium low	-1	-4	-3	-2	-2	-6	-10	-12	-6	-15	-38	-47	-1	-7	-10	-13	-3	-8	-10	-12
Medium	-3	-6	-7	-9	-3	-8	-13	-17	-13	-25	-46	-57	-2	-9	-14	-20	-4	-10	-15	-19
Medium high	-4	-8	-11	-16	-4	-9	-17	-23	-20	-38	-54	-66	-4	-11	-21	-27	-5	-11	-21	-27
High	-5	-10	-14	-20	-5	-12	-21	-29	-25	-48	-68	-80	-5	-14	-25	-34	-6	-14	-25	-33

DJF=winter, MAM=spring, JJA=summer, SON=autumn

4.1.2.3. Findings - Precipitation

Table 4-3 indicates, all values are negative. This means that a decrease in precipitation is predicted in the period 2025–2100; in all seasons and at the annual level there is a decrease of precipitation quantities, with the maximum decrease in the summer season. The following conclusions can be drawn from the data:

- For all selected years, all precipitation changes are negative. (This means a decrease in mean precipitation sums.)
- In areas with high levels of change, there is only one insignificant increase in precipitation (1%) in February (in 2025).
- In the areas with low changes, there is an increase in precipitation in February for all years (up to 5%), in April (for 2025), and in July and November for 2025.
- In the areas of medium changes there is a slight (up to 3%) increase in precipitation for all years in February for 2025.
- The intensity of changes is greatest in the warm part of the year. In July and August, the intensity of changes may reach 100%, meaning these months will probably have no precipitation at all.
- In the cold period of the year, decreases in precipitation of up to 40% of the average monthly quantities are predicted.

An analysis of the data by season produced the following findings and conclusions:

- A decrease in average precipitation quantity.
- For all years (2025–2100) there is a maximum decrease in precipitation in summer (June, July and August).
- In summer, the precipitation decrease will be greater and faster than in other seasons.
- Decreases will be more moderate in the cold part of the year.
- It is probable that there will be a continuous decrease in the quantity of precipitation in the period 2025–2100.
- The predicted changes will be most intense in the warm part of the year, meaning summers will be drier and some summer months (July, August) may have no precipitation. (In the previous period with archived data, some months were also recorded as having had no precipitation.)
- A less intense decrease in precipitation is expected in the cold part of the year.

The results for Central Point B describe the change in the quantity of precipitation in the easternmost part of the Republic of Macedonia. The analysis carried out of results for Central Point A is also valid for results in Central Point B, with the exception of a slight difference in the changes. Although these differences are slight (less than 1%), the data indicate that there will probably be a greater decrease in precipitation in the parts of the territory covered by point A than in the easternmost part. In the other part of the year, the difference between changes in Central Point A and Central Point B range from +1% to -6%. This indicates a greater decrease in precipitation in the eastern parts of the country in the warmer part of the year, especially in summer (JJA), than in any other part of the territory. These differences are indicative of the influence of the local geographical situation on climate conditions and changes. However, they are not dramatic and generally do not require significantly different measures and activities to adapt to and mitigate climate change. This means that the results generated for Central Point A, which covers almost three quarters of the territory, could be used with great certainty for the whole territory of the Republic of Macedonia.

4.1.2.4.Summary Findings

In general, the characteristics of projected changes in air temperature and precipitation for the period of study were as follows:

- Changes are predicted throughout the whole 2025–2100 period, and an increase in temperature is probable.
- The temperature increase will be most intensive and significant in the summer, and the summers will probably be increasingly warmer.
- It is likely that the spring and summer temperature changes (and therefore the average seasonal air temperatures in the eastern part of the country) will be higher compared to the rest of the country.
- There will be a continual decrease in precipitation. The greatest changes, in the warm part of the year, will be perceptible at the seasonal and annual level. At the monthly level, a total lack of precipitation is probable in July and August, while in February there will be a minimal increase when compared with the average values; however, this increase will not be noticeable at the annual level.
- In the warm part of the year, the projected precipitation changes in the eastern part of the country are more severe than in the rest of the country.
- For reasons summarized in the sections above on temperature and precipitation findings, the results generated for Central Point A, which is representative of almost three quarters of the country, can be used with a fair amount of certainty for the whole territory of the Republic of Macedonia.

In accordance with the methodology of the study, involving averaging the results of six basic scenarios, the presented results should be taken only as guidance. The significance and influence of the absolute values for the temperature and precipitation changes, as well as the differences between these changes, will depend on the macro and micro locations of the regions taken into consideration.

In conclusion, the changes in climate projected (expressed as changes in air temperature and precipitation) develop gradually, and the results are significant over a longer period. The use of mathematical models, global climate models (GCMs) and regional climate models (RCMs), which are continually updated with new knowledge on atmosphere and climate and their relationship to human influences, enable ongoing improvement in projections of future climate conditions.

4.1.2.5.Comparison of findings with other projections

In order to examine the robustness of their findings, researchers also studied differences between the findings obtained and findings from three previous modelling efforts that produced projections for the Republic of Macedonia (Bergant 2006, SEEVCCC, and CSC 2012).

- The 2006 projections, which used a previous version of MAGIC/SCENGEN, showed differences in air temperature projections; however, the differences decreased in size from 17% in 2025 to 3% in 2100. The primary causes for these differences were determined to be the use of fewer GCMs and an area of higher resolution in the earlier version of the model.
- The SEEVCCC model provided relatively similar projections for the period up to 2025/2030, but there were greater differences for the period up to 2100 (scenario A2 was used for predictions for the period 2071–2100).
- According to the publicly issued results of the CSC, which used a regional climate model and scenario A1B, the change of average annual temperature in 2100 for one central point will be 3.8°C with a probable interval from 2.3°C to 6.3°C. According to MAGICC/SCENGEN v. 5.3, these changes will be around 3.9°C, in a probable interval from 1.7°C to 7.2°C for the whole territory. The similarity in the obtained results is notable.

The primary cause for the differences in the results is that of different principles of estimation of changes. SEEVCCC and CSC use a regional climate (mathematical) model and one climate scenario for each estimate. In MAGICC/SCENGEN, the prepared results from 18 models are used and final results are obtained by averaging. The basic IPCC recommendation is also taken into account, accepting that there is currently no single climate scenario that can be favoured, and thus an ensemble principle should be applied using result averaging.

4.2.SECTORAL VULNERABILITY AND ADAPTATION ANALYSES

The following section provides information and analysis of impacts, vulnerability and adaptive capacity and measures in the following sectors: agriculture and livestock, biodiversity, forestry, human health, tourism, cultural heritage, water resources, and socio-economic development. In several sections, research focused specifically on the Southeast (SE) Region of the Republic of Macedonia because it was identified in the First and Second National Communications as being especially vulnerable to climate change

BOX 4-1: THE SOUTHEAST REGION: AN OVERVIEW

The Southeast Region is located in the extreme southeast part of the Republic of Macedonia. The region covers 10.9% of the total land area of the country, with a total population of 177,416 (2002 Census) and a population density of 63.2 people per km^2. In 2011, the SE Region contributed 9.7 % of GDP in the country (the Skopje region contributes the largest share, with 42.4%, and the Northeast Region the smallest, with 5.5%. The SE region is just behind Skopje and Pelagonija regions in terms of per capita GDP. Compared with the average for the country as a whole, the Southeast region has a higher GDP per capita (with an index of 115.6). By comparison, the region with the lowest GDP per capita has an index of 47.3 (the Poloski Region). Compared with other regions in the country, the Southeast region has the highest rate of activity and employment (70.7% and 60.9%, respectively, in 2012), and the lowest unemployment rate of 13.8% (2012); however, at the same time it has nearly the lowest average salary.

The largest share of the economy in the SE Region is in the “Agriculture, Forestry and Fisheries” sector. In 2011, this sector comprised 33.2% of the regional economy (down from a high of 43.3% in 2005). In recent years, there has been a noticeable increase in tourism. In the period 2006-2011, accommodation capacity increased by 9.7%, and the number of beds by 2.5%. The number of tourists in 2011 was about 83 % higher than in 2006, and the number of nights spent increased by 40%. This increase was mostly due to the revitalization and recovery of Dojran Lake as a tourist destination.

According to the 2002 census, the SE Region has 49,695 individual households, of which 90.7% are comprised of families, 8.6 % are single-person households and 0.7% are non-family households with more than one member. The number of single-person households is 4,286, and they contain 2.5 % of the total population in the region. Average household size is 3.4 persons, which is slightly smaller than the national average of 3.6 persons. Within the region, average household size ranges from 3.2 in Gevgelia to 3.9 in Bosilovo. The highest percentage of family households (88.9%) consists of single families, while 11.1% are households consisting of two or more families. Within the single-family households, 7.4% are families consisting of one parent with a child/children (6.0 % with a female parent and 1.4 % with a male parent).

The population aged 65 years and over has increased in absolute terms and as a share of total population (from 8.3% in 1994 to 12.2% in 2011). The absolute number and relative share of working-age population (aged 15-64 years) has also increased (from 67.2% in 1994 to 71.1% in 2011). In the same period, the share of the population aged 0 to 14 years decreased from 24.3% to 16.7%, and the share of the population aged 0 to 6 years was 7.7 % in 2012. The percentage of population aged 0 to 6 years in municipalities ranges from 5.6% in Novo Selo to 9.4% in Vasilevo. Conversely, Vasilevo has the lowest share of people aged 65 and older (9.5%), and Novo Selo has the highest share (15.7%).

4.2.1.Water resources

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=259

Surface waters are the most important part of ecosystems in the Republic of Macedonia. Also, they are the most spatially diverse and are closest to the area of human activities. Due to the geographic location of the Republic of Macedonia, a major portion (84%) of surface water is domestic. The quantity of surface waters mainly depends on precipitation and snowmelt. Influenced by topographic, geological and morphological characteristics, runoff flows into a network of rivers, streams and lakes. Karstic areas are an exception, and water there is retained longer in the ground and recharges running waters in the river network. River basins and river basin districts are depicted in Figure 4-5 below.

FIGURE 4-5: River Basins and River Basin Districts in the Republic of Macedonia

Source: MOEPP 2010

The water potential of the country's four river basins depends on the precipitation regime. Average annual precipitation in Vardar River basin totals 700 mm, in the Strumica River basin 790 mm, and in the Crn Drim River 980 mm. Maximum precipitation levels (1,400 mm) are observed in the western part of the country, and minimum levels (380 mm) in the eastern part.

In the Republic of Macedonia, 4,414 springs with a total yield of 991.9 million m^3/year have been registered – of which 58 have a capacity of over 100 l/s. Only three of these springs are located in the central part of Vardar Plain, and all others are in the western region. The eastern part of the country is water-poor, and only seven springs with very small yields have been registered there. The number of tapped and captured springs totals 1,918, with a yield of 195.2 million m^3/year. Tapped springs are located along roads and are used for micro-scale water supply because of their low yield, while captured springs are used for large-scale water supply for cities and villages.

Three natural lakes, Ohrid, Prespa and Dojran, have also great significance for the hydrographic characteristics of the Republic of Macedonia. All three lakes are trans-boundary. The largest one is Ohrid Lake, has a total surface area of 358 km^2 (229.9 km^2 located in the Republic of Macedonia) and a maximum depth of 285 m. Prespa Lake, has a total surface area of 274 km^2 (176.8 km^2 in the country) and a maximum depth of 54 m. Ohrid and Prespa Lakes are naturally connected a network of underground karsts, and their waters flow through the Crn Drim River basin. The smallest lake is Dojran Lake (total surface area of 43 km^2 (27.4 km^2 in the Republic of Macedonia). There are also other lakes, which are of glacial origin, situated in the highest parts of the Shar Planina, Pelister, Jablanitza, Jakupica, Korab and Stogovo Mountains. In addition, 21 large and 120 small dams and reservoirs have been constructed in the country.

4.2.1.1. Climate change impacts on water resources

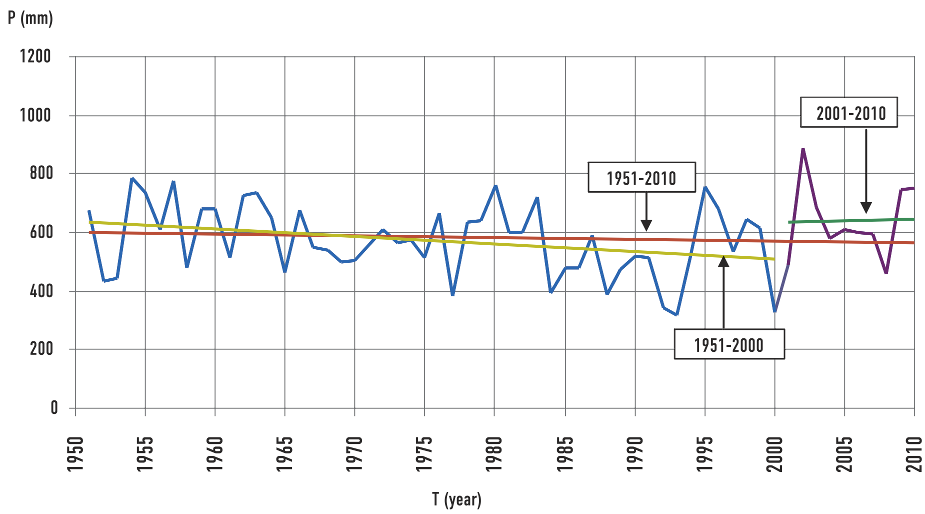
Water resources in the Republic of Macedonia are sensitive to climate change with regard to both quantity and quality. Total average precipitation is expected to decrease by 8% in 2075 and 13% in 2100. Reductions in available surface water for the Vardar River are estimated at 7.6% in 2025 and 18.2% in 2100 and for the Bregalnica River at 10% in 2025 and 23.8% in 2100. Groundwater recharge in the Vardar River Basin will decrease continuously, reaching approximately 57.6% of current recharge levels in 2100. In conclusion, overall water availability in the Republic of Macedonia is expected to decrease by 18% in 2100.

Trend analysis of time series data related to water quantity and quality is very important part in water management planning and procedures. This analysis is based on data collection and compilation of historical data such as rainfall, temperature, stream flow, stream water level, spring discharge, and groundwater level. In the FNC and SNC, the SE Region of the Republic of Macedonia was identified as the most vulnerable. Therefore, this part of the report related to time series data and statistical trend analysis is focused on that region. Time series data on basic parameters, air temperature and precipitation, for Strumica and Nov Dojran meteorological stations for the period 1951-2010 are collected and analysed (in the FNC and SNC, time series data were analysed for the period 1951-2000).

Air temperature data from Strumica show an increasing trend for the last decade 2001-2010 which resulted in an increasing trend line for the entire observed period 1951-2010. Projecting this trend to 2050, the estimated average air temperature is 12.88°C, which is almost the same as the long-term average temperature of 12.9°C, which was obtained for the period 1951-2010. Using the trend line for the period 1951-2000, the projected air temperature in 2050 is 11.22°C, which is below the long-term average temperature and is not a reliable estimation; it confirms the importance of long time series data. Only a one-decade extension of historical data changes statistical trends significantly. Trends of increased air temperature found in the utilised data at Nov Dojran show a continuous rise of the temperature in both periods the 1951-2000 and 1951-2010. The use of the regression equations obtained for the period 1951-2000 result in a projected temperature of 14.58°C in 2050, and for the extended period 1951- 2010, the projected air temperature in 2050 is estimated at 15.74°C, which is about an 8% increase compared to the long-term average temperature. On the basis of the temperature regime and statistical analysis, it can be concluded that the trend lines show significant temperature increases for both Strumica and Nov Dojran meteorological stations.

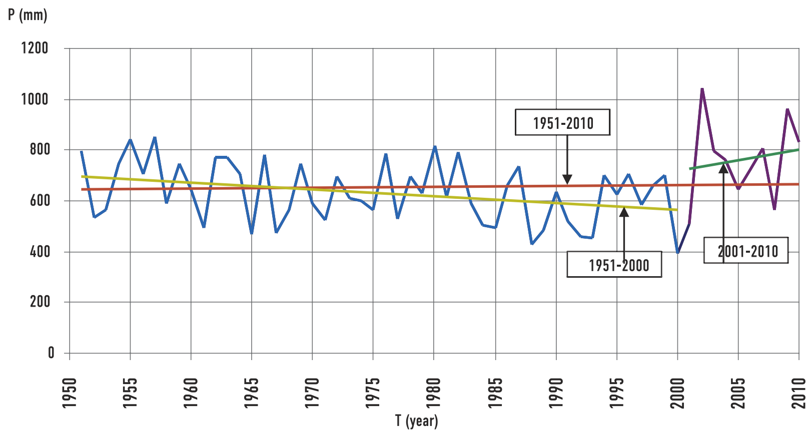
Analysing the **precipitation** regime by data at Strumica meteorological station it is observed increase of the annual precipitation sums for the last decade 2001-2010 which resulted in a less steep trend line for the period 1951-2010 (See Figure 4-6). Using the trend line for the period 1951-2000 the projected annual precipitation sum in 2050 is estimated at 376 mm which is much less than the long-term average precipitation sum. On the other hand, using the trend line obtained for the extended period 1951-2010, the projected annual precipitation sum in 2050 is 544 mm. The long-term average annual precipitation sum for the period 1951-2010 is 583 mm.

FIGURE 4-6: Precipitation trends for Strumica from 1950 to 2010



The records of the precipitation regime in the Dojran Lake region also show a significant increase of the annual precipitation over the last decade (see Figure 4-7). In 2002 it is recorded 1042 mm and in 2009, the total is 962 mm. Using the regression equation for the period 1951-2000 the projected annual precipitation sum in 2050 is 433 mm, and by trend line for the extended period 1951-2010 it is 678 mm while the long-term average precipitation sum is 654 mm. This convenient precipitation regime can be explained both by rather wet hydrological period in the country that started in 2000 and by regional redistribution of the precipitation.

FIGURE 4-7: Precipitation trends for Nov Dojran from 1950 to 2010



A similar approach to precipitation analysis was used in the Strumica Region, where it is estimated that total annual precipitation will decrease by about 7% in 2050 in reference to the long-term average sum for the observed period 1951-2010. For Nov Dojran, an increase of about 4% (not statistically significant) is predicted for the same period.

Finally, streamflow data were also analysed from two hydrological stations in the Strumica River basin (Suševo in the upper part of the watershed and Novo Selo in the lower part). Annual runoff data for the Vardar River were also collected and analysed for Skopje in the upper part and Gevgelija in the lower part.

The following concluding remarks can be made from the analysis of potential impacts:

- The period of systematic observations and measurements of 1951-2010 is a very short period for assessing the statistical trends on long-term basis.
- Recorded annual discharges (minimum, average, maximum) for the last decade (2001-2010) show an increasing trend for all hydrological stations analysed.
- Long-term trend lines for the period of study (1951-2010) have fewer gradients compared to trend lines for the period previously analysed (1951-2000).
- Annual average and maximum discharge rate trends show rapid increases in the last decade 2001-2010, especially the Strumica River at Suševo (see Figure 4-8).
- Characteristic minimum and average discharges for the Vardar River in Skopje show increasing trends over the past decade, but this trend does not have a statistically significant impact on the long-term trend (see Figure 4-9).
- Annual observed maximum discharges for the Vardar River in Skopje show a decreasing trend. The frequency of recorded flood peaks have shifted to lower magnitudes that can be explained by dams and reservoirs constructed upstream (Kozjak, St Petka and Matka on Treska River) and their corresponding retention capacities.
- For the Vardar River in Gevgelija, the use of the regression equation for the period 1951-2010, which defines 120.5 m^3/s average runoff in 2000 for the next 50 years, results in only 65 m^3/s, which is a decrease of approximately 50%.
- Maximum discharges have no significant changes in either short-term or long-term statistical trends.
- Statistical trend analysis of the recorded runoff indicates that the last decade can be recognized as a hydrological wet period.

FIGURE 4-8: Annual average discharge trends for the Strumica River at Suševo

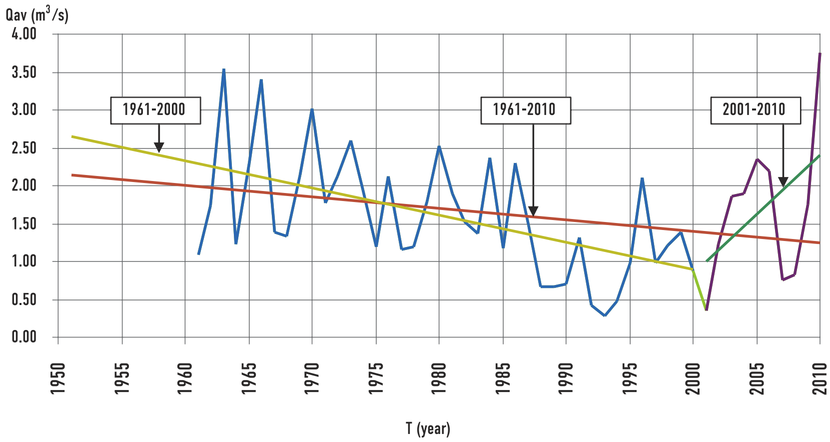
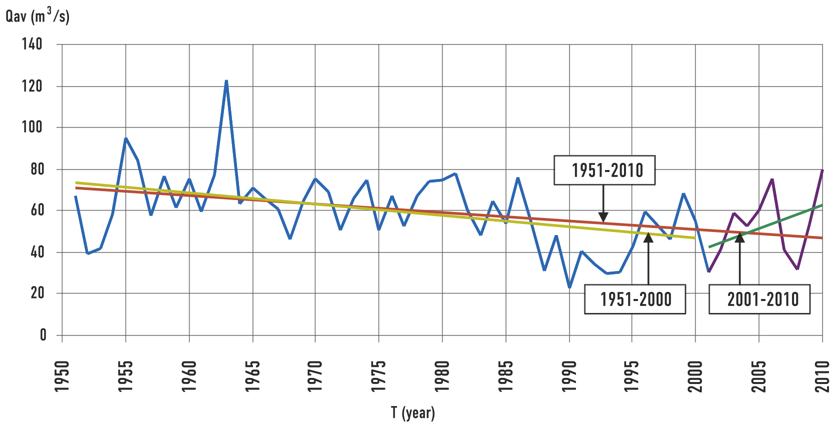


FIGURE 4-9: Annual average discharge trends for the Vardar River at Skopje



4.2.1.2. Vulnerability assessment for the Strumica River Basin

In the context of preparing the TNC, a vulnerability assessment was conducted for the Strumica River Basin. A water balance model was developed for the TNC that presents the current condition (2000/2010) year and projected condition (labelled 2025). Average monthly data for the period 1951-2010 were used as well as the projected changes in average air temperature and precipitation based on direct GCM output interpolated to geographic location of Macedonia.

BOX 4-2: THE STRUMICA RIVER BASIN

The Strumica River Basin is vulnerable region in both cases/scenarios, current condition and projected condition up to 2025. During the year, vulnerability is dependent on the season. There is no water shortage in the watershed in the January – May period, which falls outside of the irrigation season (see Figure 4-10).

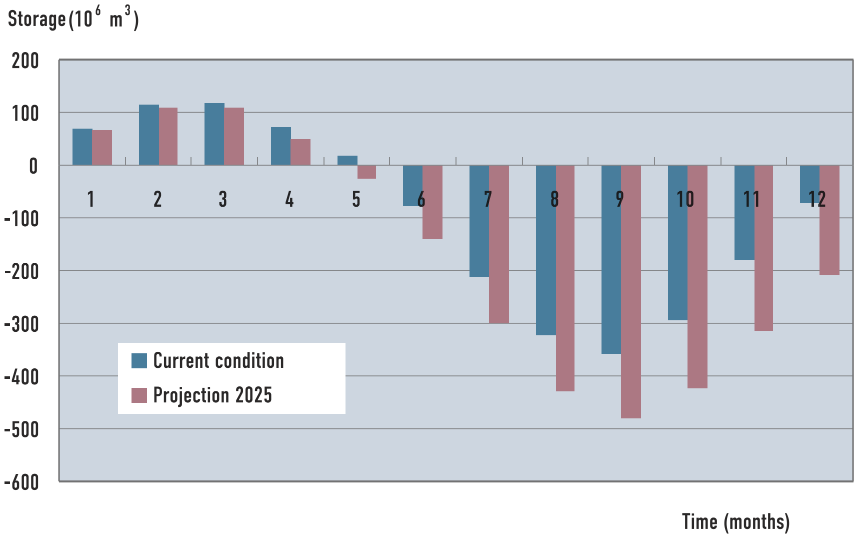
Evapotranspiration projection in the Strumica watershed is 706.8 mm, which is an increase of 29.8 mm (4.4%) from current average evapotranspiration (677 mm).

The projected outflow to 2025 from the watershed was obtained by using the runoff coefficient based on recorded runoff data at Novo Selo for the period 1961-2008. The average annual runoff at Novo Selo will decrease from 3.9 m^3/s to 3.7 m^3/s, or 5.1% based on outputs from the global climate model.

Estimates of current conditions show a maximum water shortage of about 360 million m^3 for September. Water shortages are observed in all months during the irrigation season (June to October). The average annual water shortage amounts to 257.47 million m^3.

According to projections of water demand up to 2025, a maximum monthly water shortage of 478 million m^3 is observed for September, which is about a 25% greater shortfall than under current conditions. Annual water shortages are projected at 388 million m^3, or an increase of about 34% in reference to the current condition (see Figure 4-10).

FIGURE 4-10: Water balance of the Strumica watershed under current conditions and projected to 2025 in each month



More reliable data in water balance modelling could be obtained if data on surface water and groundwater consumption in the watershed, especially in irrigation sector, are collected. Without these data the obtained and estimated water balance components may be taken as approximate and even overestimated considering the problems in irrigation and management practices and recent data on significant decrease of irrigated area on country level to only about 22,000 ha and in the Strumica watershed to about 2,000 ha. This situation with missing and/or unavailable data should be resolved by better management with the existing irrigation systems, better monitoring, and by mapping/inventory of the individual irrigation wells.

The assessment of regional vulnerability is necessarily qualitative due to uncertainties regarding the sensitivities and adaptability of natural and social systems. In a number of instances, quantitative estimates of impacts of climate change can be found. Such estimates are dependent upon the specific assumptions of future climate change, as well as upon the methods and models applied in the analyses. To interpret these estimates, it is important to have in mind that the uncertainties regarding the character, magnitude and rates of future climate change remain. These uncertainties impose limitations on the ability of scientists to project impacts of climate change, particularly at regional and smaller scales.

In summary, as in other countries, the water resources sector in the Republic of Macedonia is vulnerable to potential changes in climate because of increasing demands, the sensitivity of simple water management systems to fluctuations in precipitation and runoff, and the considerable time and expenses required to implement adaptation measures.

4.2.1.3. Adaptive capacity in the water sector (SE Region)

The following factors have been identified as barriers to strengthening adaptive capacity in the SE Region:

- Existing irrigation schemes are characterized by poor technical condition of the structures, facilities and equipment, high water losses, low efficiency, low capacity to respond to crop pattern changes, and a lack of flow regulation in delivery.
- Another problem, not only in the Strumica watershed but also at the country level, is the unregulated use of surface and groundwater. It is most feasible for farmers to use groundwater as a source for irrigation. There is also a lack of knowledge about the extent of groundwater irrigation, and there is an urgent need for mapping/inventory of existing irrigation wells.
- There are no reliable data on water consumed for irrigation. Most irrigation schemes do not have measuring devices at the level of intakes, river diversions or canal outlets.
- The price for irrigation water is defined by the area irrigated, *not* by the amount of water consumed. The percentage of non-payments ranges from 15% to 70%. These low collection rates contribute to the poor financial status of water utilities. Furthermore, the price of water per crop varies in different irrigation schemes and depends on the type of the system (gravity or pumping), climate, soil conditions, and other factors.
- Many irrigation systems are inefficient because they receive inadequate maintenance or even no maintenance at all.
- While the Water Law addresses irrigation, it is not being implemented effectively.

4.2.1.4. Adaptation measures in the water resources sector

At the national/regional level, priorities for adaptive measures include placing greater emphasis on integrated, cross-sectoral water resources management and using river basins as management units. Adaptation measures in water resources sector have been proposed in both the FNC and SNC. The priority measures consist of the following:

- Modernization of the hydro-meteorological network;
- Establishment of data monitoring, processing and availability;
- Rehabilitation and reconstruction of existing hydropower and water infrastructure; and
- The development and implementation of water management plans.

Adapting to increasing climate variability and change in Strumica River Basin may be obtained both by implementing technical and management measures and practices. Technical measures include rehabilitation of existing water supply systems as well as constructing reservoirs for runoff regulation. Better water management will require policy shifts and significant investments. Furthermore, adaptation planners should keep in mind that mitigation measures will affect the water sector in a number of ways (see IPCC 2008). Finally, there are a number of models which must be developed in order to effectively implement these adaptation measures (see Box 4-3).

At present, the following adaptation measures, listed by priority, are proposed for the water sector in the Republic of Macedonia:

- **Construction/modification of physical infrastructure:** Measures include canal linings, closed conduits instead of open channels, integrating separate reservoirs into a single system of reservoirs/hydropower plants/delivery systems; raising dam heights; removing sediment from reservoirs for more storage; inter-basin water transfers, and adaptive management of existing water supply systems.
- **Policy:** Change operating rules for reservoirs; use conjunctive surface/groundwater supply; physically integrate reservoir operation systems; coordinate supply/demand; and develop community-led options.
- **Water-saving measures**: introduce water-saving technologies; introduce domestic and municipal re-use of water; initiate leak repairs; introduce rainwater collection for non-potable uses; promote low-flow appliances.
- **Agricultural measures**: develop dual-supply systems (potable and non-potable); support timed irrigation and efficient drainage; encourage the use of wastewater effluent; promote high-value/low water use crops; disseminate drip and micro-spray irrigation technologies, low-energy, precision application irrigation systems.
- **Industrial measures:** Promote water re-use and recycling; introduce closed cycle and/or air cooling; disseminate more-efficient hydropower turbines; use cooling ponds, wet towers and dry towers.
- **Energy sector measures:** Introduce additional reservoirs and hydropower stations; support low head run for river hydropower; introduce market/price-driven transfers to other activities; use water pricing to shift water use between sectors
- Another group of measures may be proposed on flood-prone situation. Considering that flooding in Europe and in the Republic of Macedonia has become more frequent and more severe, the following measures in prevention and improving resilience can be proposed:
- **Preventive measures:** measures aiming at maintaining dam safety, afforestation and other disaster mitigation measures.
- **Structural measures to avoid mudflows:** construction of dikes; changes in the operation of reservoirs and lakes; changes in land use management; introduction of retention areas; and improved drainage possibilities.
- **Other structural measures:** temporary dams, building resilient housing, modifying transport infrastructure.
- **Urban planning measures:** restriction of urban development in flood risk zones; migration of people away from high-risk areas.
- Considering that Strumica River Basin is a trans-boundary basin it should also be noted that trans-boundary cooperation on adaptation could bring a number of benefits to all three countries that share this watershed. Trans-boundary cooperation could broaden the knowledge/information base, enlarge the set of measures available for prevention, preparedness and recovery, and thereby help to find better and more cost-effective solutions.

BOX 4-3: MODEL REQUIREMENTS FOR THE IMPLEMENTATION OF ADAPTATION MEASURES

Implementation of some adaptation measures requires the development of water resources models. There are three basic types of models: **hydraulic** (biophysical process models describing stream flow, flooding), **hydrologic** (rainfall-runoff processes), and **planning** (water resources system models). The questions that can be answered by these models are:

- Hydraulic Model

  a. How fast, deep is river flowing (flooding effects)?

  b. How do changes to flow and channel morphology impact the sediment transport and services provided (fish habitats, recreation, etc.)?

- Hydrology Model
  a. How does rainfall on a catchment translate into flow in a river?
  b. What pathways does water follow as it moves through a catchment?
  c. How does movement along these pathways impact the magnitude, timing, duration, and frequency of river flows, as well as water quality?

- Planning Model
  a. How should water be allocated to various uses in time of shortage?
  b. How can these operations be constrained to protect the services provided by the river?
  c. How should infrastructure in the system, for example dams, diversion works, be operated to achieve maximum economic, social, and ecological benefit?
  d. How will allocation, operations, and operating constraints change if new management strategies are introduced into the system?

4.2.2.Agriculture

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=260

The Republic of Macedonia has a diverse agricultural resource base, with the capacity to produce most continental crop and livestock products as well as many Mediterranean crops. The agriculture sector, including the value added in the processing industry, comprises 16% of country's GDP and provides employment to 36% of the workforce. However, official figures actually understate the importance of the agriculture sector, because they include only a fraction of the value of smallholders' outputs (which are sold at traditional farmers markets) and do not measure all family labour inputs, which are the dominant type of informal employment arrangements on family farms. The most recent national census recorded 192,675 family farms in a country of 2.1 million inhabitants. Given the fact that about 42% of country's population live in rural areas where off-farm employment opportunities are limited (and the active workforce unemployment rate can be as high as 32%), a more realistic conclusion would be that the agriculture sector is of critical importance for the wellbeing of about half of country's population.

Agriculture is also significant because of its influence on land use in the form of cropland and pastures; nearly 50% of the surface area of the country (1,121 thousand ha, State Statistical Office, 2010) is agricultural land, with forests constituting another 37% (981.8 thousand ha, State Statistical Office 2011).

Less than 10% of agricultural land is irrigated, and with the exception of the western parts of the country, water deficiencies occur in summer, resulting in significant moisture stress for summer and annual crops. In an average year, evapotranspiration is higher than rainfall, resulting in crop water deficits of approximately 250 mm in western areas and 450 mm in eastern areas.

The sensitivity of the agricultural sector to climate has important implications for the Republic of Macedonia. With a considerable proportion of the rural population dependent on agriculture for their livelihood, rural communities are particularly vulnerable to risks posed by changes that may occur as a result of climate change.

4.2.2.1. Vulnerability assessment

The 2009 report "Adapting to Climate Change in Europe and Central Asia" developed a series of indices to assess the exposure, sensitivity and adaptive capacity of selected countries to climate change. The vulnerability of the Republic of Macedonia, based on this index, was classified as "medium" compared to other countries in the region. In addition, this report identifies the Republic of Macedonia is among the five countries in the region that are most likely to experience increases in climate extremes by the end of 21st century.

In the two previous National Communications, vulnerability assessments were developed in the agriculture sector and appropriate adaptation measures and an action plan were proposed. The communications also identified most agricultural areas vulnerable to climate change in the country. These assessments were in turn used to determine the crops that will be most affected in each vulnerable area. Since 2008, comprehensive assessments have also been done in the agriculture sector that resulted in adaptation strategies and/or projects.

4.2.2.2. Impacts on crop yields

The negative effect of climate change impacts in the agriculture sector is increasing. Some analysis performed in the recent period suggested that under most likely climatic scenarios, agriculture will be most heavily affected. The agricultural sector as whole, and particularly small farms, will be exposed to prolonged heat waves, more severe droughts and floods. The climatic events in 2007/2008 and 2011/2012 with long dry periods and heat waves led to significant production losses.

Climate change is expected to reduce the yields of most crops. The Second National Communication to the UNFCCC estimates annual losses of ~EUR 30 million by 2025 due to reductions on yields for winter wheat, grapes, and alfalfa if there is no irrigation. The analysis performed within different studies shows that significant drops in crop yields can be expected without adaptation. These losses are projected to increase over time. Without adaptation, these climate change damages may become approximately the same or bigger than current net income jeopardizing the economic sustainability of farming in some areas. There are likely to be losses even for irrigated crops, although these losses are projected to be less than for non-irrigated crops.

It should be noted that both irrigated and rain-fed crops are expected to have higher water requirements due to increased crop water demands, driven by higher temperatures, and reduced soil moisture availability due to less precipitation and runoff. Water demands for the conversion of rain-fed crop areas to irrigation are expected to be further aggravated by reduced runoff, which will reduce the amount of potential reservoir storage available to irrigate crops, not to mention adding substantially to production costs as a result of new reservoir construction.

The preparation of the vulnerability assessment of the agricultural sector for the TNC is based on a new approach. In the FNC and SNC, the vulnerability assessments were performed using the following steps: 1) comparing two existing climatic datasets (1961-1990 and 1971-2000) to identify differences in key indicators affecting agriculture over time; and 2) spatial identification of the most vulnerable areas in the Republic of Macedonia. For the TNC, experts used models in order to simulate the basic climatic parameters for the period 1993-2057 centred on the year 2000. The main aim of these simulations was to predict future trends in basic climatic parameters (minimum and maximum air temperature, precipitation, solar radiation etc.). The data obtained were then used to analyse future trends in selected climatic indicators that have the most direct influence on agricultural production; e.g., average annual air temperature, average growing season air temperature, growing degree days, growing season length, average annual precipitation, average growing season precipitation, evapotranspiration, and the DeMarthone index of aridity and dryness.[15]

It should be noted that this analysis was targeted at the South East Region of the country, because in previous reports it was identified as a one of the most vulnerable regions to the negative impacts of climate change in agriculture, together with the central region. In addition to an analysis of the main climatic indicators and indexes for the period 1993- 2057, a spatial analysis was performed in order to assess the degree of vulnerability of the SE region and to compare its vulnerability to the other parts of the country.

The key findings from the analysis were as follows:

- Average air temperatures during the growing season are expected to gradually increase. This increase is visible for all sub-regions of the SE region. The average increase in growing season air temperature for the SE region is 0.14°C and 1.36°C for the periods 2000-2025 and 2000-2050, respectively. Average air temperatures in the SE region for those periods are higher than in other parts of the country by 1.08°C to 2.04°C.
- The growing period of all crop families with a base temperature of 5.6°C and higher will start earlier, and the growing stages will shift dramatically in time. In addition, the growing period will be prolonged.
- The average sum of growing degree days (GDD) for the SE region (3256.18) is much higher than the sum of GDD (2630.75) for the country as a whole, and the difference for the period 2000-2050 is 417.35 for the SE region and only 293.89 for the rest of the country. This means that the SE region is much more vulnerable than the rest of the country and we can expect more emphasized differences in plant development phases for the next 40-year period.
- Annual rainfall in the sub-regions analysed does not follow a definite pattern of increase or decrease. Generally speaking, it is very difficult to predict precipitation regimes due to the fact that there are several different precipitation regimes exist over a relatively small area 26,000 km^2. For instance, in Strumica Valley, there are two rainfall regimes: modified Mediterranean and mountainous.
- The main trend of the simulated yearly rainfalls is a decrease in the average total in all sub-regions in the period of 2000-2040 followed by a sudden increase up to the year 2050 that is similar to the trend in average annual temperature. Average rainfall in the SE region is lower than the average for the country as a whole by 94 to 185 mm, showing that the SE region is much more sensitive to the decreasing trend of annual rainfall in the period to 2050.
- In the SE region, model runs indicate a reduction in wheat yields of 21% between 2000 and 2025 and 25% between 2040 and 2050 (although it should be noted that CO_2 concentrations were not taken into account as a variable).
- Agro-management techniques were shown to have a positive impact on wheat yields in spite of climate threats. In the forecast scenarios for the SE region, delayed sowing of winter wheat (until mid to late November) in combination with sprinkler irrigation maximized the yield of winter wheat.
- Maize yields, assuming current farming practices, are projected to be significantly lower in the forthcoming period, decreasing by 56% in 2025 and by 86% in 2050. Note that this reduction is far greater than projections made in the SNC which estimated yield decrease of 25%.

[15] The modelling team used the Biophysical Model Applications (BioMA) framework developed by the Joint Research Centre of the European Commission, selecting two process-based models that simulate crop-soil interactions affected by weather and agricultural management: ClimIndices and CropSyst.

- The simulated use of agro-management techniques was found to have a positive effect on maize yields. Irrigation, regardless of the quantity, type, and water regime used resulted in increased projected maize yields in 2025 and in 2050. However, even with these interventions, yields would only reach 2000 levels in 2025. The average calculated yield in 2025 for all scenarios was 5,400 kg/ha, which was 35% higher than when using no irrigation. The highest yields resulting from an irrigation strategy using 6500 kg/ha in a sprinkler system delivered five times with an average delivery of 60 mm.

It can therefore be clearly stated that the SE region is highly vulnerable to the negative impacts of climate change in terms of increasing air temperature and that these changes will have serious impacts on agricultural production. At the same time, all scenarios with adaptation measures contributed towards increased yields and a reduction in the negative impacts of climate change compared with the baseline scenario. Compared with the baseline scenario, proposed scenarios can significantly contribute towards food security. Still, it is obvious that high yield scenarios are at the same time high water demanded scenarios. This requires serious approach in intensive planning of water resources, water balances and inter-sectoral interactions.

4.2.2.3. Economic impacts on agriculture

The economic analysis of impacts and vulnerability included the following: 1) an assessment of the economic feasibility of the baseline and modelling scenarios (with/without adaptation measures); 2) preparation of a cost-benefit analysis of the proposed measures for reducing negative impacts; 3) an assessment of the economic feasibility to upgrade and/or invest in measures proposed in the scenarios; and 4) calculation of the break-even point and sustainability of the proposed scenarios.

Various scenarios were developed involving different measures being taken – such as increasing planting depth, investing in irrigation sprinklers, and varying the volume and frequency of irrigation. The scenarios were also based on three different sets of assumptions: 1) Hypothesis 1 (presumes that farmers already have irrigation schemes and access to water, and additional costs would be limited to planting depth, loss fraction and extra irrigation water used; 2) Hypothesis 2 (presumes the need to invest in irrigation systems; additional costs would include those in Hypothesis 1 and yearly depreciation and maintenance of irrigation systems; and 3) Hypothesis 3 (presumes that water storage does not exist; additional costs are the same as in Hypothesis 2 plus invest costs for the construction of infrastructure). It should be noted that Hypothesis 3 is the most probable case given the low levels of irrigation of cereal crops (20% of total area) and the low prevalence of irrigation equipment (only 30% of farmers own this type of equipment). According to the Statistical Office of the Republic of Macedonia, around 70% of farmers have access to water. However, it is highly probable that farmers in the future will face water deficits. In order to satisfy the water need and to ensure timely and quality irrigations, investments in water collection systems will be necessary.

Conclusions on recommended measures for the crops were based on calculations assuming Hypothesis 3 – the worst case scenario – which presumes that the farmers must invest in water collecting and irrigation systems.

In the first analysis period, from 2015 to 2025, the proposed scenarios easily counterbalanced the negative climate change effects. The positive scenario results are derived predominantly from this period. In the second period from 2025 to 2050, the scenarios respond modestly to climate change challenges. Most of the scenarios in this period show negative financial results – even with adaptation interventions. In planning beyond the 2025 time horizon, it will be wise to take into consideration the potential to combine different scenarios, such as applying measures that show the best response to climate change effects up to 2025 and then applying other measures in the second period from 2025 to 2050.

The economic losses in all scenarios where adaptation measures were taken were lower than the losses from traditional production practices used in the business as usual (BAU) case assuming the Hypothesis 1 – which presumes that farmers do not need to invest in irrigation and water collecting systems. Based on this, it is certain that national support programme should be developed/continue for the implementation of climate change adaptation measures (especially for wheat and sunflower) in order crops production to achieve economic feasibility. Support can be provided in form of yields price subsides or support for implementation of adaptive measures, especially investment in water collecting and irrigation systems.

Conclusions for wheat

In the period (2015-2050), in the cost-benefit analyses for wheat, the scenario in which investments in sprinklers were made, planting depth was increased to 4 cm (instead of 3 cm), and irrigation of 60 mm took place twice per year yielded the most economically favourable outcome. Implementing the proposed agro-management practices from this scenario is expected to yield a yearly profit of EUR 127.86 per hectare up to 2025 and EUR 158.65 up to 2050, a pay-back period of as little as 15 years, a Net Present Value (NPV) of EUR 158 (assuming a 6% discount rate) and an Internal Rate of Return (IRR) of 6.42%.

Conclusions for maize

In the case of maize, the most favourable scenario in the period (2015-2050) involved a planting depth of 5 cm (which is the same as the BAU case), investments in sprinkler irrigation which would occur up to 5 times per year. Implementing these proposed agro-management practices would result in a yearly profit of EUR 534.54 per ha up to 2025 and EUR 95.99 up to 2050, had an 8-year payback period, an NPV of EUR 1.509 (using a 6% discount rate), and an IRR of 10.23%.

Conclusions for sunflower

The sunflower scenarios require subsidies in order to achieve economic feasibility. The sunflower has several scenarios with potential to become economically feasible. The most promising is the scenario which recommends extra planting depth of 5 cm instead of 4 cm and sprinkler irrigation 3 times per year with 50 mm of volume per irrigation. Implementing these proposed agro-management practices would result in a yearly profit of EUR 241.95 per ha up to 2025 and losses of EUR -87.57 up to 2050. Even though this scenario generates losses in second period, the losses are EUR 277.21 per hectare lower compared with the BAU case. In order to become sustainable, the increase of the sunflower selling price from EUR 0.49 to EUR 0.63 is necessary. Additionally, sustainability can be achieved by subsidizing investment in irrigation and water collecting systems. In any case, several sunflower scenarios show less negative results compared with the BAU case.

4.2.2.4. Adaptive capacity in agriculture

Adaptive capacity in the agricultural sector is low due to a variety of key factors: (a) small primary producers with low annual income and ability to implement adaptation measures which in some cases can be costly to implement; (b) small plots, which prevents effective implementation of adaptive measures; (c) insufficient financial support to the farmers to cope with the negative impacts of climate change; (d) low awareness among the key players about the climate change and its negative effects in agriculture; (e) weak networking and an insufficient level of cooperation between scientific institutions; (f) lack of effective extension service and farmer associations for implementing know-how; (g) lack modern production technologies and practices and a lack of dissemination of research results to potential users; (h) insufficient experience with implementing modern approaches in assessing impacts and projecting future effects and trends.

The FNC, the SNC and the recently-published Preliminary Impact Assessment and Adaptation Options Report (PIAAOR) all identify numerous shortcomings that impede the preparedness of the Republic of Macedonia to adapt to climate change. The PIAAOR contains numerous sector-specific priority actions for agriculture that have been determined in an exemplary participatory manner. Articles 49, 66 and 99 of the Law on Agriculture and Rural Development define the minimum criteria for agricultural areas and good agricultural practices, minimum criteria of the “least favoured areas” and criteria for financial support for farmers affected by natural disasters and unfavourable climatic conditions. In addition, according to the United Nations Development Assistance Framework (UNDAF) for 2010-2015, UN agencies will expand the implementation of joint programs and projects aimed at climate change adaptation, among other climate change-related topics.

There are also currently two projects launched in 2012 that are designed to improve adaptive capacity in agriculture; both are financed by the U.S. Agency for International Development (USAID). The first project, Adaptation to Climate Change in Agriculture aims to promote adaptive agricultural practices and increase the awareness of agricultural producers and in general public about the effects of the climate change in the agricultural sector. The second project, Municipal Climate Change Strategies, aims to identify and document the areas that have environmentally friendly systems of agricultural production but are very vulnerable to the negative impacts of climate change. The project will then propose measures such as agro-environmental payments to support the sustainability of these high-value systems.

4.2.2.5. Adaptation measures in agriculture

Exploring beneficial options to avoid or reduce negative effects of climate change is an imperative in climate-sensitive activities. The simulations presented above indicate that adjustment in sowing dates and depth as well as irrigation could produce substantially improved yields of wheat and maize in the SE region of the country under future climate change. Delaying the sowing date in the case of wheat or advancing the same practices for maize while using certain irrigation techniques would probably be the most appropriate responses to offset the negative effects of a potential increase in temperature through the year 2025. In addition, a preliminary analysis of the Strezevo irrigation area (Assessing the Economic Impact of Climate Change: National Case studies – AEICC) indicates that if water is not a limiting factor, adaptation through irrigation may be a cost-effective measure even without climate change. For other areas of the country, such estimations must be analysed on a case-by-case basis.

The period 2025 – 2050 will be critically important. Therefore, additional modelling studies should be made such as: modelling the effects of climate change (especially reduced precipitation) on yield in the presence of extra CO_2 and its effect on water consumption; determining what can be done to close the yield difference between high-yield and low-yield farmers; as well as introducing agro-management techniques that are likely to become available in the future. It is also highly recommended to replicate the approach of scenario development, modelling, and analysis for all regions in the country.

Based on the economic analysis conducted for this communication, it appears that maize crops can respond well to adaptation measures, while a national support program may be necessary for wheat and sunflower crops in order for those crops to be economically feasible under climate change scenarios. Support can be provided in form of yield price subsides or subsidies for investment in water collection and irrigation systems. It should be noted that some of the subsidies needed for water collecting systems under certain conditions can be easily returned by the extra taxes paid on the additional yield achieved.

Another facet of agricultural that might provide adaptive benefits is organic farming. There is a great deal of evidence confirming that organic farming systems are more energy, nutrient and water efficient that the conventional systems of agricultural production; "nutrient inputs of nitrogen, phosphate and potassium in the organic systems to be 34-51% lower than in non-organic systems, whereas average crop yields were only 20% lower over a period of 21 years" (Mader et al. 2002).

Most agriculture production in the Republic of Macedonia is rain-fed agriculture. Water for irrigation is a limiting factor that emphasizes the importance of water use efficiency. Introduction of more efficient rain-fed agricultural systems – e.g., organic farming in an increasing weather extremes caused by climate change – is a critical issue.

Organic farming system use water more efficiently due to better soil structure and higher levels of humus and other organic matter compounds. Due to the use of cover crops and intermediate crops, the soils in organic farming are better protected from direct solar radiation, which has a positive effect on transpiration, better conservation of soil moisture and decreased soil erosion. For these reasons and others, a great deal of effort has been made in supporting of organic farming in the Republic of Macedonia. The trend of increasing the total area that is organically farmed is visible and is mainly due to subsidies from the Ministry of Agriculture, Forestry and Water Economy (MAFWE) and through the increased interest of foreign markets in healthy food. However, it should be noted that there is a lack of a systematic approach in control of soil and water conditions used for organic farming, and there is also a lack of constant monitoring of the positive or negative influence of organic farming on natural conditions.

4.2.2.6. Livestock production

As a component of the preparation of the TNC, a case study was commissioned on the influence of the excessive heat on intensive production level in livestock. As indicated in the Second National Communication, heat stress decreases the productivity of domestic animals, especially modern highly-productive breeds (when compared with local breeds already adapted to the local environment). The study for the TNC was designed to focus on the vulnerability of intensive livestock production to excessive heat on a farm located in the most vulnerable regions in the country.

Livestock production contributes up to 40% of the total value of national agricultural production. The contribution of the different livestock products in total production consists of milk (57%), followed by pork (13.9%), beef (11.8%) and others; i.e. sheep and goats (6%). Livestock production is dominated by small individual family farms, which produce for household needs and offer some products at market. However, intensive production systems are major market suppliers in cow milk, pork and egg production; they are based on updated technology, highly productive breeds and improved feeding and housing management. In last decade, there has been rapid development in pig and poultry farms, which have adopted the latest technologies, resulting in high productivity.

In order to maintain a high level of production over the seasons, farms are forced to provide an optimal environment in terms of temperature, humidity and ventilation, required for particular technological process and biological status of the animals. Due to the mixture of influence of the continental and Mediterranean climate, producers are faced with cold winters and hot summer periods. Because intensive livestock farming incorporates controlled micro-environment buildings, facilities are constructed according to specific requirements, ensuring additional heating during the winter periods and additional ventilation in summer.

There is evidence of decreasing performance at livestock farms, particularly during the heat waves in 2007/2008 and 2011/2012. Hence, the objective of the case study was to analyse the influence of changing weather on intensive livestock production, and document this influence using scientifically sound methods.

For the study needs, the most suitable site was seen as a pig farm that fulfilled all selection criteria. Agria Group, in addition to having a feed factory, slaughter house, and butcher shops, is involved in pig breeding. The Agria pig farm is located in the village of Čicevo near the city of Gradsko in the central part of the Republic of Macedonia. The farm was constructed in the early 1980s with the concept "from the farrowing to finish," "all in - all out" with a projected production capacity of 30,000 finishing pigs per year.

The main focus of the case study is impact of temperatures, in particular maximum daily temperature that exceeds 25°C, because heat stress is the most relevant risk factor for intensive pig production. Although the environment is controlled and adapted to the physiological needs of the animals in all of the farm's facilities, it is still very much linked to outside weather/climate conditions. Physiologically, pigs can be more tolerant to lower temperatures than higher temperatures because while they are homeothermic animals and can maintain their body temperature, they have no ability to sweat. The cooling is done via excessive ventilation and through breathing, when water evaporation occurs. Cooling is therefore a particularly difficult challenge when the air temperature exceeds 30°C in combination with high air humidity, which hinders evaporation. Low temperatures in pig facilities are offset with heating devices, while high temperature is usually addressed with high air exchange through a ventilation system. Farms ventilate intensively on days when the outside temperature is higher than 25°C, because animals are also radiating heat and the indoor temperature is above optimal range. Heat stress is provoked in pigs when they are exposed to higher than optimal temperature for longer period. In case of adult pigs, heat stress occurs when the air temperature is 2-4°C higher than the optimum range.

For the needs of this case study, two separate databases (weather and production) were merged into a unique dataset. The data consisted of 24,828 farrowings that occurred between January 2006 and December 2012, involving 6,512 sows, including variables for numbers of total born and live born pigs, weaned pigs and duration of the period from weaning to conception (non-productive days).. The results from performance were combined with average occurrence of the unfavourable daily temperatures in order to calculate total productivity loss. In the economic analysis, losses were calculated on the basis of the percentages obtained from the statistical analysis combined with the occurrence of the heat exposure over 28°C as a percentage of the total annual period.

The study found that the yearly number of live born pigs is 2.14% less per litter when taking high temperatures into account. In case of weaned pigs, the annual loss is 1.7% per litter. Total annual loss in weaned pigs (including less live-born pigs and loss of weaned pigs) averaged ~198 out of 3540 pigs mating annually, due to exposure over 28°C. Higher temperature was also associated with prolonged conception of the sows. Sows that weaned in period when the temperature were above 28°C had a better ability to conceive, and hence a shorter period from weaning to conception by 11.34%. Sows that weaned in hot weather had increased non-productive days that totalled 1,563 sow-days on the farm. In this period, typical feed consumption is around 3.2 kg feed per day, and the farm uses 5 tonnes of feed annually for those sows. In conclusion, the economic losses were evident: lost net income due to the deaths of weaned pigs is 296,925 MKD (~EUR 4,800) annually and expenses for feeding non-productive sows for additional days is 90,003 MKD (~EUR 1,460). Total annual losses are 386,928 MKD (~EUR 6,260).

4.2.2.7. Adaptive measures for livestock breeding

Climate change scenarios project the occurrence of high seasonal temperature, heat waves and rapid weather change. In such cases it is realistic to expect that intensive animal production will face production losses in regions that are most vulnerable to climate change. At the national level there is limited knowledge and research on this issue that should be rapidly increased having in mind the importance of adaptation to climate change in this sector.

Adaptation options are as follows:

- **Genetically heat tolerant breeding animals**: Such a process has been started by breeding organizations world-wide, but the process is slow and the heat tolerance of the animals should be analysed in local conditions. In the case of the Republic of Macedonia and its specific climatic conditions, the genotype-environment interaction has to be studied and even better the specific genetic combination should be produced locally. Hence, a breeding programme aimed towards robust and high productive livestock is an adaptation measure with a long-term cumulative effect.
- **Adoption of special feed and feeding techniques in periods of excessive heat:** Due to the fact that in excessive heat the needs of the live animal is changed dramatically, the conventional feed compositions need to be upgraded to specific conditions of ambient and animal category. On the other hand the feeding techniques need to be changed in order to increase feed efficiency and their digestibility.
- **Better housing conditions by adopting proper ventilation, in-house conditioning and installation of cooling systems:** These adaptive measures need investment in installation and use energy – thus potentially having significant costs which must be accounted for in any cost-benefit calculation.
- **Introduce continuous monitoring of farm productivity that can then be correlated with heat waves and high temperatures to ensure precise loss calculations:** The results can be used in determining threshold loss levels in order to find the balancing point between potential losses and investments to reduce risk.
- **Continuous measurement of GHG emissions** from day-to-day operations and introduction of energy efficiency measures for farms can help can result in green labelling for production that could assist with marketing. This type of system should be established on a voluntary basis and should reflect the real cost of green production, including costs for investments and waste treatment.

Clear economic calculations are needed in order to determine threshold when is the most appropriate time to invest in the farm. Incentive measures (governmental or otherwise) can boost implementation of adaptation measures in order to decrease losses due to global warming.

It should be noted that at the case study farm, management has noticed the negative effects caused by the increased temperatures during the summer period (especially during heat waves) and introduced adaptation measures in order to reduce some of the losses (such as improving the energy efficiency of the farm). So far, the thermal insulation of the farm has been improved, low pressure sprinklers were installed in some of finishing compartments (with limited efficiency, due to temperatures higher than 30° C), a chiller was installed in the boar compartment and latest (in 2013) high pressure sprinklers were installed in gestation room.

4.2.2.8. Viticultire

Viticulture is one of the most important sectors of Macedonian agriculture with wine being a significant export commodity. Viticulture and wine production comprise 17-20% of agricultural GDP. Wine, after tobacco is the second most important product related to the export value of agricultural commodities in the country. Most vineyards are situated in Povardarski and South East Planning region. The cultivated varieties and the overall wine style that a region produces is a direct result of the average climatic conditions, while climate variability determines vintage quality differences. Changes in climate which influence both variability and average conditions have the potential to impact growth, grape composition, wine style and spatial distribution of grapevines. Without adaptive measures which will mitigate the changes caused by climatic influences, many of the regions where quality grapes are grown will be abandoned or reoriented to other types of farming.

For the TNC, a number of simulations based on climate models were run to assess the vulnerability and potential adaptation measures for viticulture. From the simulations the following can be concluded:

- The expected increase of average temperatures from now until 2050 during the growing season can have a serious impact on agricultural in Povardarski Region, since the majority of the area is under intensive agriculture production: viticulture and orchards.
- The Growing Season Length in the Povardarski part of Macedonia is expected to be shortened for max 30 days.
- The average sum of Growing Day Degrees (GDD) for the Povardarski Region is expected to be 3,023°C which is approximately 400°C higher than the whole country (2,631). This leads to the conclusion that the Povardarski Region is much more vulnerable than the rest of the country and we can expect more emphasized differences in plant development phases for the next 40-year period.
- The total projected change of evapotranspiration rates for the period 2000-2050 is not very significant though this change is projected to become more pronounced for the period 2025-2050 (a 14% increase).
- Without irrigation, it is expected that there will be a drop in production of both table grapes and wine grapes.

TABLE 4-4: Projected yields of grapes due to climate change without irrigation

Year	Table grapes projected yield (tonnes/ha)	Wine grapes projected yield (tonnes/ha)
2000	26	12
2025	25	11
2050	24	10

An analysis of the potential impact of adaptation measures was also carried out with the following results:

Related to irrigation:

- With furrow irrigation, the average table grape yield is projected to be approximately 30 t/ha – there are no differences in yields between the years (periods) of investigation (2000-2025, 2025-2050). For the yield of wine grapes the average yield is projected to be approximately 14 t/ha, also without differences in yields between years (periods) of investigation.
- With drip irrigation, the average table grape yield is projected to be approximately 32 t/ha. The yield of table grapes is almost same regardless of the quantity of water used for both scenarios (160 and 120mm). If compared with the no-irrigation scenario the increasing of yield is approximately 22% for 2025 and 26% for 2050. The same conclusion (an increased yield) applies to wine grapes.
- This may lead to the conclusion that despite the increase in temperature which is real and should be expected, proper irrigation will ameliorate the effects of high temperatures and will contribute to increased production. The quality of the grapes was not the subject of this study.

Related to the use of UV nets:

- UV nets completely change the microclimate in the vineyards by decreasing the temperature of the air and on the grapes, preventing the occurrence of diseases caused by precipitation, and removing the risk from hail events as well. Without UV nets, the yield of table grapes was projected to be around of 30 t/ha with a slight change in the timing of the beginning of maturation. In the case of wine grapes the projected yields without UV nets was 14 t/ha, with minimal differences of the beginning of maturation.
- When simulations utilised UV nets that decreased the temperature by 2°C, the yield of table grapes in all three periods of investigation was between 32 and 33 t/ha (2 to 3 t/ha higher than without UV nets), while the period of beginning of maturation occurred later (7 – 10 days). For wine grapes the yield in all three periods of investigation was above 14 t/ha, while the period of beginning of maturation started later, between 22 and 29 of July.
- For the simulation utilising UV nets that decreased the temperature by 5°C, the yield of table grapes was around 30 t/ha with later beginning of the period of maturation. For wine grapes it was noticed that the beginning of maturation was similar between the different scenarios. The achieved yield was on the level of 14 t/ha. Thus, the bigger shading and lower temperature do not lead to the higher yield.
- Comparing the situation when the UV Net is not used and when it is used as adaptive measures with purpose to ameliorate the

impacts of climate change, we may conclude that the UV Net (to the certain level of shading which will cause certain decrease of the temperature) has a positive effect to the yields of both table grapes and wine grapes.

- The change of altitude to a certain level results in a projected significant impact on the yield and time of maturity of table grapes. The increase of altitude is projected to cause a delay in the maturation of the grapes for 15 days. An increase of altitude by an extra 250 m caused the highest projected yield. Increase of altitude for an extra 500 m compared to the common altitude will reduce the yield and will delay time of ripening.

4.2.3. Biodiversity

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=255

Biological diversity is constantly exposed to the climate change impacts, and it reacts according to its own adaptation capacity. The Republic of Macedonia has a specific geographic position on Balkan Peninsula where different climatic influences (continental and Mediterranean) on a small area in separate parts of the country intertwine. In combination with other ecological and historic factors they have led to development of a specific and very rich biological diversity. Beside its intrinsic value, biodiversity in the country has other values, especially economic, and it provides a lot of goods and services.

4.2.3.1.Climate change impacts on biodiversity

Climate change impacts on biodiversity can be analysed using different approaches on many different levels. One of the basic levels is assessing the climate change impact on particular plant or animal species – future distribution and shifts in range, population size and trends, aspects of ecophysiology, etc. The next level in ecological hierarchical system is the community level, which should be assessed from the aspects of species composition and dominance, alpha and gamma diversity etc. The ecosystem level has an infinite number of processes, conditions and forms to be assessed according to the climate change impact. The FNC and SNC identified *refugia*[16] and regions as susceptible to climate change impacts and vulnerable to varying degrees and in need of tailor-made approaches. Another significant threat to the biodiversity in the country in relation to climate warming and predicted drop of precipitation is the danger of disappearing of vegetation and species in the refugia and in the high mountain belt (SNC 2008). These refugia are very important for biodiversity in the Republic of Macedonia due to the extraordinary species richness, especially endemic and relict species, which have found shelter there as a response to the climate changes in the former epochs.

Assessments for the TNC are mostly based on habitat and species modelling, but expert judgment was also an important approach due to the lack of data and continual monitoring of biodiversity components. All available data on climate parameters were taken into consideration in the assessment. Malcolm et al. (1998) have presented a comprehensive manual of the groups of methods to be used on different ecological levels in terms of biodiversity impacts assessment. This guideline was followed to structure the presentation of the existing methods for species, communities, ecosystems, wildlife refuges, biomes and landscapes.

There are 18 habitats and 58 plant species that were identified as vulnerable to climate change. An overview of the vulnerability of plant species shown on the bases of different vegetation belts is given below.

- **Lowland belt.** Various impacts are possible – decrease of humidity in the habitat, increase of temperature, drying of habitats etc. The following species are considered the most vulnerable: *Thymus oehmianus, Ramonda nathaliae, Ramonda serbica, Adianthum capillus-veneris*, *Drosera rotundifolia, Blackstonia perfoliata, Cladium mariscus, Carex elata, Marsilea quadrifolia, Salvinia natans*.
- **Mountain belt.** The increase of temperatures will lead to shorter snow pack lasting on the mountains, which are without a typical alpine belt (below 2,300 m above sea level - Galichica, Bistra, Jablanica and others). Changed ecological conditions in the sub-alpine region will affect the species that grow around the melting snow patches. Such species are Macedonian high mountain local endemic floristic species: - *Crocus cvijici* (Galichica), *Colchicum pieperianum* (Bistra), *Fritillaria macedonica* (Jablanica) and others: *Ranunculus degenii, Saxifraga stellaris* subsp. *alpigena, Sphagnum spp., Crocus scardicus, Crocus pelistericus, Trollius europaeus, Salix retusa, Salix reticulata, Salix herbacea, Salix alpina, Rhododendron myrthifolium, Pedicularis ferdinandi, Rhododendron ferrugineum, Empetrum nigrum, Loiseleuria procumbens, Dryas octopetala, Listera cordata* (due to the spruce forest decline and dye back); *Ranunculus degenii* on Shar Planina Mt., *Silene pusilla*, *Sphagnum* species (water capture).
- **Dojran Lake.** These changes particularly affect the Common reed (*Phragmites australis*) zone and other aquatic macrophytic vegetation (ass. *Myriophyllo-Nupharetum* is completely extinct). Vulnerable plant species are: *Nuphar lutea, Nymphaea alba, and Salvinia natans*.
- **Prespa Lake.** Endangered plant species are: *Aldrovanda vesiculosa*, *Salvinia natans* and *Trapa natans*.
- **Ohrid Lake.** Endangered plant species are: *Carex elata*, *Senecio paludosus*, *Ranunculus lingua.*

[16] *Refugium/ Refugia* is a bio-geographical term that refers to areas that served as refuges for plants and animals during former periods of climate change

The most vulnerable animal species of the Republic of Macedonia to climate change impacts were already identified in the FNC and SNC. Both of these reports focus on the species connected to the refugia, species in mountain ecosystems, especially those associated to mountainous wetlands (glacial lakes, mountain streams), natural lakes, and lowland wetlands. However, a number of vulnerable species were identified additionally in this report based on their ecology, present population size and distribution. A total of 224 vulnerable animal species are presented in the study on the biodiversity sector.

It should be noted that the impact of the climate change on the phenology of species has not been studied in the Republic of Macedonia, although such activities could be very important as an indicator of the changes induced by climate change. Phenology can be easily observed, at least in some species and this should be reflected in the Action Plan for Climate Change Adaptation for the country. Such an activity can be well used for communication with the wider public as well.

Studying and monitoring of phenological changes can easily be integrated into a national biodiversity monitoring system, but unfortunately the monitoring system in the Republic of Macedonia does not track phenological changes. The only related activity is irregular/incomplete monitoring of some migratory bird species. Recently, the arrival of certain bird species (swallows, storks) in the Republic of Macedonia began to be tracked, but the time series is too short to be used for robust analysis (Velevski, pers. comm).

4.2.3.2.Vulnerability in protected areas

A specific problem for the Republic of Macedonia is that the existing protected area system is still not harmonized with existing legislation. The Law on Nature Protection stipulates that harmonization and re-proclamation of all protected areas must be completed within a six-year period (starting in 2004). Little has been done to date. Additionally, for some categories it is not clear what the management objectives are (or why were they designated), and it is not easy to ascribe some of the categories in force to existing protected areas. The process is led by the Nature Sector, which was established within the Environment Administration in the Ministry of Environment and Physical Planning, but it is proceeding very slowly and has no priority plan. Most of the existing protected area categories will definitely serve as a backbone for the future Natura 2000 Network (Habitats Directive requirement). They will also serve as core areas in the future National Ecological Network (which is also mandated by law). The results of an analysis of the representativeness of habitats in the national protected areas system are shown in the biodiversity study.

FIGURE 4-11: Map of areas in the Republic of Macedonia that are sensitive to climate change

Source: Brajanoska et al. 2011.

4.2.3.3. Modelling vulnerability of biodiversity to climate change

MaxEnt[17] software was used to predict the possible changes in distribution of selected communities, plant and animal species. The model was developed using current distribution data, 19 climatic variables representing the current and future climate (http://www.worldclim.org/bioclim) (Hijmans et al. 2005) and variables defining the elevation, aspect, and slope of the terrain. For the modeling purposes three species (plants *Crocus cvijicii* and *Pedicularis ferdinandi*, and insect species *Trechus goeblii matchai*) and two plant communities (*xero-termophilous* Kermes oak scrub and sub-alpine mountain pine shrub land) were selected.

The assessment was performed using the **A1B scenario** from Special Report on Emissions Scenarios (SRES) published by IPCC in 2000 (IPCC 2000). This scenario assumes a market-oriented world with relatively rapid per capita economic growth. The scenario envisages world population maximum in 2050 followed by a decline. It is a rather pessimistic scenario but less pessimistic than the A2 and A1FI scenarios.

Selected findings and conclusions are summarized below:

Plant species

- Mountain pine community (*Pinus mugo*) on Jakupica Mtn. – A considerable shrink and vertical shift might be expected in 2050 while in 2100 it will completely disappear from Jakupica Mt.
- *Pedicularis ferdinandi* on Jakupica Mtn. – The modelling in the TNC showed that climate conditions in 50 years will not be suitable for this plant species even on the highest part of the peak Solunska Glava.
- *Crocus cvijicii* on Galichica Mtn. – It was expected that changes similar to the case of *Pedicularis ferdinandi* on Solunska Glava would occur. However, the modelling exercise showed that after significant decrease of the distribution range of *Crocus cvijicii* in 50 years, there will be expansion of its range in 100 years.
- Changes in *Quercus coccifera* community distribution is very interesting and opposite of what we thought before. The model predict shift in distribution range towards the east Macedonian mountain while the experts expected shift towards north, along the Vardar valley.

Animal species

- *Trechus goebli* on Jakupica Mtn. – This was the only animal species that was modelled in MaxEnt. A significant shrink of the distribution areas is expected in 2050 according to the model - suitable conditions for its survival will be matched only on the top of the Solunska Glava peak. In 2100 the species will disappear completely.
- Vertical shifts in the distribution range can be expected for a number of animal species (e..g the Balkan snow vole (*Dinaromys bogdanovi*), the bird Syrian woodpecker (*Dendrocopus syriacus*), the ground beetle *Trechus goebli* and *Paradeltomerus paradoxus*.
- A number of species can be observed to have expected horizontal shifts in distribution range: *Testudo graeca* (Greek tortoise), *Coluber najadum* (Dahli's whipsnake), *Burrhinus oedicnemus* (Eurasian Stone-curlew), *Buteo rufinus* (Long-legged Buzzard), *Podarcis taurica* (Balkan wall lizard), *Vormela peregusna* (Marbled polecat). Most of these species are connected to the sub-Mediterranean forest and shrub land communities of the Querco-Carpinetum orientalis zone (*Testudo graeca, Coluber najadum, Buteo rufinus* and *Vormela peregusna*). The shifts of the natural vegetation and changes of communities' composition will affect the distribution and population status of these animals. *Burrhinus oedicnemus* and *Podarcis taurica* are species of open habitats (steppe like habitats) and their distribution expansion might be expected.
- For monitoring of changes in the phenology different species can be monitored: *Montifringilla nivalis* (White-winged Snowfinch) is expected to change its reproductive cycle – earlier mating and nesting. The changes in the phenology of this species will probably correspond to the snow cover duration in the high mountain zones. *Hirundo rustica* (Barn swallow), *Delichon urbica* (House martin), *Neophron percnopterus* (Egyptian vulture) and *Ciconia ciconia* (White stork) are species easy to monitor from the aspect of their migration (spring arrival and autumn departure dates) and changes in the reproduction biology (mating, nesting, reproduction success).
- Species connected to lowland wetlands: *Vanellus vanellus* (Northern Lapwing), *Triturus vulgaris* (Smooth newt), *Rana balcanica* (Balkan water frog), *Diacyclops pelagonicus* and *Lycaena dispar*. These species are sensitive to lowland wetlands hydrology which is expected to be disturbed significantly due to the climate change.

4.2.3.4.Identified constraints and gaps

The following constraints and gaps in addressing climate change threats to biodiversity were identified for the Republic of Macedonia:

1. Lack of data for precise distribution of different species, population density and abundance; Vegetational map – communities and habitats; Insufficient definition of biogeographical characteristics of Macedonian territory;
2. Lack of data on vulnerable biodiversity components to climate change;

[17] MaxEnt is a maximum entropy-based machine learning program found to perform best among many different modelling methods (Elith et al. 2006; Ortega-Huerta & Peterson 2008; Kumar & Stohlgren 2009). MaxEnt uses presence points to define species distributions based on simple functions related to each climate variable (Phillips et al. 2006).

3. A monitoring system of climate change impacts on biodiversity does not exist;
4. *Ex situ* conservation of wild species threatened by the climate change does not exist;
5. The spatial plan does not consider consequences of climate change to biodiversity;
6. Problem of periodic natural and induced hydrological fluctuations; Water extraction is not regulated;
7. Impact of climate change on mountain ecosystems has not been assessed;
8. Protected areas system was not established to cope with climate change impacts;
9. Lack of good intersectoral cooperation;
10. Insufficient capacities (human and knowledge);
11. Lack of awareness about climate change impact on biodiversity; and
12. Lack of financial mechanisms.

Of the actions proposed in the Action Plan within the SNC, only seven were partially or fully implemented (most of them within the reports commissioned for the Third National Communication). The MAK-NEN project (Establishment of Macedonian Ecological Network) resulted in partial completion of two actions regarding the ecological network. However, the MAK-NEN project focused primarily on brown bears and only briefly touched on species in steppe regions and riparian species. The identification of bio-corridors, core areas, restoration areas and buffer zones for these species and habitats is still pending.

4.2.3.5. Adaptation measures in biodiversity

A revised action plan for climate change adaptation in the biodiversity sector was prepared in a similar way to the preparation of the action plan provided in the SNC. Strategic planning was based on simple list of identified problems that prevent the achievement of one, overarching goal: **to prevent excessive loss of biodiversity in the Republic of Macedonia during this century due to the climate change impacts**.

The SNC contained several actions aiming at collection of data on biodiversity in relation to climate change. However, some of these activities were partially fulfilled within the frame of the National Biodiversity Strategy (2004) or most probably will be part of the new national biodiversity strategy, which is under preparation. Thus, the activities concerning basic data collection were modified in order to reflect better the needs for data on species and ecosystems, but in relation to climate change. The revised action plan for the biodiversity sector is provided in Annex 2.

4.2.4.Forestry

This section is a summary of a report developed for the TNC. The full report is available at:
http://www.unfccc.org.mk/Default.aspx?LCID=254

Forests in Republic of Macedonia are expected to experience high level of impact from climate change, especially the boreal forests, where those impacts could be more dramatic. Climate change is already been documented throughout the Country as temperatures increase, precipitation decreases, and seasonal changes. All those changes have a huge impact on forests.

4.2.4.1.Impacts and exposure in the forestry sector

The major sources of exposure (and associated impacts) for forests in the country are as follows:

- **Increasing temperatures:** Temporal changes, such as an increasing working season, longer period of vegetation; Increasing frequency of extreme events, such as floods and droughts; Impacts are threats to infrastructure, life, inhabitants, and socio-economic factors.
- **Increasing frequency of forest fires:** Changes include the threat to infrastructure, reduction in wood supply, GHG increased emissions, decreased GHG absorption; Increasing frequency of insects and disease outbreaks; Impacts: reduction of wood supply, decreased growth and yields.
- **Changes in forest productivity:** Impacts: wood supply and carbon sequestration changes; Changes in species composition; Impacts are related to the market and recreational values.

The most significant impact on forest management in the period between the SNC and the TNC has been forest fires. Their impacts were felt not only at the time they occurred, but also in subsequent periods due to post-fire management activities that were necessary. Approximately 2,800 forest fires have been recorded in the period 1999-2012 that have burned almost 130,000 ha of forest and forest land. The total damage (direct and indirect) is estimated at around EUR 67,000,000.

There have also been several years in which ordinary forestry activities were interrupted briefly due to extremely wet periods, but it is very difficult to find a direct connection between these events and climate change.

4.2.4.2.Vulnerability of the forest sector to climate change

While the influence of climate change is becoming clearer in many other sectors, there is still no conceptual framework for the determination of vulnerability in the forestry sector. This type of framework would assist forest managers to incorporate climate and climate change into the forestry management plans.

Nonetheless, according to climate projections for the country and previous experience, the following segments of forest management are deemed to be most vulnerable till 2025:

- **Forest management planning:** Due to all previously explained already happened and expected disturbances caused by climate change the planning of the forest management activities (10 years management period) will be very difficult. It is most likely that interventions into management plans and activities will be necessary.
- **Forest utilization:** This sector will be also affected by climate change by 2025. Mainly this is due to activities which have to be carried out according to current laws (post fire management, insects' infestations, dieback process, infrastructure damages, etc.) which are not economically justified[18].
- **Forest protection:** Almost the same as with forest utilization, a huge amount of finances will be spent to control fires, control insects, monitor the health conditions of the forests, etc.
- **Hunting and tourism:** Due to expected disturbances in forests in the period until 2025 (fires, dieback, etc.) wild animal populations will be under threat. Also, as consequence of these disturbances, the tourism value of forests will decrease.
- **Silviculture:** Many of forest management activities and techniques are long term activities (for 20 to 60 year periods, sometimes more). It means that they have to be changed and harmonized with new conditions due to climate change.

It is worth noting that land use changes are not expected to occur in the forestry sector, at least not permanent ones, due to the obligations of the Forest Law. Some temporary land use changes are expected to occur as a result of forest fires and clear cuts, but they will be eliminated in the next 3-5 years after occurring. There is a trend of land use change in mountain areas, where villages have been abandoned and forests are reclaiming agricultural land.

4.2.4.3. Forest health

It is very likely that the forested area in the Republic of Macedonia will change under the influence of changes in temperature and precipitation regimes. Almost everywhere, in all forest types, there will be change in species composition, but that will be more visible over the long term. By 2025, according to the climate change scenario, those climate changes will not be so dramatic that forest cannot adapt to them. A temperature increase of 1.2°C, and decreased and changed precipitation regime, will affect the annual growth and yield of the forests, but that will not be as dramatic, due to the different needs of different tree species.

In the last 10 years, territorial expansion of some trees was noticed in the country, but it is very difficult to conclude that it is as a consequence of climate change. For example, *Pinus peuce* in the Pelister National Park has occupied terrain between 2,400 and 2,500 m above sea level. According to the literature, the highest point for its spreading was considered to be 2,200 m above sea level. However, in the same park that species has occupied lower terrain in the past as well. On the other hand, impacts could be noticeable in artificially planted forests, as mostly coniferous species that are not suitable for the environmental conditions in planting areas (especially in the sub-Mediterranean climate), and some losses in forests planted with those species are to be expected.

In order to evaluate the health of the forests in the Republic of Macedonia, experts examined the results of the International Cooperative Programme (ICP) forest assessment for the country. This is an assessment done using a standard methodology for Europe, the USA, and Canada to assess tree (forest) conditions in relation to air pollution and climate change. According to this methodology, 29 plots for assessment have been established in the Republic of Macedonia. There are many indicators for the health condition of the forest but we will show just two of them: water availability for the trees (soil moisture) and crown transparency. These are indicators of the health of the trees related directly to climate change. This analysis was carried out for the years 2008, 2009 and 2011. In order to have a clearer picture for the health condition of forests in the country and for the sake of continuity, some of the results from the previous reports (for the period 1991-2006) were reviewed as well. This study has resulted in a picture of the health condition of forests in the country over the last 20 years.

[18] The lack of economic justification means that after a forest disturbance (fire, insects, wind damage, dieback, etc.) according to the current law/regulation, different measures for sanitation of the damage must be carried out. Usually, these measures (wood cutting, roads construction, etc.) under regular forest management can be economically justified (i.e. there is a profit). But in the case of responding to these disturbances, they have to be conducted even though the activity does not result in profit. In some cases/years this means that forestry actors mainly have to work to solve these problems instead of working on regular forest management activities. On the end, this means working with economic losses.

The results of the assessment indicate that the health of forests in the country in the period between the SNC and this TNC (2006-2013) has remained more or less the same. There have been no significant changes in terms of the percentage of crown transparency. Approximately 50% of the trees assessed do not have signs of crown transparency, but around 45% of the trees are in Classes 1 and 2 on the scale of needle/leaf loss (>10<60%). This classification means that these trees will be most vulnerable to climate change in the future. Actual damage will depend on factors such as the severity of the changes, tree types, forest management practices, pests and disease infestations, etc.

Results for water availability for trees (soil moisture) indicated that at in the period between the SNC and TNC, a majority of trees examined have consistently not had sufficient water (see Table 4-5). Given the month and the soil types, however, this is not very unusual. At the same time, it should still be taken into consideration for analyses of the influence of future climate change.

TABLE 4-5: Percentage of trees with sufficient water in the years between the SNC and the TNC

Year	% of trees with sufficient water	% of trees with insufficient water
2008	24%	76%
2009	36%	64%
2011	30%	70%

According to the scenario for climate change in the Republic of Macedonia (air temperature and precipitation), significant impacts on forest health are not expected. However, there are no observed or predicted climate extremes (short and severe dryness, extreme min. or max. air temperature etc.) in the scenario as sources of "stress" for the trees. These stressors can lead to physiological weakness of trees, which is a precondition for health disturbances. If there are some climate extremes, negative changes in forest health can be expected even in the period up to 2025.

4.2.4.4. Forest productivity and carbon sequestration

The impact of climate change on forest productivity varies according to the geographical area, tree species, stand composition, tree age, soils, CO_2 effects, nitrogen fertilization and interaction. In the period between the SNC and the TNC there has been no significant change in the forest productivity. In general, until 2025, it is possible to expect increased productivity of forests, due to the rising temperature and CO_2 fertilization. However, the water deficit could decrease the productivity that may not result in the forest dieback. Natural disasters are also a factor that can decrease productivity through the damage they cause to standing trees.

Because carbon sinks depend on forest productivity, all factors that affect productivity will also affect carbon sequestration. As mentioned, only forest fires have had a significant negative influence on the carbon storage and sequestration capacity of forests in the previous period. By 2025, forests in the Republic of Macedonia, due to the projected increases in productivity, will be able to increase their carbon sink capacity if there are no substantial changes in the number and intensity of forest fires (i.e. as there was in 2000).

More generally, the estimation of the forest carbon sequestration requires very complex and long-term research in the Republic of Macedonia. There are numerous factors that have to be taken into consideration. The primary data should come from forest inventory data as well as soil carbon, litter and forest products. One approach would be to use the European forest information scenario (EFISCEN), which is a forest resource model suitable for large-scale (>10,000 ha) and long-term (20-70 years) analysis of the future development of forest resources in Europe.

4.2.4.5. Adaptation measures in the forestry sector

Adaptation measures which have been identified for this sector include the following:

- Develop a complete programme for adapting forestry to global climate change;
- Establishment of 5 monitoring stations in forest regions for the continued monitoring of climate change;
- Introduction of technologies for efficient biomass usage in forestry;
- Purchasing of proper vehicles for forest fire suppression;
- Conduct a thorough biomass stocking exercise (the last one was done in 1977);
- Adaptation of the Management plans in the forestry sector to incorporate climate change factors.

4.2.5.Human health

This section is a summary of a report developed for the TNC. The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=256

4.2.5.1. Climate impacts on human health

For this National Communication, research on health impacts from climate change focused on the Southeast (SE) Region. An overview of those impacts is provided in Table 4-6 below.

TABLE 4-6: Overview of the CC consolidated impacts and predicted pressure to the health sector in the SE region

Climate effect	Impact	Confirmed in the study	Consequence (pressures to the health system)	Probability of happening
Increased summer temperature, included heat waves	Increased summer mortality especially among elderly	+	Increased demands on health and adult care services	High
Warm periods/ heat waves	Increased emergency calls	+	Increased demands on health and adult care services	High
Increased average temperatures	Increased in frequency and intensity of Summer air pollution (ozone)	To be confirmed (no appropriate data)	Increase in cases of mortality and morbidity linked to respiratory diseases and associated hospital admission	Moderate
Summer temperature	Temperature morbidity	+	Increased demands on health and adult care services (including workers)	High
Increase in average temperature	Extended pollen season and more days with high pollen counts	Assumption to be checked and confirmed (needs investigation)	More people suffering with hay fever and pollen asthma	Moderate
UVB radiation	Sunlight/UV exposure	To be confirmed after introducing proper monitoring and warning system	Increased demands on health and adult care services especially vulnerable population of workers	Moderate
Winter temperature	Temperature mortality (winter)	+	Reduced demands on health and adult care services	High
Winter temperature/cold waves	Low temperature morbidity	+	Increased demands on health and adult care services	High
Extreme weather events	Increase in demand for emergency medicine	+	Overwhelming of public services	High
Extreme weather events	Health facilities infrastructure	Hospital safety index	Potential impacts on safety of hospital facility and operation	Low-to-moderate
Extreme weather events	Transport network failure, destruction of homes, water shortages, displacements, disruption of access to health services	Assumption	Increased demands on health and adult care services in risky areas	Moderate
Temperature and rainfall	Increased prevalence and survival of certain arthropods such as ticks and mosquitoes	To be monitored and confirmed	Vector borne diseases	Low-moderate
Increased average temperatures	Increase in certain water borne diseases, deterioration of drinking and surface water qualities, especially rural settlements	Potential treatable, to be monitored permanently	Health impacts such as diarrhoea and nausea	Low-moderate
Summer temperature	Multiplication of pathogenic microorganisms	Partially confirmed	Increase in food-borne diseases	Moderate
Summer temperature	Exposure of medicines to high temperature	Hospital safety index	Reduction in medicine efficacy	Low-moderate
Extreme weather events	Patient recovery rates in hospitals may be compromised	Hospital safety index	Increased demands on health and adult care services Reduction in health workers' performances	Moderate
Extreme weather events	Impact on health workers and working conditions	Hospital safety index	Reduction in health workers performances	Moderate

It is evident that the SE Region and the central region of the country, when compared with the other parts of the country, have the lowest total rainfall and could be at higher risk given current climate conditions. The SE Region is especially sensitive to climate extremes such as floods and droughts. In particular, floods occur every year in the Strumica region. The effects of climate change on floods and droughts could be investigated in terms of health impacts, although this would be difficult to quantify. Understanding the health implications of flooding, particularly impacts on mental health and impacts from disruptions in the supply of critical utilities such as electricity and water, has increased in recent years. However, knowledge gaps still remain.

While heat waves are also very frequent in the SE Region, cold temperatures are still likely to contribute to the majority of temperature-related health effects over the coming decades. The analysis of the frequency of the emergency calls confirmed that the elderly are more vulnerable to extreme heat and cold than younger people, so future health burdens are likely to be amplified by an aging population.

Climate change can influence the incidence of certain water and food-borne diseases, which show seasonal variation. It should be mentioned that climate change is also likely to affect the risk from water and food-borne disease through changes in human behaviour associated, for example, with food hygiene. Increased temperatures will allow pathogens such as Salmonella to grow more readily in food. However, interventions to prevent this are likely to have more of an effect in reducing numbers of cases than climate change will have on increasing them. Climate change may also lead to reductions in the availability of certain food groups, which may lead to reductions in the nutritional quality of dietary intake in some population groups.

Vector-borne diseases are influenced in complex ways by the climate, land use changes and human activities, and as such it is difficult to make quantitative predictions of future changes due to climate change. However, following the findings in other locations in the country and projections provided in maps of the European Environmental Agency, it is likely that the range, activity and vector potential of many ticks and mosquitoes will increase in the SE Region in the decades to come.

Finally, hospitals, health centres and care homes may be adversely affected by high temperatures during heat waves and flooding.

4.2.5.2.Adaptive capacity in the health sector

A policy and legal framework exists in the Republic of Macedonia in the form of the National Climate Change Health Adaptation Strategy, which has an inter-sectoral and multi-level (national/local) approach. It is estimated that most of the goals in the strategy paper have been achieved, though there is still room for improvement. Inter-sectoral engagement (including coordination) should be improved, especially the involvement of the local government which so far has not been the case in the SE region as well.

Knowledge of the climate health risks (among health workers) has been initially introduced, but there is a lack of proper follow-up and evaluation. There are no data about activities/campaigns for raising public awareness about climate change and health as well as for the number and structure of flyers and brochures about climate change risk distributed publicly. The Heat Wave Action Plan is functional all over the country including in the SE Region, and it serves as an example of an integrated (weather and health) early warning system dedicated to the prevention/adaptation to climate change events. The Regional Public Health Centre has a special role in implementation. Recently, a Cold Weather Action Plan has also been adopted at the national level.

In the area of the infectious diseases there is also a functional early warning system that could be useful for addressing climate change health risks observed in the region. An early warning system for the monitoring and management of food-borne and water-borne disease operates on a regular basis, and it includes public campaigns and health promotion activities from the Centres for Public Health. Finally, while the monitoring of drinking water supply systems and drinking water samples is under the control of the public health system and seems to be manageable even in more extreme conditions, food safety control and implementation of the Hazard Analysis Critical Control Point System (HACCP system) is uncertain due to a lack of proper and transparent information.

The vector-borne communicable diseases monitoring system in the country is in need of strengthening, and it should pay attention to the SE Region as there are predictions from international agencies (European Environmental Agency) of the enlargement of certain vector populations and higher transmission risks for some vectors in the region. Specifically, the climate in the region will be suitable for the spread of mosquitoes such as *Aedes aegypti* and the Asian Tiger mosquito and the appearance of diseases such Lyme borreliosis (which has already been registered in the country), Chicungynua, and West Nile fever.

Finally, the region also needs more precise meteorological observations (including extremely hot or cold periods), data and predictions in order to take precautionary measures in risky periods. The existing national air pollution alert system should include the SE Region as well. Currently there is no air quality data for the region.

4.2.5.3.Adaptation measures in the health sector

Despite the numerous activities implemented in the health sector of the Republic of Macedonia to mitigate health effects from climate change, there is still much to be done. As long as climate change is not too rapid or strong, many health effects can be controlled by strengthening the public health system. Activities would include strengthening preparedness, public health services and health security, advocating action in other sectors to benefit health, and better informing citizens. Health systems need to strengthen their capacity to assess potential climate-related health effects, to review their capacities to cope, and develop and implement adaptation and mitigation strategies, and to strengthen a range of key areas of work – from disease surveillance and control to disaster risk reduction – that are essential for rapid detection of and action against climate-related risks.

The most elementary form of adaptation is to launch or improve health monitoring and surveillance systems, which will summarize the mechanisms for a comprehensive monitoring scheme for the types of potential health impact of climate change. Priority areas for monitoring and adaptation in the country are as follows: heat stress, vector-borne diseases and other communicable diseases, natural disasters, freshwater supply, food chain and supply, and others.

Primary and secondary adaptive measures, inter-sectoral and cross-sectoral adaptation strategies are needed to reduce the potential health impacts arisen from climate change. Suggested measures include the following:

- The Ultraviolet (UV) radiation risks morbidity and mortality data and UV radiation protection measures and monitoring system, though emphasized in the National Climate Change Health Adaptation Strategy, has still not been introduced. It will be of considerable importance for a region at risk of UV radiation and a potential increase in skin cancer incidence. There is also a need for a special assessment of UV health risks to population of exposed agricultural workers and workers in other outdoor jobs.
- Unfortunately, pollen monitoring has still not been introduced outside of Skopje, though there is evidence that the extended seasons of pollenosis (i.e. hay fever) in the country will become serious threats due to climate change conditions. The SE Region should be among the first to be observed.
- The early warning system for flooding, which is managed by agencies in many sectors (hydrometeorology, health, and crisis management) at several levels, is operating on a satisfactory level, including regular check-ups and crisis simulations. However, there is much more to be done, especially in the health sector, in order to prevent possible health impacts, especially in rural/agricultural settlements. The activities planned in the National Crisis Preparedness Program also recognize the importance of the health sector (especially hospitals) in such circumstances. This type of system should be established for other extreme climate events that are relevant to the region.
- More accurate data are needed to assess health and adaptation costs following the recent publication of a WHO tool for making these calculations.

4.2.6.Tourism

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=258

A vulnerability assessment of the tourism sector was commissioned for the TNC. Methodologies included interviews with private and public sector stakeholders on their attitudes and actions concerning climate adaptation and a review of regional-level documents. The Regional Climate Assessment Report published in 2012 by the South East European Forum on Climate Change Adaptation (SEEFCCA) provided a useful regional overview of tourism and climate change. It proved particularly useful in the case of geographically small countries such as the Republic of Macedonia because insofar as climate and weather are concerned, they are very much part of a larger climate system. SEEFCCA described tourism as being particularly vulnerable to climate change. Moreover, it emphasized the point that climate change will not affect regions and people equally. This is especially so in rural areas where poverty and an aging population are altering land use patterns in Macedonia's highly-climate-sensitive agriculture sector. This may impact on the ability of the rural economy and related activities to be sufficiently robust to support rural tourism enterprises; after all, tourists will want to engage with a healthy and interesting socio-economic, as well as the aesthetic landscape.

With regard to the Republic of Macedonia, the Regional Climate Assessment Report recognized tourism's potential in livelihood diversification but noted the need for appropriate infrastructure investment. For tourism, this means communications, facilities and attractions as well as traditional infrastructure such as reliable water and energy sources and reasonably comfortable roads. It can also be inferred from SEEFCAA's general discussion on the need for ecotourism in regional national parks, the same will apply to the Republic of Macedonia's three major national parks on the basis that *"sensitively developed, sustainable ecosystems provide a way to raise public awareness of national parks and biodiversity, while providing income for their upkeep"* (p. 26).

4.2.6.1. Impacts and vulnerability in the tourism sector

It is self-evident that an economic sector that is significantly weather- dependent and reliant on the natural environment is both sensitive and vulnerable to climate change. Warmer winters and hotter summers will place stress on all aspects of tourism, but particularly winter tourism, which relies on snow-security – primarily for ski resorts below 1400m. In addition, cultural tourism is at some risk as physical heritage attractions (ancient buildings, monuments and archaeological sites) are impacted by severe weather and flooding (i.e. the product deteriorates and becomes less attractive); and extreme summer heat curtails field excursions by tourists outside their perceived temperature comfort zone.[19]

BOX 4-4: WINTER TOURISM IN EUROPE: IMPLICATIONS FOR THE REPUBLIC OF MACEDONIA

Winter tourism in Europe is a significant leisure market segment with an annual turnover of some EUR 50 billion making a considerable economic contribution (Abegg et al. 2007). The success of ski-related tourism is predicated on the amount and reliability of snow cover, or what has been termed 'snow security' which, in the case for example of Switzerland, is defined by Elsasser and Bürki (2002) as *"the altitude above sea level on which between December 16 and April 15 enough snow for skiing on at least hundred days is available."* They go on to explain that "With an increase of the mean temperature of 2°C this altitude will change from 1,200 m to 1,500 m [by] 2030. [in 2002] about 85% of ski resorts in the Swiss Alps have are snow secure according to this rule. Agrawala (2007) notes that a 1°C increase in air temperature will move the snow line up by 150 metres. Table 4-7 shows climate risk/ snow security for seven Macedonian ski resorts including the most popular ones. Altitudes higher than about 1,300 m have traditionally been considered, before the perturbations bought about by climate change, to fulfil the criteria for reliable weather conditions. However, it can be seen that the majority of locations are at risk.

TABLE 4-7: Macedonian Ski Resorts and Climate Risk

Ski Resort	Height	Risk from 2°C increased mean temperature*
Krusevo	1240-1400	High risk
Mavrovo/ Zare Lazarevski	1255-1860	High risk
Mount Kozuf	1550-2200	Medium risk
Oteshevo	1400-1600	Medium to high risk
Pelister	1429-2601	Medium to high risk
Ponikve	1560	Medium risk
Popova Sapka	1708-2510	Low to medium risk

* Based on IPCC AR4/ AR5 commentary September 2013

Whilst it is encouraging that the most developed and popular resort, Popova Sapka is in the low risk category, there is cause for varying extent of concern regarding all the other resorts. As indicated above, winter tourism is both exposed and sensitive to climate change climate making it a particularly vulnerable industry.

At one level, the vulnerability of tourism in vulnerable regions could be reduced by shifting the product from winter skiing to summer outdoor activities such as walking, hiking, cycling etc. changes to observable weather patterns, i.e. shortened season potentially falling below the critical viability mass of one hundred days will cause apprehension and wariness within the investment community.

4.2.6.2. Adaptation measures in the tourism sector

Tourism sector stakeholders seem to be both unaware and unconcerned about the impact climate change might have on their businesses and are thus taking no mitigation or adaptive measures. Climate change does not figure into Government tourism planning. The paradox is, that while the Republic of Macedonia has a solid scientific community and sections of Government that are fully aware of expected climate change, the tourism sector is not and is continuing, for example, to invest in mid to low altitude ski resorts that evidence from other parts of Europe indicate are at risk with a high degree of certainty.[20]

There are several acute policy implications for tourism as climate change becomes a driver for environmental change and impacts the sector. Prime among them should be awareness and sensitivity building towards 'no-regrets' adaptation. By tackling this issue, other

[19] Discussion of vulnerability and adaptation in the cultural heritage sector is covered in Section 4.2.7 of this chapter.

[20] As directly promulgated by the IPCC 4th Assessment Report (details from AR5 are pending).

policy actions such as encouraging energy efficiency and water efficiency in the hotel sector. For the beginning, a favoured tax of 5% is foreseen for trade and import of thermal solar systems and components (Official Gazette of the Republic of Macedonia no. 44/99 and 12/2014). Policy on tourism must incorporate and address climate issues.

The following proposed adaptive policies and measures, if implemented, will reduce vulnerability and guide tourism onto a more sustainable, lower-carbon pathway:

Incentivise scientific research in tourism;

- Plan for 21st century (contributing to a low-carbon economy) tourism rather than 20th century mass tourism (developed in the era of cheap oil and naïve environmental assumptions);
- Facilitate future touristic developments along sustainable lines;
- Adapt through product and spatial diversification;
- Conduct a detailed sensitivity and exposure assessment of tourist assets;
- Facilitate sustainable deve lopment in and throughout the tourism value chain;
- Incentivise and support private sector adaptation measures (e.g. through tax relief on retro-fitting hotels with insulation and more efficient heating/ cooling devises).

In terms of data needs, there is substantial room for improvement. Whilst basic temporal and spatial data on tourist arrivals, distribution, and spend is efficiently collected, insofar as climate change is concerned, more data--most especially site- specific meteorological data--needs to be collected. Other recommended policies and measures are as follows:

Research

- Development of site-specific case studies to enable adaptation action plans to be developed
- Assessment of tourist product for quality and site specific risk and vulnerability so as to better understand environmental impacts within their climate context
- Assessment of impact on local cultures (including traditional knowledge), populations and jobs as tourism products change in response to climate
- Effective management practices in reducing energy usage and thus energy risk

Advocacy

- Prioritisation of modes of communication and target audiences
- Communication of key findings in forms accessible beyond the scientific community
- Government partnerships with private and third sector stakeholders in combatting climate issues
- International/ regional research and mentoring partnerships
- Outreach to civil society/ general public about risk to leisure activities

Training

- Site specific workshops for stakeholder professionals
- Training for specific phenomena changes
- Sensitivity raising and awareness training for the tourism sector

Risk Preparedness

- Planning for adaptation throughout the tourism supply and value chains
- Monitoring and reporting site-specific change to inform action plans

4.2.7. Cultural heritage

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=284

Certain aspects of climate change and their increasing trends over the past several decades represent significant challenges that will need to be addressed at both policy and management levels in a local, regional, and global context (IPCC 2007). For this National Communication, an assessment of the cultural heritage sector was commissioned through the regional project “Climate Change Adaptation in Western Balkans,” which was financed by the German Government and implemented by Deutsche Gesellschaft fur Internationale Zusammenarbeit (GIZ).

Although quite often overlooked in impact assessments, vulnerability studies, or climate policy priorities, cultural heritage will most likely be affected by changing climatic patterns, both in its physical and its intangible form. Whereas other ecosystem elements may have regenerative potential, the impacts of climate change on cultural heritage are expected to result in irreversible alterations or even permanent losses.

4.2.7.1.Impacts and vulnerability related to cultural heritage

The assessment team developed an innovative impact matrix of risks to be expected by climate change and the relevant parameters describing the composition of the site and the surrounding area. This impact matrix is included in Annex 3 of this National Communication. Additionally, based on expert judgment, available descriptions of selected sites were assessed in combination with the likelihood of changing climate parameters and climate events for the specific region. National climate change scenarios offered the necessary information about climate change predictions with a spatial resolution at a sub-national scale. In addition, historical weather data for the Republic of Macedonia is available with information about past weather extremes, their frequency, temporal characteristics and long-term trends.

The selection of cultural heritage sites to be analysed as part of the rapid vulnerability assessment was based on a workshop of cultural heritage professionals identified by the Ministry of Culture and National Heritage Protection Office and organized by the United Nations Development Programme (UNDP) and GIZ. The workshop, which was conducted in a participatory manner, allowed participants to nominate cultural heritage sites that they thought were particularly suitable for study or challenged by climate change phenomena. Eleven sites were suggested during this brainstorming process. As a second step, the workshop attendants were invited to select those sites among the eleven that would be most suitable in terms of the aims and objectives of the project. Each participant was given three votes to select three sites of his or her preference. As a result, two sites received an overwhelming majority of votes – the archaeological site of Plaosnik at Ohrid and the archaeological site of Stobi – and the third-highest number of votes was given to the Skopje Aqueduct.

Rapid vulnerability assessments were carried out for these three cultural heritage sites. The sites were evaluated during site visits with an average time of 1.5 days for each. It was difficult within a limited time frame to arrive at reliable and confirmed results and assessments. Hence, the results of the vulnerability assessment should be seen as initial indications towards climate change vulnerability but may have to be verified through further detailed studies taking into consideration additional factors, including the soil composition and geological stratigraphy of each site. It was recommended to the Ministry of Culture and the cultural heritage authorities in the Republic of Macedonia to continue the observations and assessments of climate change phenomena at these sites over a longer time frame to verify the findings presented in the complete report. The summary findings of the rapid assessment were as follows:

Skopje Aqueduct: In summary, it should be noted that climate-related effects are destabilizing the aqueduct, and with the current extent of static damage, a collapse of certain sections must be expected. As a result, the still contiguous structure would decay into several individual pieces.

Stobi Archaeological Site: As a result of the rapid vulnerability assessment on whether the archaeological site Stobi is exposed to climate change impacts, it can be stated that severe damage to the ancient walls could be expected before 2100. In particular, the high number of days with a temperature range above and below 0°C (freeze-thaw weather), increasing heavy rainfall and unpredictable flood events will affect the archaeological remains. These physical impacts of climate change affect both the structural stability of the archaeological remains as well as the building materials. The grey tertiary sandstone, as the most important material of the Roman buildings, is most vulnerable to climate caused damage processes including surface recession and stone deterioration.

Plaosnik Archaeological Site in Ohrid: Under normal circumstances the archaeological site of Plaosnik would not be significantly exposed to potential threats caused by climate change. Although wind and water erosion phenomena are likely to increase with a larger number of extreme weather events predicted for the region, the recently added preservation layers on most archaeological walls reduce the wind and water erosion impacts significantly. Water erosion merely remains a significant risk in the soil of the archaeological elements as rain water runoff streams, especially following heavy rain events, could wash out soil segments underneath the archaeological stratigraphy and wall foundations. Such wash out processes increase with runoff speed and water volume but may at times cause the collapse of walls or unexcavated archaeological remains following the creating of cavities in the ground. The mosaics and other valuable archaeological features have been protected by shelters and temporary roofing structures which provide complete rain protection and also largely prevent wind erosion processes. As for the two sites previously analysed, at Plaosnik the number of freeze/thaw days measured at the weather station in Ohrid is relatively high compared to other regions, and frost damages comparable to what was described for Stobi can be expected. Yet, due to the large scale of mortar repair and surface coverage of the archaeological remains, this phenomenon may cause less significant damage than anticipated for the two previous sites.

4.2.7.2. Policies and measures to adapt to climate change in the cultural heritage sector

The development of a National Action Plan on risk assessment and adaptation of climate change related phenomena on cultural heritage is based on preliminary findings resulting from these two short term missions and should be jointly discussed with the relevant authorities in the Republic of Macedonia. The overall goals of a National Action Plan could be identified by the recommendation of the Council of Europe for research work on impacts of climate change on cultural heritage (Sabbioni et al., 2008). A full consideration of all relevant aspects of global climate change impacts on cultural heritage in the Republic of Macedonia requires in-depth investigations and step-by-step implementation, with focus on the following aspects:

1. Improving the understanding of adverse impacts of climate change on cultural heritage;
2. Assessing the vulnerability of built and archaeological heritage as well as historical cultural landscapes in the Republic of Macedonia by rapid impact assessment;
3. Establishing a monitoring program for damages on built and archaeological heritage as well as historical cultural landscapes for short-term extreme weather events and long term climate change;
4. Identification of tools and adaptation measures for the main categories of cultural heritage in the Republic of Macedonia;
5. Limiting damages through implementation of a long-term management strategy related to the adaptation of climate change impacts on heritage in the Republic of Macedonia.

The proposed goals of the National Action Plan should be considered in a gradual approach starting with case studies of the different categories of cultural heritage. Based on the results of the July 2013 workshop and the field surveys of three selected sites Stobi, Plaosnik in Orhid and the Aqueduct in Skopje, the first findings for the category of archaeological sites are available and could be used for the identification of main action fields. Therefore, impacts of climate change on cultural heritage, the vulnerability of built heritage as well as adaptation measures, should be investigated, documented and steadily improved. The assessment team suggested approaching the implementation of a national action plan for climate change and cultural heritage through the design of specific short-term and medium-term work packages.

Final decisions about the proposed work packages as relevant action fields for a National Action Plan should ideally be taken in participatory workshops, following the provision of ample background information to all partners involved. During the development of a National Action Plan on Climate Change Risk Assessment and Adaption for Cultural Heritage in the Republic of Macedonia the general public should be involved in order to enhance the public awareness and to integrate wider social and economic benefits.

However, climate change will be a key pressure with increasingly severe damages, in particular on built heritage, even already accruing and with a risk potential difficult to predict. Thus, any adaptation strategy has to be seen in the context of the uncertainty of extreme climate events, which have unpredictable damage potential and comparable uncertainty in material and soil composition of cultural heritage sites. While these uncertainties allow for general approaches at an academic level, they require that adaptation solutions should also be considered within a specific local context.

4.2.8.Socio-economic vulnerability and climate risks – A regional assessment

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=257

Sectoral vulnerability assessments also included an assessment of socio-economic vulnerability. As mentioned above, the SE Region was selected for study because it was identified in the FNC and SNC as being especially vulnerable to climate change. Research for this study was closely coordinated with work on disaster risk reduction in the Republic of Macedonia. The research consisted of a socio–economic vulnerability assessment of the population in the ten municipalities in relation to disaster risk and climate change based on a set of indicators selected by applying the deductive method. A review of relevant literature served as a basis for identifying and selecting the indicators.

Once the socio-economic indicators were selected, the next step was to define and calculate one aggregate indicator/index on the socio–economic vulnerability of the population that would enable the ranking of the ten municipalities in the SE Region according to the socio–economic vulnerability of their inhabitants. The assessment used the Social Vulnerability Index (SoVI) developed by Susan Cutter. The input data used were from taken the State Statistical Office from most recent population and housing census (2002), agricultural census (2007), sex and age population estimates (2012), data on health institutions and medical staff obtained by the State Health institute (reports based on the evidence that the medical institutions are keeping), and data on financial benefits as well as data on disabled persons from the Ministry of Labour and Social Policy (based on evidence maintained by social centres). Values of the calculated indexes for each municipality were classified in three groups:

- municipalities with low social vulnerability (up to the 33rd percentile)
- municipalities with medium social vulnerability (from 33rd to 66th percentile)
- municipalities with high social vulnerability (over the 66th percentile)

With additional research in the future and the use of mapping tools, these grades of social vulnerability and the calculated vulnerability of other exposed elements can be linked with identified hazards and assessed exposure to elements in order to obtain an assessment of total vulnerability in relation to a specific hazard.

Research to date has faced the following constraints:

- Inaccurate statistical data for some statistical units, particularly at the settlement level, because the Census of Population, Households and Dwellings was not conducted in 2011.
- Certain data in the field of health, social care, employment, etc., are not available at the municipal level due to the method of processing and disclosure of relevant institutions. The above information is processed and disseminated at the level of 30 centres.[21]
- The official statistical data on incomes and expenditures of households, poverty, socially excluded groups and related indicators are available only as totals for the Republic of Macedonia as a whole and are not disaggregated.[22]
- Comparability of data over time is not possible due to changes in applied methodology and changes in the administrative divisions in which the census data are published.
- Limiting factors meant that the composite socio-economic index could not include indicators on the economic situation of the population, such as the unemployment rate and the level of household income.

The vulnerability of the local population to specific natural hazard events and natural disasters increased when influenced by certain socio-economic factors. The social vulnerability index for the SE Region incorporated the following characteristics: socioeconomic status; ethnicity; age; occupation (i.e. with risk exposure); and households with many dependents or single-parent families. The index also included two factors that could contribute to a decrease in the vulnerability of the population: greater access to health services and the percentage of owner occupied housing; persons with disabilities; and tourists. Table 4-8 lists the social vulnerability index of selected municipalities in the SE Region.

TABLE 4-8: Social Vulnerability Index (SoVI) of the population in the municipalities of the SE Region

Municipality	Bogdanci	Bosilovo	Valandovo	Vasilevo	Gevgelija	Dojran	Konče	Novo Selo	Radoviš	Strumica
Social vulnerability index (SoVI)	-3.84	-3.52	-0.44	1.76	-1.11	9.5	-0.004	-0.04	0.97	-3.28
% Roma	-0.64	-0.35	-0.16	-0.59	-0.56	2.58	-0.66	-0.61	1.14	-0.16
% young on age under 6	-1.37	-0.1	-0.24	1.78	-0.64	-0.43	0.9	-1.49	0.71	0.87
% elderly on age 65+	0.91	0	0.21	-1.91	0.72	0.58	0.01	1.56	-1.2	-0.89
agricultural workers per 1000 population	-0.56	1.45	0.01	1.78	-1.06	-0.73	0.75	0.37	-0.85	-1.16
% of owner occupied dwellings	-1.16	1.26	1.01	1.62	-0.67	-1.45	-0.29	0.51	-0.73	-0.08
% One parent family (father)	0.35	-1.66	0.94	-0.05	-1.17	1.08	-0.2	1.72	-0.82	-0.19
% One parent family (mother)	0.55	-0.99	0.02	-0.96	1.41	1.5	-1.54	0.5	-0.88	0.39
% of population living in single households	0.27	-1.44	0.37	-1.58	1.47	1.66	-0.52	-0.16	-0.05	-0.03
% Households consist of two or more families	-0.31	2.06	-0.62	0.04	-0.88	-0.1	-0.99	1.71	-0.75	-0.16
% of illiterate out of total population on age 9+	-1.35	0.3	-0.77	1.71	-1.53	-0.65	1	0.24	0.86	0.18
% of population with less than high school out of total population aged 15+	-0.12	0.86	-0.15	1.19	-1.49	0	1.45	0.58	-0.68	-1.65
Average annual population growth rate	-1.31	-0.65	0.18	1.71	0.38	-0.11	-0.32	-1.71	0.73	1.09
Doctors per 1000 population	-0.07	-0.89	0.1	-0.91	2.04	-0.41	-0.93	-0.63	0.04	1.66
% population with disabilities	0.11	-1.15	1.24	-1.09	1.53	-0.84	0.68	-1.09	1.03	-0.42
% population with disabilities residing in institutions	-0.33	-0.33	-0.33	-0.33	3	-0.33	-0.33	-0.33	-0.33	-0.33
Tourists per 1000 population	-0.35	-0.35	-0.35	-0.35	-0.22	3	-0.35	-0.35	-0.35	-0.31
% social security recipients	-0.94	-0.8	0.31	1.11	-0.71	0.43	-1.1	-1.08	1.71	1.07

[21] These centres correspond to the administrative-territorial division (ATP) of the state that was in effect until 1996, when there were 34 municipalities. Thus, 29 centres are covering identical territory of 29 municipalities and 1 centre covers an area that is identical with the territory of the 5 municipalities of Skopje in accordance with the above mentioned ATP.

[22] Some of the required data from regular statistical sample surveys are processed and/ or disseminate only at the state level

It should be noted that the quantification of these population groups identified as socially vulnerable is very important, but also is important how each factor or variable influences or how all factors affect each other and make socially vulnerable groups. The vulnerable groups listed can be considered as groups upon whom natural hazards and disasters will be additional to the already existing burdens due to socio-economic status, age, gender, living conditions and work and family circumstances.

According to the index of social vulnerability of the population, municipalities were ranked in three groups: low, intermediate (moderate) and high level of social vulnerability. Relative rankings are depicted in Table 4-9.

TABLE 4-9: Ranking of selected municipalities in the Southeast region by the level of social vulnerability

Municipality	SoVI	Level of Social vulnerability
Bogdanci	-3,840	Low
Bosilovo	-3,518	Low
Strumica	-3,276	Low
Gevgelija	-1,109	Medium
Valandovo	-0,438	Medium
Novo Selo	-0,040	Medium
Konče	-0,004	Medium
Radoviš	0,973	High
Vasilevo	1,756	High
Dojran	9,497	High

4.3. INNOVATIVE ACTIONS UNDERTAKEN RELATED TO VULNERABILITY AND ADAPTATION

The following section describes the actions that have been taken to address vulnerability in the various sectors – building upon the findings of previous National Communications and other efforts.

4.3.1. Water resources

One of the main achievements of the NC process which is a best practice related to water resources is the establishment of a multidisciplinary national team which improved the data and experience exchange, the knowledge and capacity of decision makers and other stakeholders, and the technical ability of those involved in the work. In particular, water sector tools were used more intensively such as the use of mathematical models and software for assessing supply and demand of water resources and adaptation measures.[23]

Additionally, during the preparation of the TNC, a Water Balance model for the Strumica river basin was developed and statistical trends of the basic hydrological and meteorological parameters were obtained. Insufficient data in water balance modelling was highlighted as well as necessity of monitoring improvement on water use and groundwater.

4.3.2. Agriculture

During the preparation of the TNC for CC in Agriculture sector, several innovative practices and approaches were implemented.

The most important achievement is the implementation of the modelling approach in the agriculture sector. The vulnerability assessment of the selected region was performed using the ClimIndices model which enabled modelling of an enormously large number of agro-meteorological indicators (Dates, Counts, Thermal sums, Water balance, Waves, Indices) for the whole territory of the country for a 60 years period (1993-2053).

Additional accomplishments and innovative practices included:

- Compressive databases were developed as a prerequisite for running of models and development of scenarios: e.g. soil data base, crop management data base etc. using different methodologies.
- Adaptation measures were analysed using the biophysical model CropSyst model under the BIOMA platform developed by the JRC. Several adaptation measures were tested through development of different scenarios for three target crops.

[23] The models summarized long-range simulation tools such as WEAP and IRAS, short-range simulation models like RiverWare and WaterWare, and spatial tools for river basin water budget modeling such as MIKE BASIN, STREAM and HEC-HMS which was used in water balance modeling.

- The data gained from adaptation analysis served as input data for in-depth economic analysis. This analysis provided clear answers on the viability of each scenario.
- Models used in the economic analysis provided answers as to the future needs and interventions needed to be implemented for mitigating against the negative effects of climate change in the sector;
- In order to quantify the future needs for irrigation water in the periods up to 20025 and 2050 a CROPWAT model was used.
- During the period of designing of the methodology and approach for preparation of the Report, as well during the whole period of its preparation, a close and intensive collaboration with the JRC in Ispra, Italy was established. This collaboration was conducted in a form of intensive training program and transfer of know-how to representatives of the expert team, sharing of JRC specialists' previous experience especially in the process of calibration and validation of modelled results.
- The analysis of the data and model results were presented at a JRC info day organised in Skopje.моделот беше претставена на информативниот ден на Центарот за заеднички истражувања организиран во Скопје.

4.3.3. Biodiversity

The most important good practice undertaken related to biodiversity and the TNC is the implementation of modelling of species and habitat changes expected due to climate change. This exercise was implemented for the first time in Macedonia as a part of the process.

4.3.4. Forestry sector

In the forestry sector, a national early warning system for forest fires has been developed as an adaptation measure during the period of the development of the TNC: The Macedonian Forest Fire Information System (MKFFIS)[24] The system was developed within the framework of the JICA/UNDP/CMC project: *"Development of Integrated System for Prevention and Early Warning of Forest Fires"*. The forestry sector, as one of the users and creators of the system, will use it to protect the forest from forest fires. Based on the products of the system, the forestry sector will be able to conduct measures of prevention and pre-suppression, which will lead to decrease in the number of forest fires and burned area.

The following tools and products of the MKFFIS will be used:

- Hot Spot Map;
- Vegetation Dryness Map;
- Fire Weather Index Map;
- Forest Vegetation Map;
- Fire History Map;
- Topographic Map and others

4.3.5. Human health

Related to the health sector, the Heat Wave Action Plan was adopted by the Government in February 2011 and published in 2011 in three languages: Macedonian, English and Albanian. The primary goal of the Plan is to reduce heat-related morbidity and deaths through issuing heat-health warnings, with particular emphasis on the most vulnerable population groups, raise awareness amongst the public and health workers, and coordinate and mobilize all available resources in a timely manner to prevent the health consequences of heat-waves. A heat-health early warning system has been developed, for timely announcement of heat-waves, including design of software and donation of equipment for its functioning. Information leaflets for protection against heat-waves, aimed at the general population, managers in health and social institutions, general practitioners and workers have been developed and printed in three languages: Macedonian, English and Albanian. More than 300 health professionals, environment professionals, journalists and other professionals have received training on the influence of health on climate change, with to the emphasis on heat-waves.

[24] More information available here: http://mkffis.cuk.gov.mk

4.4. CONSTRAINTS AND GAPS IN VULNERABILITY ASSESSMENTS

Several constraints and gaps were identifying during preparation of the thematic studies on vulnerability assessment within this study. The most persistent constraints and gaps were as follows:

Data availability, consistency and transparency: Additional sectoral, socio-economic, and climate data are necessary at higher levels of resolution (i.e. for smaller areas). Examples range from crop data to economic and employment indicators. There is a shortage of relevant databases and GIS layers at the appropriate scale and other databases at the institutional level. Data issues are closely related to gaps in institutional and financial support for monitoring equipment and personnel, particularly in the hydro-meteorological sector. Several important indicators, such as snow cover, are simply not monitored. On a related note, it was observed that while equipment donated for monitoring was useful, constraints could arise over operating and maintenance costs, which were not generally covered by donors.

Scenario development for extreme weather events and seasonal forecasting: The need was identified for developing scenarios for future extreme weather events and using regional models for preparation of seasonal weather forecasts for the country. This would involve investments in hardware, software, training.

Institutional Structures: Enhancement of the role of the National Climate Change Committee is recommended for coordination of climate change activities. Sectors such as water resources and agriculture, tourism and cultural heritage, and forestry and biodiversity are closely linked, and it is important to use existing institutional resources as efficiently as possible.

Research: Low levels of investment in research were identified as a constraint in vulnerability assessments. There is a need for a variety of new models (such as hydraulic, hydrological, and planning models in the resources sector). However, the overall assessment has benefitted from several new studies, and researchers are participating in a variety of international initiatives (see Chapter 6).

Human capacity: A shortage of well-qualified and trained personnel was identified in several areas, including: modern monitoring and data processing technologies, and implementation of adaptation measures.

4.5. OPPORTUNITIES AND CONSTRAINTS IN THE IMPLEMENTATION OF ADAPTATION MEASURES

For effective adaptation, measures need to be implemented on different time scales. Long-term measures are related to decisions to address long-term (decadal) climate change and are based on long-term projections. They usually exceed the scope of water sector planning because they affect the development model and the socio- economic background through institutional and legal changes (for example land use changes). Medium-term measures are related to medium-term (one or two decades) climate change projections and introducing hydrological planning measures such as risk management (for example drought and flood management plans). Short-term measures are related to decisions addressing identified problems mainly under the current climate and hydrological variability. They correspond to measures that can be adopted in the current institutional, legal and infrastructural framework, and usually refer to risk assessment, preparedness and vulnerability reduction (for example revised water allocations during drought). A common problem is a focus on short-term measures. Medium and long-term measures should be fostered, although this is often difficult due to short electoral cycles, funding constraints and high uncertainty associated with medium and long-term forecasts.

A complete list of potential adaptation measures identified during the preparation of the TNC is included in Annex 2. However, these measures were not prioritised into a “strategic adaptation plan”.

One of the constraints in moving forward with an overall strategic adaptation plan in the Republic of Macedonia is a lack of consistency in the use of terminology and prioritization methods between and amongst sectors. Very often the terminology used in climate change is used also in many other sectors. The concepts behind the terminology used are not always the same in all sectors. Harmonizing these concepts and terminology can be a key step to achieve successful adaptation strategies across sectors. Once the issue of concepts and terminology is clear, a vulnerability and risk assessment could be performed aimed to answer the questions of where and in what to invest resources. Additionally, a clear framework for analysis will be required for comparing within and among sectors in order to prioritize resource allocation.

Finally, explicit connections among various planning documents in different sectors are often not present – even if in actuality there is an unintended agreement. In order to incorporate climate change in the country or sector priorities and find politic support and the resources needed, it will be necessary to be explicit on how climate change actions support and are aligned with national priorities. Therefore, consistency between climate change adaptation strategies and national actions plans and policies must be precise and explicit.

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5 CLIMATE CHANGE MITIGATION

5.1. INTRODUCTION

The climate change mitigation analysis presented in this chapter is built upon the analyses conducted under Second National Communication, but also accounts for developments within the country, particularly for the specific position of the Republic of Macedonia under the UNFCCC, as an EU candidate, and as a member of the European Energy Community. It also includes detailed analysis of a number of Nationally Appropriate Mitigation Actions (NAMAs) which were submitted by the country as a part of its submission for the Copenhagen Accords (See Annex 1 of this document for a list of these NAMAs). As a member of the Energy Community, the Republic of Macedonia is already committed to complying with the *acquis communautaire* related to energy[25] – involving, for example, renewable energy usage, energy efficiency standards in buildings and equipment, energy efficiency incorporated into public procurement, and related to the reduction of certain pollutants (e.g. SO_x and NO_x) from power plants. Additionally, if the Republic of Macedonia enters the EU by 2020, it will be required to implement EU mitigation policies and be part of the EU effort-sharing scheme for emissions reductions of 20% by 2020. This will include measures such as those for the Energy Community and additional measures related to, for example, the participation in the EU emissions trading scheme (EU-ETS). If the does not enter the EU, it will probably continue transposition of climate-change related directives but at a slower pace. It would then have choice between joining Annex I and offering Quantified Emission Limitation or Reduction Commitment (QELRC) type of target, or to stay in the position of a developing non-Annex I country and offer a target in the form of baseline deviation. In all cases similar types of policies and measures will likely be implemented, but with different speed and intensity.

Accordingly, the mitigation analysis under TNC addresses the following questions:

- What the country can expect in terms of **possible GHG emissions limitation/reduction targets** in view of the ongoing UNFCCC negotiations about future climate regime and of the EU candidate status?
- What **measures/activities** can be undertaken in order to achieve the GHG emissions limitation/reduction?
- **How costly** would be the different levels of ambition for GHG emissions limitation/reduction?
- What is the mitigation potential of **non-energy sectors**?
- How to **involve** as many as possible relevant **stakeholders** and set the priorities applying participatory approach?
- How to diffuse the climate change mitigation in the relevant sectoral policies and ensure **joint and cooperative action**?

In addition to an intensive analytical work within and across different sectors, the mitigation analysis has also included participatory work with a number of relevant stakeholders, particularly when it has come to evaluation and prioritization of the measures in the mitigation action plans. Moreover, not less important is the capacity building and knowledge transfer component realized through engagement of a chief technical advisor, an international expert and expert support for the modelling work. As a final point, it should be emphasized that the findings of this study should have an indicative character, to show "where we are and where we can go" with regards to climate change mitigation measures. Given the dynamics of relevant developments at national and at international levels, as well as high level of uncertainties associated with the UNFCCC process and the EU accession, this should be rather seen as a building of analytical capacities in the country to generate a solid base for well-informed and wise policy-making and for devising the national position in the international and European negotiation processes.

[25] A list of the directives within the *acquis communautaire* related to energy is here: http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY/Legal/EU_Legislation

5.2. MITIGATION ANALYSIS IN THE ENERGY SECTOR

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=271

The Research Centre for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU) conducted a comprehensive assessment of climate change mitigation potential of the national energy sector by making use of MARKAL energy system model. The "national energy sector" should be considered in a wider sense, since the MARKAL model covers the emissions which are associated with fuel combustion, incorporating thus energy supply and demand sectors – households, industry (fuel combustion emissions), transport, commercial and services and agriculture (fuel combustion emissions). The ICEIM-MANU team has developed a baseline scenario and three groups of mitigation scenarios until 2050, with emissions limitation/reduction targets and measures and activities from the various sectors adopted for the Macedonian context as defined the by an international expert (Duic 2013). The work of ICEIM-MANU has also included a sensitivity analysis and a comparative assessment of the economic aspects of different types and levels of emissions limitation/reduction targets corresponding to different level of ambition of the national policies. Lastly, based on the analytical results, the mitigation measures and actions which are most appropriate for the country are summarized in a mitigation action plan.

5.2.1. Baseline scenario in the energy sector

To assess the impact of different climate change mitigation policies and programs on the evolution of the energy system, a Baseline Scenario was developed, taking into account specific characteristics of the national energy system, such as existing technology stock, all possible new technology options, resource availability and import options, and near-term policy interventions. For this purpose all available national data sources (State Statistical Office, National energy balances, etc.) as well as some international databases (e.g., International Energy Agency) were utilized. The key indicators for the baseline scenario are shown in Table 5-1.

TABLE 5-1: Key indicators for the Baseline Scenario in energy

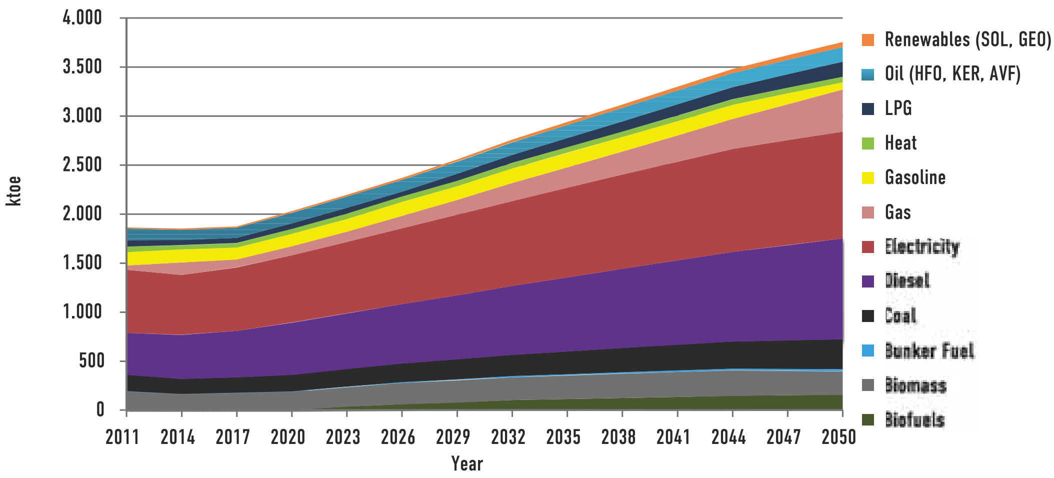
Indicator	2011	2032	2050	Annual Growth Rate 2011 - 2032 (%)	Annual Growth Rate 2011 - 2050 (%)	Overall Growth 2011 - 2032 (%)	Overall Growth 2011 - 2050 (%)
Final Energy Consumption (ktoe)	1.863	2.758	3.754	1,89%	1,81%	48%	102%
Power Plant Capacity (MW)	1.838	2.687	2.875	1,82%	1,15%	46%	56%
Electricity Generation & Import (GWh)	8.870	11.945	14.980	1,43%	1,35%	35%	69%
Primary Energy Supply (ktoe)	3.008	4.381	5.252	1,81%	1,44%	46%	75%
CO_2 Emissions (kt)	9.481	14.118	14.166	1,91%	1,03%	49%	49%

The following results from the analysis are of note:

Under the Baseline scenario, energy consumption is projected to grow by 48% in terms of final energy by 2032, and by 102% by 2050. The most significant share in final energy consumption is related to diesel and electricity use, as well as natural gas, available through import (Figure 5-1). Diesel and electricity have the largest share in the final energy consumption over the entire planning period. After 2035 the natural gas and coal have increasing share due to increased demand of these fuels in commercial and industry sectors.

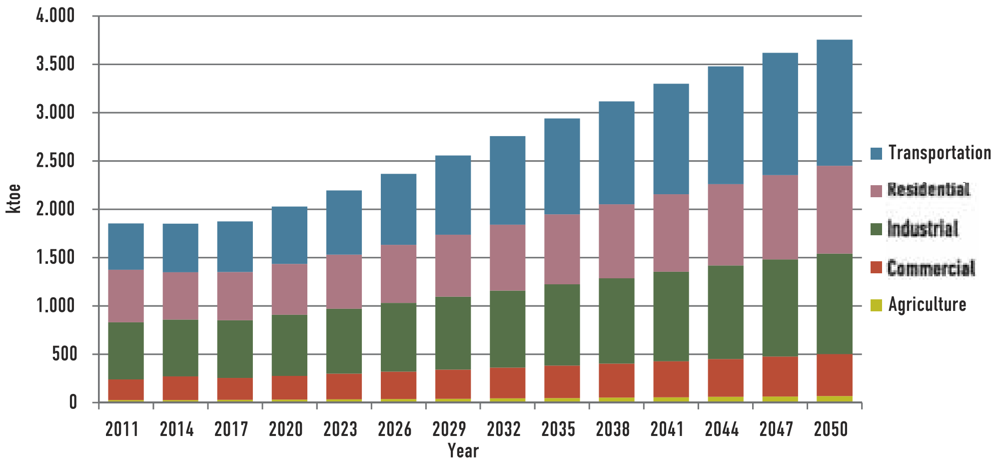
The highest increase of the final energy consumption over the period 2011 -2050 is expected in the transport (around 172%) and agriculture sectors (around 164%) (Figure 5-2). Energy consumption in the commercial and industrial sector is also expected to increase, while in the residential sector the final energy consumption is expected to change relatively slowly.

FIGURE 5-1: Final energy consumption by fuel type under the Baseline scenario (ktoe)



*SOL-Solar; GEO – Geothermal; HFO – Heavy fuel oil; KER – Kerosene; AVF – Aviation fuel; LPG - Liquefied petroleum gas

FIGURE 5-2: Final energy consumption by sector under the Baseline scenario (ktoe)



To address the electricity demand investments in new generation capacities are expected to take place. The total installed capacity expected to be used for electricity generation during the period 2011 - 2050 is shown on Figure 5-3. The following is noteworthy related to existing and expected installed capacity:

- By 2017 the existing coal power plant Bitola (with around 600 MW) will need to be revitalized to satisfy the requirements under the EU's Large Combustion Plant Directive[26] and is expected to be available for operation until 2032.
- Existing gas-fired power plants are also expected be available until 2032 with a total capacity of 290 MW.
- Existing hydro power plants are expected to be available during the whole planning period with the same capacity of 579 MW.
- Significant investments in new coal-fired power plants (700 MW) and gas-fired power plants (920 MW) are expected.
- Significant investments in hydropower (363 MW) are expected via three new large hydro power plants (HPP Sv. Petka, HPP Boskov Most and HPP Lukovo Pole) and small HPPs.
- Wind investments are also expected of 150 MW before 2032 and another 139 MW by 2050.
- Solar investments are expected of 25 MW by 2032.
- These other generation capacities (hydro, wind and solar PP), will operate mostly at full capacity.
- Figure 5-4 shows the actual electricity expected to be generated by the various sources over the time period and levels of imports. A small amount of electricity import is expected, which is expected to remain almost at the same level over the planning period.

[26] Directive 2001/80/EC on the limitation of emissions of certain pollutants into the air from large combustion plants (the LCP Directive). http://ec.europa.eu/environment/air/pollutants/stationary/lcp/legislation.htm

FIGURE 5-3: Installed capacity of existing and new build power plants under the Baseline scenario (MW)

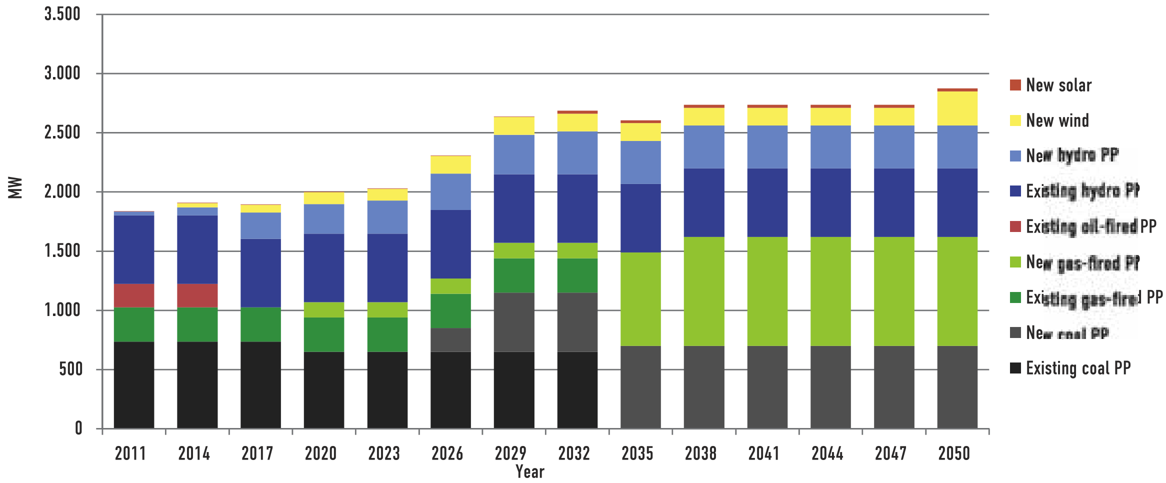
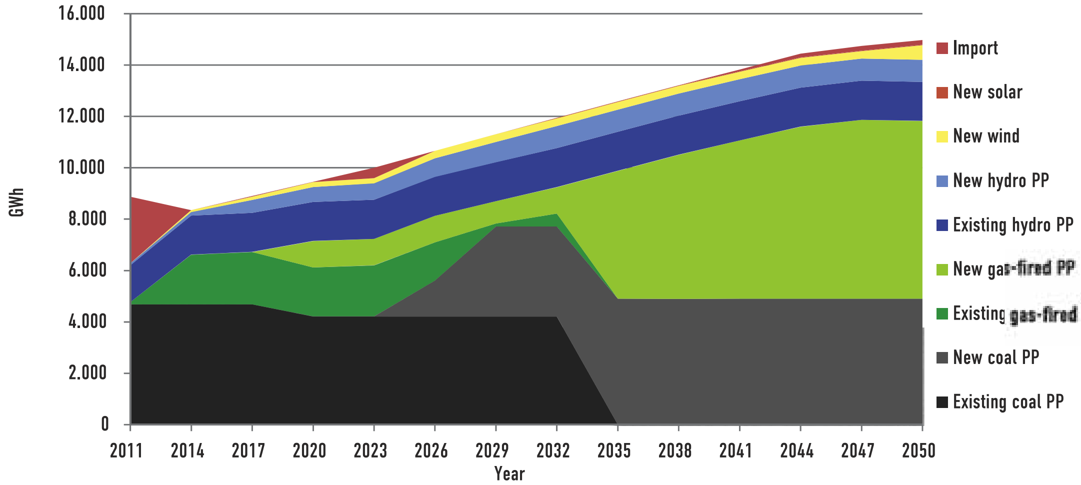
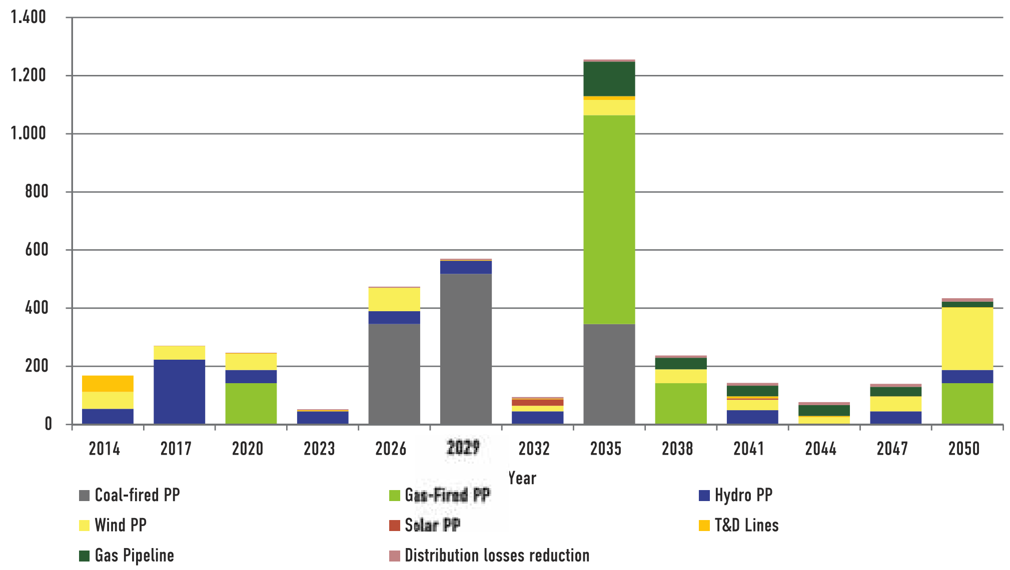


FIGURE 5-4: Electricity Generation and Import under Baseline Scenario (GWh)



The investment expenditures for new power plants and devices are expected – a total investment of around EUR 4,005 million plus an additional EUR 95 million for new transmission and distribution networks. A significant level of investment of around EUR 1,129 million is foreseen in the three years around 2035 when old power plants are retired and new additional capacities (mainly gas-fired and coal-fired) are built. Additional investment in new gas pipeline of EUR 285 million is also expected to be necessary. Figure 5-5 shows the capital investment requirements associated with the new capacity added in each three year period.

FIGURE 5-5: Total Investment Cost of New Power Plants and Gas Pipe line under Baseline Scenario (MEUR)



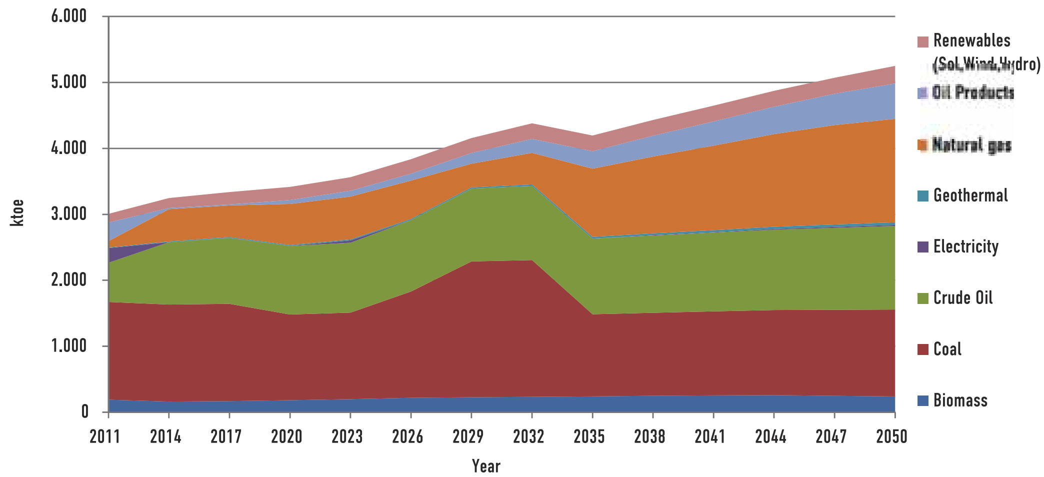
* Investment levels are not annual but cumulative for each three-year period

Primary energy supply in 2032 is projected to be 4381 ktoe and 5252 ktoe in 2050, increasing from 2011 levels by around 46% and 75%, respectively. The total discounted system cost (cumulative over the period 2011 – 2050) for realization of the Baseline Scenario is estimated to be EUR 51,181 million.

The supply is expected to become more diverse. As shown in Figure 5-6:

- The share of imported natural gas is expected to increase over the planning period.
- The growth in transport demand is reflected in the consumption of oil products (imported) and crude oil.
- The share of coal as a primary energy source is expected to decrease after 2032.
- The contribution of renewable energy sources (excluding biomass) to total primary energy during this period is expected to grow by 119% over the period 2011-2050. This is primarily due to expected additional wind capacity in the power sector.
- The biomass contribution is expected to be almost the same in 2032 and drop slightly by 2050

FIGURE 5-6: Primary Energy Supply under Baseline Scenario (ktoe)



Based on these projections, CO_2 emissions would change from ~9.5 Mt in 2011 to ~14 Mt in 2032 - then reducing sharply and increasing again to ~14 Mt in 2050 with power generation making up the largest share. The CO_2 emissions expected in the baseline scenario from all energy sectors are given in Table 5-2. The projected decrease in 2035 is a result of the retirement of the existing coal- and gas-fired power plant units. The emissions are expected to rise again when new coal power plants enter into the system (in 2035). Additionally, there is an expected significant growth of CO_2 emissions other sectors, particularly from the transport and commercial sectors. As a result of expected growing numbers of vehicles in the fleet and increased consumption of petroleum products, the CO_2 emissions from transport are expected to increase by more than 140%. The expected increased emissions from commercial sector are mainly because of the increased utilization of gas in this sector.

TABLE 5-2: Projected CO_2 emissions by sectors under the Baseline scenario (kt)

	2011	2014	2017	2020	2023	2026	2029	2032	2035	2038	2041	2044	2047	2050
Agriculture	75	46	49	52	56	60	65	70	75	80	85	89	94	99
Commercial	165	342	228	240	256	271	288	305	327	352	384	425	476	540
Industry	1.346	1.245	1.261	1.332	1.414	1.497	1.582	1.659	1.724	1.811	1.898	1.981	2.092	2.192
Power Sector	6.327	7.043	7.069	6.518	6.549	7.704	9.141	9.348	6.624	6.841	7.040	7.230	7.325	7.310
Residential	145	144	146	153	163	179	216	260	307	339	378	410	474	543
Transport	1.424	1.490	1.546	1.754	1.904	2.064	2.259	2.475	2.655	2.863	3.052	3.241	3.355	3.482
Total	9.481	10.311	10.298	10.049	10.343	11.774	13.550	14.118	11.712	12.286	12.837	13.376	13.816	14.166

5.2.2. Mitigation measures in the energy sector

Over the course of developing the TNC, three different sets of mitigation scenarios were analysed:

- The first group of scenarios were labelled **"EU scenarios"** which implied that the Republic of Macedonia would join the EU and follow a relatively ambitious path towards emissions reductions – i.e. from 1990 levels as the base, 20-40% reductions by 2030 and 40-80% reductions by 2050.

- The second group of scenarios were labelled **"QELRC"** – or "Quantified Emission Limitation of Reduction Commitment". In these scenarios, the targets were based on the cumulative reductions in emissions over the course of the period as compared with the levels which would have been the case if the base continued (i.e. if each year was the same as 1990 levels). The 1990 level of total emissions was about 9,500 kt CO_2-eq.[27] The QELRC scenarios involved a wide range of emissions targets and subsequent energy choices for 2021-28 (ranging from -20% to +20% comparing to 1990). For each subsequent budget period (i.e. each 8 years), each sub-scenario had targeted emissions reductions of 10% less at the end of each period (Table 5-3

TABLE 5-3: Definition of QELRC Mitigation Scenarios (in comparison to 1990 reference levels)

	2021 o 2028	2029 to 2036	2037 to 2044	2045 to 2052
QELRC _Low	+20%	+10%	0%	-10%
QELRC _MediumLow	+10%	0%	-10%	-20%
QELRC _Medium	0%	-10%	-20%	-30%
QELRC _MediumHigh	-10%	-20%	-30%	-40%
QELRC _High	-20%	-30%	-40%	-50%

- The third group of scenarios were labelled "**BAU Deviation**" scenarios and involved modelling what would occur if the Republic of Macedonia defined mitigation as a deviation from the Business as Usual track. See Table 5-4 for details on the emissions reductions.

TABLE 5-4: Definition of BAU Deviation Mitigation Scenarios (in comparison to the Baseline scenario)

	2020	2028	2036	2044	2052
BAUdev_Low	-10%	-15%	-20%	-25%	-30%
BAUdev_Medium	-15%	-20%	-25%	-30%	-35%
BAUdev_High	-20%	-30%	-40%	-50%	-60%

These scenarios were compared based on their economic and environmental effectiveness, including the following three indicators:

- **Cumulative emissions:** Sum of the annual emissions over the period 2011-2050
- **Cumulative total system costs:** Sum of the annual total system costs over the period 2011-2050
- **Incremental specific reduction cost:** Calculated as ratio between increment of cumulative total system costs and reduction of cumulative emissions compared to baseline scenario

In order to make the comparison possible, the first two indicators are of cumulative, while the third one depicts the performances of the mitigation scenario against the baseline scenario. This third indicator expresses the costs which would need to be added on top of carbon prices in order to achieve the emission reduction.

In case of all mitigation scenarios carbon pricing is introduced in the model, as presented below:

- until 2020: 0 EUR/tCO_2
- 2021 – 2024: 15 EUR/tCO_2
- 2025 – 2027: 20 EUR/tCO_2
- 2028 – 2030: 25 EUR/tCO_2
- 2030 – 2050: 30 EUR/tCO_2

For each indicator, three levels are introduced as to whether they are satisfactory – good (green), acceptable (yellow) and poor (red), as presented in Table 5-5. With two green scores and one yellow score the **QELRC-Medium scenario was shown to be the most satisfactory mitigation scenario.** It assumes:

- Maintaining the 1990 emission level (0 % reduction) over the budget period 2021-28
- 10% reduction of 1990 emission level over the budget period 2029-36
- 20% reduction of 1990 emission level over the budget period 2037-44
- 30% reduction of 1990 emission level over the budget period 2045-52

The QELRC-Medium mitigation scenario will be used as a basis for elaboration of a Mitigation Action Plan.

[27] So over the course of, for example, 8 years, the cumulative reference point of emissions is 76,000 kt CO_2-eq. The QELRC targets would be based on the cumulative amount of emissions over the same 8-year period. So a target of a 10% reduction would be a target of 76,000 kt CO_2-eq – 7,600 = 68,400 over the same period.

TABLE 5-5: Comparative Assessment of the Mitigation Scenarios

		AMBITION LEVEL		
		Low	Medium	High
EU	Cumulative emissions (kt)	302.613	269.871	234.929
	Cumulative total system costs (2012 MEUR)	51.725	52.243	52.487
	Incremental specific reduction cost in addition to a carbon price (EUR/t)	2,7	4,53	4,85
OELRC	Cumulative emissions (kt)	345.878	320.961	285.950
	Cumulative total system costs (2012 MEUR)	51.338	51.521	52.092
	Incremental specific reduction cost in addition to a carbon price (EUR/t)	0,99	1,86	4,17
BAUdev	Cumulative emissions (kt)	347.519	340.113	300.290
	Cumulative total system costs (2012 MEUR)	51.550	51.809	52.945
	Incremental specific reduction costs in addition to a carbon price (EUR/t)	2,35	3,82	8,64
	Colour code:	Good	Acceptable	Poor
	Cumulative emissions (kt)	<300.000	300.000 - 325.000	>325.000
	Cumulative total system costs (2012MEUR)	<51.600	51.600 - 52.000	>52.000
	Incremental Specific reduction costs (EUR/t)	<2,00	2,00 -4,00	>4,00

5.2.2.1. Energy supply with a focus on electricity

The first area to examine potentials for mitigation measures is related to energy supply. Using the MARKAL model as described above, the QERLC Medium scenario was evaluated as the best mitigation scenario on the energy supply side. It would result in changes of the total installed capacity of the power plants over the entire planning period. In this scenario, the following new capacity would be installed:

- 1087 MW in new gas-fired power plants,
- 1087 MW in new hydro power plants
- Additional renewable energy capacities of 385 MW, as follows:

a. Wind and solar power plants subsidized by feed-in tariffs with total capacity of 150 MW and 25 MW, respectively, and

b. From 2032 an additional 210 MW of wind power plants without feed-in tariffs

c. Biogas and Biomass technologies were also initially included, but the model did not select them due to high costs. Additionally, reliable data for modelling of these technologies, including resource potential was not available.

As can be seen, related to energy supply, the most cost-effective areas for mitigation are therefore:

- Installing natural gas-fired power plants instead of coal plants;
- Hydropower development;
- Wind power development; and
- Some solar power development.

The new gas –fired power plants would require 1,554 million Nm^3 which, with the additionally needed amounts in other sectors will make about 1,800 million Nm^3. Therefore, on top of the existing gas pipeline (capacity of 800 million Nm^3) additional amount of 1,000 million Nm^3 gas would need to be ensured. The planned hydro and wind projects are in line with the national energy strategy[28] and renewable energy strategy[29] and most of them are included in the investment plans of national power company ELEM[30].

For these additional generation capacities EUR 4,982 million will be needed (Table 5-6). Also, additional investment of nearly EUR 291 million in new transmission and distribution networks are necessary.

[28] Government of the Republic of Macedonia (2010) Strategy for Energy Development in the Republic of Macedonia until 2030, Skopje.

[29] Government of the Republic of Macedonia, Strategy for Utilization of Renewable Energy Sources in the Republic of Macedonia by 2020, Skopje, 2010.

[30] http://elem.com.mk/index.php?option=com_content&view=article&id=65&Itemid=150&lang=en; http://elem.com.mk/index.php?option-=com_content&view=article&id=102&Itemid=153&lang=en

TABLE 5-6: Mitigation actions in the energy supply sector

Technology	Installed capacity (MW)													Lump Sum Investment (MEUR 2012)
	2014	2017	2020	2023	2026	2029	2032	2035	2038	2041	2044	2047	2050	
Gas CHP	-	-	-	-	-	-	-	-	-	6,7	-	-	-	7
Gas CHP 1	-	-	-	-	100,0	-	-	-	-	-	-	-	-	109
Gas CHP 2	-	-	-	-	-	-	-	380,0	-	-	-	-	-	414
Gas CHP 3	-	-	300,0	-	-	-	-	-	-	-	-	-	300,0	654
Gas CHP 4	-	-	300,0	-	-	-	-	-	-	-	-	-	300,0	654
Gas	-	-	600,0	-	100,0	-	-	380,0	-	6,7	-	-	600,0	1.838
HPP Sv. Petka	36,0	-	-	-	-	-	-	-	-	-	-	-	-	54
HPP Boskov Most	-	68,2	-	-	-	-	-	-	-	-	-	-	-	83
HPP Galiste	-	-	-	-	-	-	-	-	-	193,5	-	-	-	390
HPP Lukovo Pole	-	58,0	-	-	-	-	-	-	-	-	-	-	-	95
HPP Gradec	-	-	-	-	-	-	-	-	54,6	-	-	-	-	305
HPP Demir Kapija	-	-	-	-	-	-	24,0	-	-	-	-	-	-	148
HPP Gevgelija	-	-	-	-	-	-	-	-	17,0	-	-	-	-	116
HPP Babuna	-	-	-	-	-	-	-	-	-	17,0	-	-	-	88
HPP Gradsko	-	-	-	-	-	-	-	-	-	-	-	17,0	-	106
HPP Kukuricani	-	-	-	-	-	-	-	-	17,0	-	-	-	-	104
HPP Krivolak	-	-	-	-	-	-	-	-	17,0	-	-	-	-	104
HPP Dubrovo	-	-	-	-	-	-	-	-	-	17,0	-	-	-	124
HPP Militkovo	-	-	-	-	-	-	-	-	-	-	17,0	-	-	128
HPP Chebren	-	-	-	-	-	-	-	-	-	333,0	-	-	-	570
Small HPP	-	28,2	28,3	28,2	28,2	28,3	28,2	-	-	30,6	-	28,2	28,3	410
Total Hydro PP	36,0	154,4	28,3	28,2	28,2	28,3	52,2	-	105,6	591,1	17,0	45,2	28,3	2,825
Solar PV	-	-	-	-	-	-	21,0	-	-	4,0	-	-	-	27
Wind	36,0	29,0	35,0	-	50,0	37,1	184,9	33,7	31,0	23,3	16,7	45,7	86,4	947
Total Other RES	36,0	29,0	35,0	-	50,0	37,1	205,9	33,7	31,0	27,3	16,7	45,7	86,4	974
Distribution Losses Reduction	12,6	19,9	21,3	20,8	6,2	3,7	3,3	-	-	2,4	2,6	-	-	291
TOTAL	84,6	203,3	684,6	49,0	184,4	69,1	261,4	413,7	136,6	627,5	36,3	90,9	714,7	5.928

In addition to power supply, mitigation measures related to reducing or altering energy demand will be important. In the course of preparation of the TNC, the demand-side options were not modelled and analysed for their technical and economic potential. However, the sections below outline the types of measures which could be implemented and would result in decreases in GHGs. Further analysis is necessary to prioritize these measures and develop specific project proposals.

5.2.2.2. Buildings

In the buildings sector, mitigation measures can be carried out in the residential sub-sector and in commercial buildings. Some of these measures are in theory planned as a part of the Republic of Macedonia's commitments as part of the Energy Community. At the same time, though, additional assistance from the international community in carrying them out effectively will be necessary.

The mitigation measures in residential buildings could be compulsory and voluntary measures and incentives, as well as promotion and technical support, based on international best practices. Specifically, they include:

- Skopje District Heating end-use heat metering and consumption-based billing;
- Energy Efficiency in Social Housing;

- Building codes and enforcement/certification;
- Electrical appliance and equipment labelling, and energy performance standards;
- Replacement of fire wood furnaces with high efficiency models;
- Information centres; Information campaigns on energy efficiency;
- Hot water boiler and air conditioner labelling and energy performance standards control;
- Financial support to natural persons for EE investments;
- Solar systems and geothermal heat pumps in old houses;
- EE measures in existing multi-apartment residential buildings:
  - Window and door replacement
  - Attics insulation
  - Façade insulation
  - Introduction of efficient lighting in residential apartments and common space

Public building interventions have also been proven to be fairly cost effective, either targeting a single technology improvement (lighting, windows, motors, and building envelope) or applying an integrated facility approach. As the fastest penetration approach, the compulsory measures should be applied in the public buildings. Public buildings are probably the only category of buildings where energy efficiency measures can and must be imposed. Specifically, these measures include:

- Building codes enforcement and certification
- Inspections of boilers/air conditioning systems
- Education sector-schools renovation
- Information centres, campaigns, municipal EE network
- Energy management and auditing in the commercial and services sector
- Street lighting efficiency upgrades
- Electrical appliance and equipment labelling and energy performance standards
- Hospital Buildings Refurbishment
- Solar systems and geothermal heat pumps
- EE and Corporate social responsibility

5.2.3. Transport

This section is a summary of a report developed for the TNC. The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=273

As noted in Section 5.2.1 above, the transport sector is expected to have dramatic growth in energy demand and consumption in the Baseline scenario. This is potentially problematic due to the increased GHG emissions expected as well as the increased costs of import of fuels. Therefore, mitigation measures in the transport sector were examined for their costs. Five basic types of mitigation measures were examined closely:

Measure 1: Introduction of low carbon fuels: According to the national RES strategy (Government of the Republic of Macedonia 2010) it is necessary for the Government to adopt a Rulebook on the manner of securing a relevant share of biofuels in the total energy consumption in transport. This is in accordance with the EU *acquis communautaire*. This will likely be achieved by putting blends into market circulation under a clearly defined dynamic aimed to increase share of biofuels. For that purpose, measures are needed by which the State will promote the use of blends with biofuels without significant increase of fuel prices. Also, as part of the program on agricultural development, it would be possible to stimulate the production of domestic raw materials for biofuels by supporting producers of biofuels to invest in agricultural production of raw materials, guaranteed purchase, favourable crediting lines, etc. Compress Natural Gas (CNG) also has a considerable potential for reduction of GHG emissions at low (even negative) costs. However, higher utilization is conditioned upon gasification of the country. Some examples of CNG support in other countries include grants for the purchase of CNG vehicles or conversion and grants for filling stations.

Measure 2: Awareness raising campaigns: This measure is aimed at improving the driver behaviour which considerably affects fuel economy. Minimizing unnecessary braking (for instance, by not tailgating), observing the speed limit, anticipating the actions of other drivers, and avoiding excessively rapid acceleration can increase kilometres per litre by a few percent over normal driving behaviour. Studies of programmes to promote these behaviours, however, have found that it is difficult to sustain the gains without regular awareness rising campaigns and driver training.

Measure 3: Improvement of travel behaviour: This measure includes more actions aimed at promotion of more sustainable modes of transport and travel behaviour. The implementation of some of these measures requires big investments and must be part of greater national projects. For the TNC analysis, this specifically meant using public transport instead of own car and biking and walking instead of driving. These could be facilitated by:

- Renewal of public transport bus fleet;
- Promotion of greater use of bicycles – including investments in the bicycle network infrastructure, as well as a public campaign for greater use of bicycles;
- The introduction of trams in Skopje;
- The introduction of integrated traffic management system, in particular within the centre city of Skopje;
- Introduction of paid parking schemes to encourage public transport use;
- Car-free day promotions through the media (TV, radio, posters, etc.);
- Promotion of greater use of railway for intercity travel. The improvement of national railway infrastructure is a capital undertaking that include huge investments. However, within this measure, it is expected to increase the railway intercity passenger ridership by improvement of rail timetables – better service suited to the passenger needs, and by a public campaign.

Measure 4: Improvement of vehicle fleet: Contributing to this measure, the Government has already provided tax relief for energy efficient vehicles (in accordance with Article. 51v of the Law on Excise "Official Gazette of the Republic of Macedonia no.32/01...82/13" hybrid passenger cars, with combination of gasoline engine and electric motor, are exempt from excise). Besides these, regulatory and fiscal measures could additionally incentivise the purchase and use of clean and energy efficient cars by implementing policies such as:

- Provision of bank credits with lower interest rates, if a new clean and energy efficient car is purchased. The difference from commercial rates can be covered by the Government, but also other financial arrangements can be made between the government and the commercial banks.
- Lower costs for vehicle registration for clean and energy efficient cars;
- Lower costs for parking in the centre of the city for the clean and energy efficient cars;
- Lower ecological tax and tax on property (if there is any) for clean and energy efficient cars.

Measure 5: Advancement of vehicle equipment: This strategy is aimed at promoting the utilization of advanced equipment (i.e. low resistance tires and low viscosity lubricant) which can considerably contribute to fuel economy improvement. Furthermore, it is possible to reduce the fuel consumption by another few per cent via optimal vehicle maintenance. Here again, regular awareness rising campaigns and driver training are crucial factors of success.

Mitigation potential and cost-effectiveness

The total achievable reduction in transport sector (if all considered mitigation strategies are implemented with the assumed breakthrough rate) in 2020 is estimated to be 0.45 Mt CO_2 which is 22% of the baseline level in 2020 (about 2 Mt CO_2) (see Table 5-7).

TABLE 5-7: Mitigation options and their expected impact in the transport sub-sector

Mitigation option	EUR/ tCO2	Unit type	Emission reduction (tCO2/ unit)	Units penetrating in 2020	Emissions reduction in 2020		
					Per option (Mt/ year)	Cumulative (Mt/ year)	Cumulative fraction of the projected baseline level in 2020 (%)
Campaigns for awareness raising	-463	Campaigns	16.762		0,02	0,02	1%
Improvement in travel behaviour	-415	Passenger	0,20	70.000	0,01	0,03	2%
Advance vehicle equipment	-67	4 tires, 4l lubricant	0,05	600.000	0,03	0,06	3%
Introduction of low-carbon fuels	67	26.5 PJ	264.053	1,00	0,26	0,33	16%
Improvement of the vehicle fleet	73	Vehicles	0,57	216.200	0,12	0,45	22%

From the above table, the following is noteworthy:

- Three of the five mitigation strategies are of negative costs (win-win type) although with relatively low environmental effectiveness: 3% of the achievable reduction can be realized at negative costs. These strategies include Campaigns for awareness rising, Improvement of travel behaviour and Advanced vehicle equipment.
- The bulk of the achievable emission reduction can be realized at relatively high specific costs (around 67 EUR/t CO_2).
- The highest environmental effectiveness is associated with the introduction of low carbon fuels (0.26 Mt CO_2 per year), which represents more than half of the total achievable emission reduction.
- The highest economic effectiveness is associated with the rising awareness campaigns aimed at improvement of driver behaviour (-463 EUR/t CO_2).

5.2.4. Industry

Mitigation measures in industry are important for GHG reductions as well as ensuring the competitiveness within industries – especially where energy costs make up a significant share of production costs. The mitigation measures examined are focused on improvement of technologies, equipment, and process control systems. Companies will be required to apply best available technologies in performing their activities. Co-generation is promoted when searching for local energy supply. Specifically, the measures include:

- Improvement of process performances (Cleaner production, integrated pollution prevention and control – IPPC – permitting);
- Energy Auditing;
- Co-generation;
- Energy performance of non-residential buildings;
- Improved lighting and improved heating systems;
- Fuel type change;
- Waste heat utilization;
- Smart drives;
- Compressed air supply;
- Good house-keeping; and
- EE and Corporate social responsibility.

5.3. MITIGATION ANALYSIS IN THE WASTE SECTOR

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=270

Total annual quantities of waste generated in the country are 26,218,257 t of which the biggest parts (95%) are related to extraction and processing in the mining industry (17,246,000 t or 66%), agriculture waste (5,610,000 t/y or 21%) and waste from thermal processing industry (2,015,379 t or 8%).[31] The remaining waste is industrial waste, construction waste and municipal waste, medical waste and waste water treatment waste.

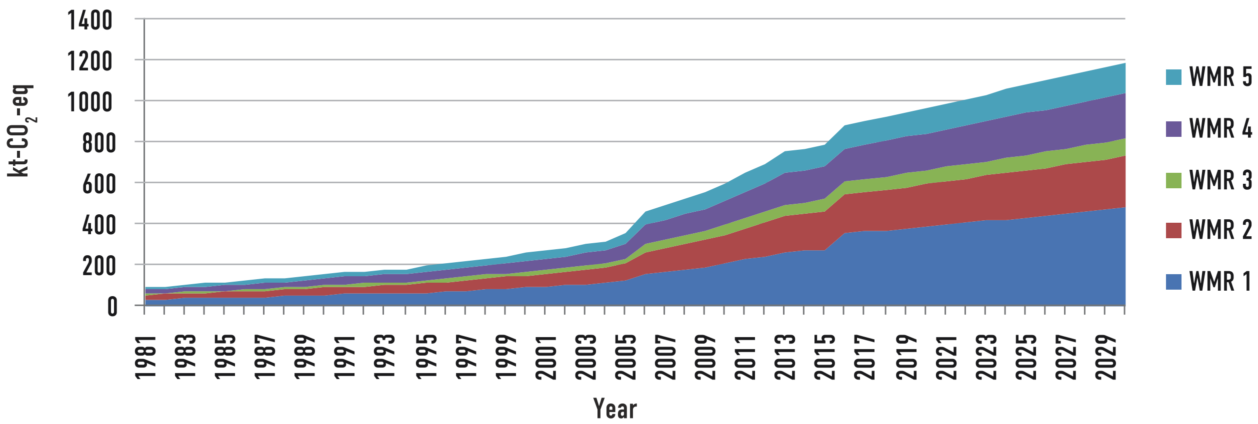
The specific waste generation in the country is estimated at 332.63 kg per capita per year, which makes 688,284 t/year.[32] 70% of the population in the country is covered with collection schemes of Public Communal Enterprises (PCE), but only 10% are covered in the rural areas mainly due to the lack of technical and human capacities at the PCEs. The remaining 30% of the population dispose their waste at wild dumps – of which it is estimated that there are 1,000. The percentage of biodegradable waste is significant (75.1%) which includes organic waste, paper and cardboard, wood and textiles.

Collection, transport and landfilling are the main, regular methods for the final disposal of almost each of the waste fractions. The available facilities and capacities for treatment and disposal of wastes are inadequate, legislation and standards are not effectively enforced, and current waste management practices contribute to the pollution of air, water resources and land. The main waste disposal option is landfilling.

5.3.1. Baseline scenario in the waste sector

The baseline scenario for the waste sector was developed and emissions are calculated using Tier 2 methodology and taking into account disposed waste from year 1981 onward – projected until 2030 based upon expected population and economic growth. The basic assumption is that there will be no investment in new landfills but that existing sites will only have maintenance costs that amount 3.45 EUR/t on average. Figure 5-7 shows the expected trajectory of GHG emissions from the waste sector in the baseline scenario.

FIGURE 5-7: The baseline scenario of GHG emissions in the waste sector sorted according to waste region



5.3.2. Mitigation measures in the waste sector

The proposed measures for reduction of GHG emissions target two types of landfills: Existing non - compliant landfills and new regional landfills. Additional mitigation measures are possible for wastewater treatment from households and industry but were not analysed for the purposes of the TNC:

For the wastewater treatment sector for households, the mitigation measure is generally the development of new sewage systems in the settlements that are not covered with organized collection of sewage and upgrading of the existing sewage systems. These measures are mainly driven by the Government policies, prioritization in municipalities and foreign funds. Since they are not easily predicted, very costly (average EUR 10 million) and can achieve only slight emission reductions, these measures are not analysed further in this document.

[31] Data from the National Waste Management Plan 2009-2015 – NWMP2
[32] Population of 2,069,219 as estimated by the World Bank

For the wastewater treatment sector for industry, the mitigation measure is the implementation industrial wastewater treatment plants – which are already a part of IPPC requirements and they need to complete their applications by the year 2019. Since these emissions are only 1.58% of total waste emissions and depend on private investments of industries, they are not analysed further in this document.

For municipal solid waste management, the National Waste Management Strategy (2008- 2020) prescribes the establishment of the new regional municipal waste management systems in accordance with EU requirements on landfilling and the implementation of an integrated approach. In this plan, new regional landfills would be opened in all Waste Management Regions (WMRs). There are five different WMRs currently proposed for the development of regional landfills.

- WMR1: Skopje region;
- WMR2: East, Northeast and Vardar regions;
- WMR3: Southeast region;
- WMR4: Pelagonia and Southwest regions; and
- WMR5: Polog region.

The overall aim of the Waste Management Strategy is as much as possible to reduce waste sent to the landfills. In practice, this means collection, transportation and disposal of waste, waste treatment and eventual use of Refuse Derived Fuel (RDF) as a fuel in cement facilities as a final stage of the waste management cycle. The closing of existing landfills and development of new regional landfills are connected because the closure and remediation measures for the existing non-compliant landfills cannot be implemented if there is no construction of the new regional landfills. Therefore, there are five basic measures for GHG mitigation in the waste sector:

Measure 1: Closing and covering the existing non-compliant landfills followed by gas extraction and flaring: The current practice of the municipal landfills is only to unload the waste without compaction and covering activities. Based on the special study of the National Waste Management Plan 1 – NWMP1 (2006 - 2012) there are 55 landfills which are not in accordance with the EU standards. The entire surface which must be covered and rehabilitated is 86 ha. There are four municipal landfills which need urgent closure and rehabilitation: Kicevo, Ohrid, Kriva Palanka, and Gevgelija. They occupy 11 ha of land. For these existing landfills the most feasible option suggested by waste experts worldwide and prescribed in the NWMP1 is to cover the whole disposal area and introduce gas extraction and flaring, converting methane emissions to CO_2 which has significantly lower global warming potential. Burning one tonne of CH_4 results in an 87% reduction of CO_2-eq, which is a significant GHG reduction. Production of electricity as an option is not chosen in this study because there is uncertainty in landfill gas quantities.

Measure 2: Mechanical and biological treatment (MBT) in new landfills: This measure involves the sorting of waste for removal of metals, plastics and glass (see Figure 5-8 and Figure 5-9). It is a necessary step for any other treatment (composting, anaerobic treatment, or RDF development).

Measure 3: Aerobic treatment (composting) in new landfills: Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. It is a key ingredient in organic farming. The process of composting simply requires making a heap of wetted organic matter (leaves, "green" food waste) and breaking down the materials into humus over a period of weeks or months – usually including closely monitored inputs of water, air, and materials. Aerobic bacteria manage the chemical process by converting the inputs into heat, carbon dioxide and ammonium. The ammonium is further converted by bacteria into plant- nourishing nitrites and nitrates through the process of nitrification. There is a reduction of GHGs by reducing methane emissions and instead resulting in CO_2 emissions.

FIGURE 5-8: Channelled concrete floor of a composting pad for perforated piping that delivers oxygen to the composting mass

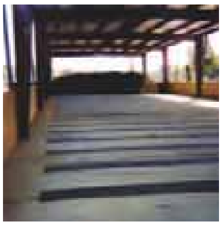


FIGURE 5-9: Aeration System for a Closed Chamber Composting Facility

Measure 4: Anaerobic treatment of organic waste: This measure involves the placement of organic material in anaerobic digesters with subsequent energy production (see Figure 5-10 and Figure 5-11 below). Within the anaerobic digesters, the organic waste is transformed into biogas (which can be burned as a fuel) and other material which can be used as a fertilizer. There is a reduction of GHGs by reducing methane emissions and instead resulting in CO_2 emissions. The burning of the methane can also displace fuel sources with higher-GHG content such as coal.

FIGURE 5-10: Stages of Biodegradable Waste Decomposition in Anaerobic Conditions

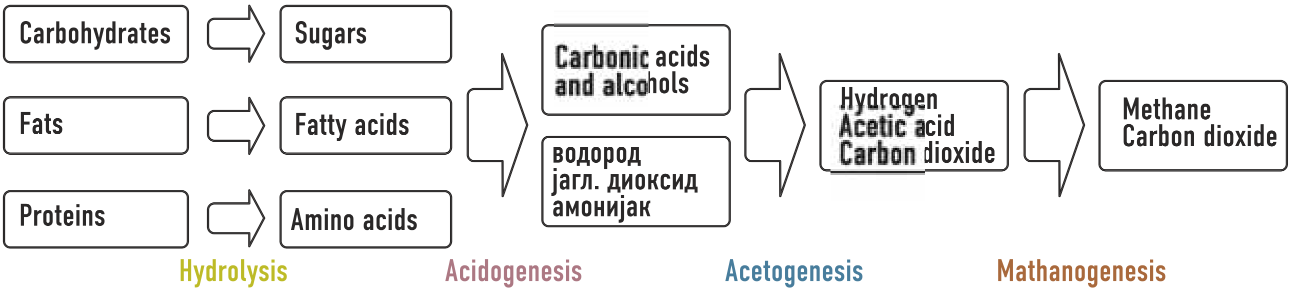


FIGURE 5-11: A typical anaerobic digestion plant which is a part of an MBT plant

Measure 5: The production of RDF: The production of RDF involves converting combustible waste materials to an engineered fuel. The RDF system provides additional GHG reduction because all the carbon contained in the waste is incinerated instead of put into landfills – which can reduce methane emissions and displace fuel sources with higher-GHG content such as coal.

The costs of investment and operation both on a total basis and per-unit basis are provided in Table 5-8.

TABLE 5-8: Costs of investment and operation on a total and per-unit basis for various mitigation measures

Facility	New regional landfill[1]	Gas extraction and flare[1]	Composting plant[2]	Anaerobic digestion[2]	MBT plant[1]	RDF plant[1]
Capacity (t/y)	150.000 t/y.	500 m³/h	150.000 t/y. mixed waste	150.000 t/y. mixed waste	150.000 t/y.	51.000 t/y. selected waste
Investment costs (EUR)	3.594.444	590.859	5.481.714	12.649.226	27.768.889	2.407.516
Operational costs (EUR)	212.011	53.977	567.155	1.163.193	1.502.592	561.632
Investment unit price (EUR/t)	23,96	3,93	36,54	84,34	185,13	16,05
Operational unit price (EUR/t)	0,81	0,36	3,79	7,76	10,00	3,73

[1] Drisla feasibility study

[2] Own expert data

5.3.3. Mitigation scenarios

Studies for the TNC examined five scenarios (Baseline plus 4 additional scenarios) which are the subject of analysis done in this project. Table 5-9 describes the costs and GHG benefits of each of these scenarios.

TABLE 5-9: Economic and environmental effectiveness of the mitigation scenarios

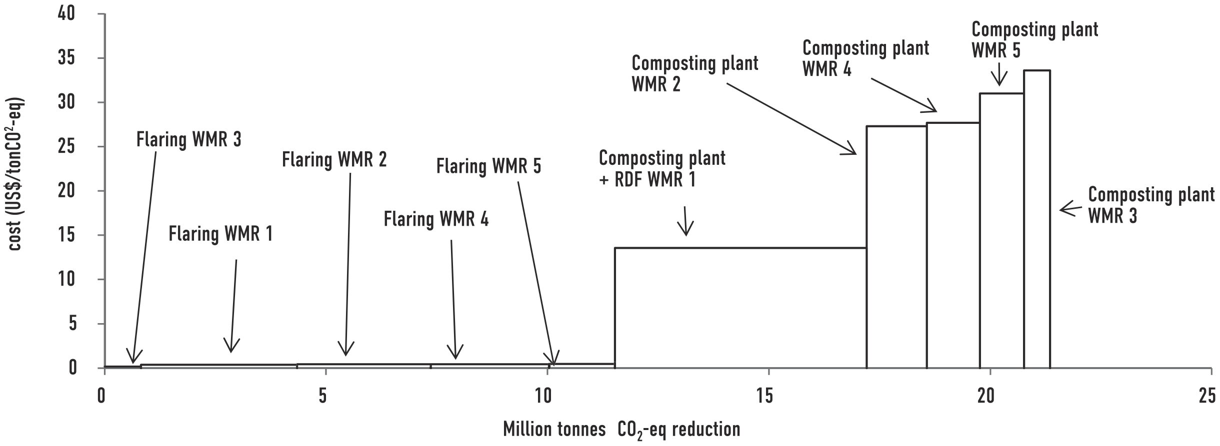
Scenario	Costs (2012 MEUR)	Expected cumulative emissions (kt CO_2-eq)	Cumulative GHG reduction (kt CO_2-eq)	Marginal abatement costs (EUR/t CO_2-eq reduced)
Reference-Baseline	26	26.679	/	/
First scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology with composting	165	7.476	19.203	7,21
Second scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology using anaerobic digestion with production of electricity	217	6.840	19.839	9,61
Third scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology using anaerobic digestion with production of electricity - Production of RDF intended for cement industry (only for WMR1)	226	4.692	21.987	9,08
Fourth scenario: - Closure and reclamation of existing landfills with burning of the landfill gas on flare - Introduction of MBT technology with composting - Production of RDF intended for cement industry (only for WMR1)	174	5.328	21.351	6,91

It can be concluded that fourth scenario has the best performance from economic point of view, even though the reductions of GHG emissions are not the best ones. The difference of emission reductions between the third and fourth scenario is 636 kt CO_2eq, which is only 3% less reductions from the scenario with the highest reductions (the third scenario). However, the specific costs of the fourth scenario are 6.91 EUR/t CO_2-eq, which is the least expensive. The third scenario has costs of 9.08 EUR/t CO_2-eq which is 31% higher.

Therefore, it appears that the combination of landfill gas burning and MBT plant with selection of recyclables, composting of biodegradable waste and production of RDF intended for the cement industry (only for WMR 1) is the best option for a mitigation scenario for the country. If there are possibilities in the future to produce RDF for thermo power plants in other regions, the situation will be even better.

The marginal abatement cost curve for the best scenario is presented in Figure 5-12. It can be noticed that the flaring activity has a very low marginal abatement cost while composting becomes significantly more expensive – though the costs are less if RDF is involved.

FIGURE 5-12: Marginal abatement cost curve for composting + RDF Scenario



A number of conclusions can be drawn from the analysis of these mitigation potentials and scenarios:

- Inclusion of composting instead of anaerobic digestion in MBT technology appears to be a better solution especially if one takes into account that there is no separate collection of biodegradable waste in the country. This separate collection is a precondition for successful implementation of anaerobic digestion.
- If feasible, the production of RDF in the other WMR(s) will significantly increase the level of GHG emissions reduction.
- The recommendations derived from this analysis are in line with the already accepted waste management policy expressed in the national waste management documents. Introduction of MBT technology with aerobic treatment of the waste will fulfil the requirements of EU directives related to waste management (no untreated waste on the landfills), save landfill space, open new jobs and at the same time significantly reduce the GHG emissions released in the atmosphere.

Table 5-10 lays out a number of concrete steps and projects which can be undertaken in the waste sector which would result in mitigation of GHGs – including likely budgetary needs, risk factors, etc.

TABLE 5-10: Mitigation activities in the waste sector, expected results, investment parameters and risks

Mitigation activity	Expected results	Financial support for Implantation	Indicators	Verification sources	Risks	Lump sum investment (MEUR 2012)
Change of technology at a cement factory to receive fuel (5-15%) from RDF by 2016	Reduction of CO_2-eq emissions by 80%, use of renewable source as fuel (up to 15% of total fuel used)	Private investment	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year Substituted fuel with RDF (%)	Environmental permit, Inspections	Mutual agreement with the regional landfill must be made and costs of transport and disposal agreed, change of company's policy to use another alternative fuel, non-acceptance of new technology by the locals	1
Installed RDF system at the regional landfill by 2016		Public Private Partnership	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year, jobs created	Environmental permit, Inspections	Installation incomplete due to lack of finances, postponing obligations in environmental permit	5
Mechanical treatment (MT) followed by a biological aerobic treatment (composting) in new 5 regional landfills all regions by 2020	Reduction of CO_2-eq emissions by 76%	Public Private Partner-ship, IPA funds, other donors	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year Number of landfills opened with MBT + composting, new jobs created	Environmental permit, Inspections	Non-compliance with legislation, lack of funds	265
Closure and reclamation of existing landfills with burning of the landfill gas on flare by 2020 in all regions	Closure of landfills, reduction of CO_2-eq emissions and odours	IPA funds, municipal budget, other donors	Annual reduction of the amount of GHGs expressed in t CO_2 eq/year Non-compliant landfills closed and flares installed	Sate Inspectorate (MoEPP), Municipalities	Lack of funds, awareness of local administration and local people	3

5.4.MITIGATION ANALYSIS IN THE AGRICULTURE SECTOR

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=274

The agricultural sector is the second biggest contributor to GHG emissions in the country. Agricultural activities are expected to increase due to growing demand for food and with that the increase of GHG emissions from this sector is inevitable. Methane (CH_4) is the primary GHG from the sector. The biggest part of CH_4 emissions (89%) is generated by enteric fermentation from domestic livestock, and these emissions have been continuously decreasing in line with the reduction of livestock populations. Manure management emissions account for 8% of GHG emissions, while the remaining emissions come from rice fields and the burning of residues.

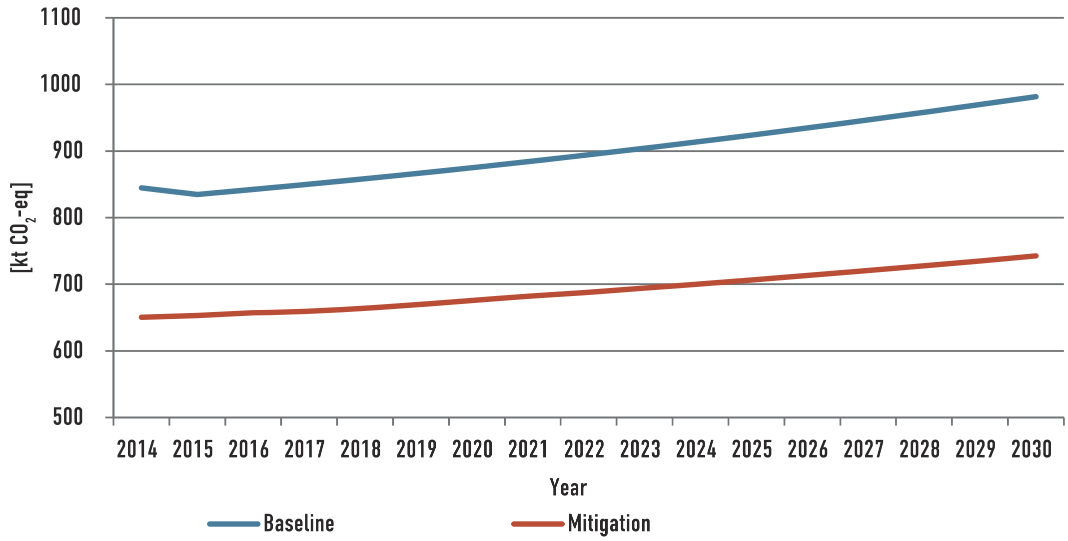
Detailed analysis was carried out of the potential for the following mitigation options in agriculture as a part of the TNC:

- Increase in organic agriculture
- Livestock management for less GHG-intensive enteric fermentation
- Improved crop residues management
- Improved sprinkler and drip irrigation
- Altering tillage techniques
- Improved management of fertilizers
- Improved manure management
- Production of biogas from farming

The analysis found that the technical mitigation potential of agriculture is extremely large, especially relative to emissions from the sector. In terms of abatement costs, the sector is particularly attractive, with many abatement options being cost neutral or net-profit-positive (increases in agricultural production, already economically justify the adoption of some mitigation activities), with low capital investment required.

In order to ensure sustainable agriculture it is important to integrate the mitigation measures with adaptation measures. The presented mitigation measures are chosen in a way to ensure the most effective reduction of GHG emissions but at the same time to combat as much as possible the hazardous impacts from climate change. The implementation of these measures will also result in side benefits like improved air quality, increase in yield production, healthier food production, reducing reliance on synthetic fertilizers, lowering water consumption, additional profit generation, reduction of agricultural waste and its usage for energy purposes. From the Figure 5-13 it can be seen that the mitigation potential slightly increases with the increment of agricultural activities and reaching its maximum in the last years of the observed period. The cumulative reduction of GHG emissions per year is amounted to be 24 % at most in 2030 year.

FIGURE 5-13: GHG emissions in the agricultural sector – baseline versus with mitigation



The proposed methodologies and financial analysis showed that in almost all cases there is a solution for reduction of GHG emissions. At the same time, the analysis showed that in many cases the proposed interventions, although viable, need significant initial financial inputs. Additional weak points for implementing measures apart of the low financial capacity are: low awareness of the importance of mitigation measures, in some cases the effects are not visible and cannot be transferred into immediate income for the farmers.

5.4.1. Mitigation measures in the agriculture sector

In this assessment few mitigation options of agricultural practices and techniques applicable in the Republic of Macedonia are proposed in order to achieve specific reductions in GHG emissions:

5.4.1.1. Measure 1: Increase in organic farming

Compared to the conventional agricultural practices, organic agriculture directly contributes to reduction of greenhouse gas emissions as it emits less N_2O from nitrogen application (lower nitrogen input), biomass waste burning is avoided (less N_2O and CH_4 emissions) and there is almost no usage of chemical fertilizers. The increased soil quality is also a value added that makes the agriculture sector more resilient to droughts or extreme weather events. In the Republic of Macedonia, the amount of land under organic agriculture has expanded quickly from 266 ha in 2005 to 4,663 in 2012. Assuming that this level of growth continues until 2030, the emissions reductions associated with organic farming were calculated and are shown in Table 5-11. It is worth noting that vegetables had a net increase in GHG comparing to the baseline due to the fact production of organic tomatoes results in more GHG than conventionally produced tomatoes.

For the purpose of this study, six different scenarios are developed that incorporate assumptions about the amount of investment, possible subsidies by the Government and the behaviour of the market. Taking into account these six scenarios the economic analysis was made by calculation of the IRR, payback period, and net present value (NPV) over a 15-year investment span with a 10% discount rate. As expected for all type of crops the most convenient scenario is that the Government gives adequate subsidies for the farmers and the benefit of the organic products is recognized by customers. It is notable that under most scenarios, a positive NPV was calculated for cereals, oilseeds, orchards and vineyards, and vegetables. This is most likely due to market growth and subsidies. However, it points to the fact that for relatively high-value agricultural products, organic farming can yield GHG reductions while also resulting in net economic benefits.

TABLE 5-11: Emissions levels associated with organic farming versus the baseline scenario

CO_2-eq [kt] Mitigated per year with organic crop production									
	2015	2017	2019	2021	2023	2025	2027	2029	2030
Cereals	-8,22	-10,69	-13,38	-16,29	-19,40	-22,70	-26,18	-29,84	-31,74
Fodder Crops	-4,12	-5,36	-6,71	-8,16	-9,72	-11,37	-13,12	-14,95	-15,90
Industrial crops	-0,03	-0,03	-0,04	-0,05	-0,06	-0,07	-0,08	-0,09	-0,10
Oilseeds	-0,13	-0,16	-0,20	-0,25	-0,30	-0,35	-0,40	-0,46	-0,49
Orchards	-6,60	-8,58	-10,74	-13,07	-15,56	-18,21	-21,01	-23,95	-25,47
Vineyards	-0,44	-0,58	-0,72	-0,88	-1,04	-1,22	-1,41	-1,61	-1,71
Vegetables	3,02	3,92	4,91	5,98	7,12	8,33	9,61	10,96	11,65
Fallow	-	-	-	-	-	-	-	-	-
Total	-16,52	-21,48	-26,88	-32,72	-38,96	-45,59	-52,59	-59,94	-63,76

5.4.1.2. Measure 2: Livestock management for less GHG-intensive enteric fermentation

Enteric fermentation is a natural part of the digestive process for many ruminant animals where anaerobic microbes, called methanogens, decompose and ferment food present in the digestive tract producing compounds that are then absorbed by the host animal. Measures to mitigate enteric fermentation would not only reduce emissions, they may also raise animal productivity by increasing digestive efficiency. The baseline scenario for emissions from enteric fermentation is provided in Table 5-12. They are based on different assumptions for the livestock mix.

TABLE 5-12: Two baseline scenarios for GHG emissions from enteric fermentation up to 2030

T1 Enteric Fermentation	2014	2020	2030
Dairy	12,17	12,01	11,8
Non-dairy	5,86	5,81	5,74
Buffalo	0,05	0,05	0,05
Total CH_4 (kt)	18,08	17,87	17,59
Total CO_2eq (kt)	379,68	375,2	369,38

T2 Enteric Fermentation	2014	2020	2030
Dairy	11,88	10,98	9,48
Non-dairy	6,4	6,35	6,27
Buffalo	0,06	0,06	0,06
Total CH_4 (kt)	18,34	17,39	15,81
Total CO_2eq (kt)	385,17	365,24	332,01

Two options for mitigation were examined for cost-effectiveness: *propionate precursors* and *probiotics.* Both are additives given to animals as daily supplements – generally only to larger herds. For both measures, a slow penetration rate has been assumed, i.e. if the measures are implemented from year 2014 on a 6.6% of cattle population (dairy and non-dairy animals), in year 2015 on 8.3% population, 2018 – 10%, 2022-12.5%, 2026-20% and by year 2030 on 50% of cattle population in the country. Table 5-13 shows the cumulative level of emissions savings possible and associated costs associated with each option.

TABLE 5-13: Cumulative GHG reduction potential and cumulative costs for measures related to enteric fermentation for the period 2014-2030

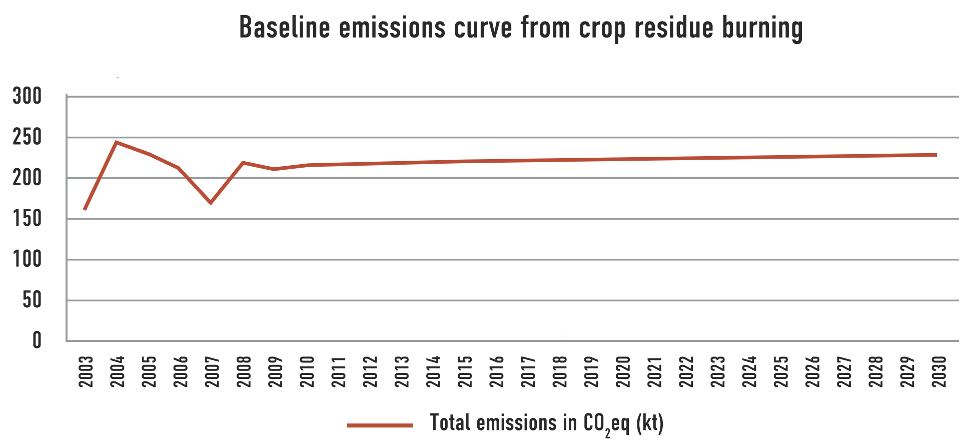
Trend line for livestock mix	Total GHG emissions (kt) - Baseline	GHG reduction with measure	Total costs (EUR)	GHG reduction
Measure: Propionate precursors				
Trend line T1	6 360	1 498	22 567 210	24%
Trend line T2	6 096	1 278	19 262 481	21%
Measure: Probiotics				
Trend line T1	6 360	449	13 489 682	7%
Trend line T2	6 096	384	11 513 737	6%

It is important to note that the emissions reductions offered by these options are still very uncertain and further research is required to confirm the data. In addition, the estimates below do not take into account any savings from the increased productivity which may result from the use of the additives, so the costs may thus be overestimated. What is clear is that mitigation measures related to enteric fermentation are very expensive to be introduced by farmers and are considered feasible *only if the Government gives adequate subsidies* in the upcoming period for replacement of feed intake of animals.

5.4.1.3. Measure 3: Improved crop residues management

The burning of crop residues is very common in the Republic of Macedonia causes various concerns: GHG emissions, pollution linked to respiratory and health issues, possible soil erosion, adverse effects on soil fertility, organic matter depletion and soil structure damage, reduced numbers of macro and micro-organisms, and fires that get out of control. The open fire burning of agricultural residues generates 1.82 t of CO_2-eq including emitting CO_2, CH_4, and N_2O. emissions for each tonne of burned dry material. The baseline scenario for GHG emissions related to crop residue burning is provided in Figure 5-14. By 2030, it is expected to be ~227 kt CO_2-eq. A study done for the TNC estimated that a total of 3,792 kt CO_2-eq could be reduced from this cumulative total if better crop residue management was used – especially by using the residues as a fuel source.

FIGURE 5-14: Baseline emissions curve from crop residue burning up to 2030



With recent policy changes, open-fire burning of the agricultural residues in the country is strictly prohibited, and now farmers are seeking a solution for the collection, transport and the disposal of the crop residues, which will have a significant financial cost. However, it is important to note that the residues can be converted into a value-added good. They can be used as an energy source, for livestock food, insulation material, etc. The most effective and common practice for managing crop residues is using mechanical equipment for residue removal and packaging. The study carried out for the TNC assessed the feasibility of using the crop residues for production of briquettes for fuel use. The financial analysis showed that this measure provides high environmental and economic benefits, and investment in even the most expensive production plant (an investment of ~EUR 430,000) has a pay-back period of 4.3 years.

5.4.1.4. Measure 4: Improved sprinkler and drip irrigation

Irrigation is important to achieving high yields in arid and semi-arid regions, but on the other hand irrigation is very carbon intensive meaning that lot of energy is spent for pumping water. Emissions are estimated at 1,448 kg CO_2-eq /ha for furrow irrigation, 446 kg CO_2-eq/ha for sprinkler irrigation and 792 kg CO_2-eq /ha for drip irrigation (ITRC 1994). Furthermore, inefficient irrigation that leaves the soil overly wet leads to higher emissions of N_2O which has a higher global warming potential than the CO_2. CO_2 emissions can be reduced with effective irrigation by increasing yields and crop residues which can enhance carbon sequestration. Increasing yields generally reduces emissions as well, since more food results from the same or less effort.

For the purposes of the Third National Communication an investigation was made of the impact of irrigation to three of the most economically important crops: maize, wheat and sunflower. The research was done for the South Eastern Region and further extrapolated for the whole territory of the country. The modeling of the crop yield production was done in the BioMa framework developed by the Joint Research Center in Ispra by utilization of the CropSyst model.

A mitigation strategy would include the following:

- Abandonment of flood and furrow irrigation favour to sprinkler irrigation and drip irrigation, since they are proven to be more effective techniques.
- Higher frequency of irrigations with lower amounts of water per irrigation.

In most scenarios investigated for wheat, corn and barley, the implementation of the above two measures resulted in less GHG emissions per kg of crop produced as well as net positive economic gains due to improved efficiencies of resource usage.

5.4.1.5. Measure 5: Altering tillage techniques

Tillage systems influence physical, chemical, and biological properties of soil and have a major impact on soil productivity and sustainability. Conventional tillage practices may adversely affect long-term soil productivity due to erosion and loss of organic matter in soils. Sustainable soil management can be practiced through conservation tillage (including no-tillage), high crop residue return, and crop rotation. Conservation tillage is defined as a tillage system in which at least 30% of crop residues are left in the field and is an important conservation practice to reduce soil erosion. The advantages of conservation tillage practices over conventional tillage include: reducing cultivation cost; allowing crop residues to act as an insulator and reducing soil temperature fluctuation; building up soil organic matter; conserving soil moisture. Typical carbon sequestration and GHG emissions per hectare from three different tillage techniques are shown in Table 5-14. Additionally, scenarios were developed for penetration of the various conservation measures starting with implementation of measures on 5% of arable land in 2014 and increasing to 100% in 2030 with the results also shown in Table 5-14.

TABLE 5-14: Comparison of emissions reductions according to different soil tillage techniques

Soil technique/ Scenario	Emissions (kg CO_2-eq per ha-year)	Sequestered (kg CO_2-eq per ha-year)	Cumulative emissions until 2030 (kt CO_2-eq)	Cumulative sequestration until 2030 (kt CO_2-eq)
Conventional tillage	1.140	0	1.579	0
Reduced tillage techniques	570	570	789	692
No till	140	1.100	181	1.523

For 227,000 ha total arable land in the country (State Statistical Office, Statistical yearbook 2011), a GHG (nitrous oxide) reduction of 88.5% and significantly more carbon sequestration can be achieved through changing to no-tillage techniques.

The economic performance of this measure also seems to yield positive results:

- The investment needed is 8% lower than current techniques – a EUR 186 million cumulative investment for period 2014-2030, compared to 202 million EUR with baseline practices.
- There is potential profit from crop sales (382,000 tonnes/yr) of 76.4 million EUR per year, excluding other associated costs (transport, storage, etc.).

5.4.1.6. Measure 6: Improved management of fertilizers

Efficient use of nitrogenous fertilisers can reduce N_2O emissions from agricultural fields. In addition, by reducing the quantity of synthetic fertilisers required, improved management can also reduce CO_2 emissions associated with their manufacture. Fertilisers can comprise up to 30 % of farm expenditure, so it is important to use the right quantity and product. Specifically, activities to improve management of fertilizers and their technical potential for GHG abatement are listed in Table 5-15 and include:

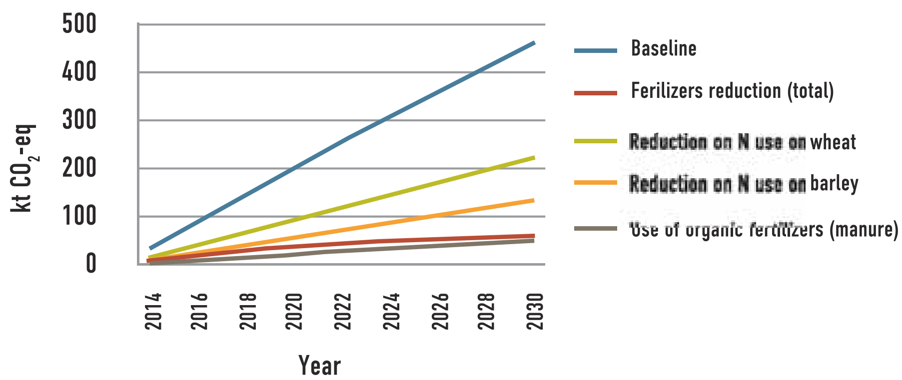
- For wet conditions, a fertilisation strategy in which fertilisers containing only NH_{4+} are applied instead of the commonly used NO_{3-} fertiliser, may be an appropriate option to mitigate N_2O emission from intensively managed arable land or grasslands.
- A reduction (e.g. by limits) of the application of synthetic fertiliser in arable and grassland systems by an efficient use of manure that is otherwise disposed of as waste products (Hendriks et al., 1998).

On the costs side, substitution of 7,423 tonnes synthetic fertilizers (State Statistical Office, Statistical yearbook 2009) with animal manure should reduce the costs for fertilizer from EUR 2,264,296 per year to EUR 402,451 per year (not considering costs for enrichment of soils with nitrogen, phosphorus and potassium, since animal manure has a very low percentage of these elements in contrast to synthetic fertilizers). On the sales side, if the market for manure is stimulated, farmers which have livestock can sell their manure as a fertilizer.

TABLE 5-15: Technical potential for emissions reductions through management of fertilizers

Type of measure	Crop	Land (ha)	Reduc-tion potential (kg/ha)	N_2O-N reduc-tion (t)	N_2O reduction (t)	N_2O reduction (kt)	Cumulative N_2O under BAU (kt)	Cumulative N_2O reduction (kt)
Reduce use of N-fertilizers	Wheat	67 105	50	3 355	41,94	13,00	406,78	185,79
	Barley	23 881	30	716	8,96	2,78		47,26
Use of animal manure	Wheat and barley	90 986	22	2 001	25,02	7,76		131,92

FIGURE 5-15: Projection of different scenarios for reduction of substitution of synthetic fertilizers and GHG emissions



5.4.1.7. Measure 7: Improved manure management

Improving management systems for handling waste of animal origin can significantly reduce GHG emissions associated with manure treatment. This practice is based on the drying of cattle waste, since dry cattle manure produces ~14% of the methane than the equivalent in wet weight. In the Republic of Macedonia only cattle farms have N_2O emissions from anaerobic lagoon systems. With respect to CH_4 emissions, over half of them come from cattle manure (56.8%) and most of the remainder from pig manures (36.2%). Under the baseline scenario, the emissions from manure are projected to be 529 kt CO_2-eq in 2030.

Practical measures to reduce methane releases resulting from animal manures fall into two categories:

1. Measures to ensure aerobic decomposition and avoid methane evolution, which include *daily spread of manures* and *composting*;
2. Measures to convert evolved methane to carbon dioxide, including *anaerobic digestion* and *covered lagoon systems*.

The cost–effectiveness of this measure has been estimated using data collected from the Farm Management Pocketbook (Nix 1996) and costs from Adjustment Plan in IPPC Environmental Permits from largest farms in the country. Since these mitigation measures fall under IPPC environmental legislation (A-Integrated permits), they must be completed by 2014, according to latest amendment of the Law on environment (Official gazette of R.M, no.53/05) and IPPC Decree (Official gazette of R.M, no.89/05). Management of manures with composting only for dairy, non-dairy and swine populations gave the best results for mitigating GHGs, with a total accumulated cost of EUR 22 million, a profit of EUR 44 million (period 2019-2030) and a possible reduction of 7.06% in net GHGs (37.5 kt CO_2-eq).

5.4.1.8. Measure 8: Production of biogas from farming

Biogas is produced when the organic material decays (anaerobic digestion) in environment with limited oxygen presence in the presence of microorganisms. The Final product of the breakdown is a fuel called biogas and organic residue in cupboards containing minerals and is suitable to be used for fertilization as liquid or solid bio fertilizers. Biogas can be purified from other compounds and the remaining methane can be used as fuel, be injected in natural gas pipeline or system, and used as a heat source or production of electricity. The benefits in terms of GHG reduction are: reduction of the CH_4 from the etheric fermentation and manure management, reduction of CO_2 emissions from fossil fuels used as an electricity or heat source, reduction of CH_4 and nitrogen absorption in the soil and the waters. Under the baseline scenario, by 2030 there is expected to be between 808 and 871 kt CO_2-eq related to large livestock (pig) farm operations which could be addressed by biogas production.

The Republic of Macedonia has huge potential for the production of biogas from manure and sludge management. This potential is currently not used at all, because of a lack of financial incentives for these types of mitigation measures as well as lack of the awareness from the farmers and potential investors. The Rural Development Component of the Instrument for Pre-Accession Assistance from the EU (IPARD) can potentially be used to provide subsidies for the purchase of such equipment from which the state will have multiple benefits.

Two sets of scenarios were constructed for the implementation of biogas plants in the Republic of Macedonia based upon two livestock growth curves. The first set of scenarios assumed a 5-year implementation period for the initial biogas plants and 1% growth per year in animals covered by these plants. The second scenario assumed a 4-year implementation period for the initial biogas plants and 1% growth per year in animals covered by these plants.

In terms of environmental benefits and GHG emissions reduction, they are projected to potentially be quite significant – with savings of over 50% projected assuming that biogas is produced in many large livestock cooperatives (see Table 5-16). The cumulative GHG reduction until 2030 is estimated to be

TABLE 5-16: Baseline emissions projections and mitigation scenarios for producing biogas in large pig farm operations

Scenario	Number of animals	Baseline emissions in 2030 (t CO_2-eq per year)*	Emissions reduction from biogas usage (t CO_2-eq per year)	Projected emissions in 2030	% reduction
Scenario 1: 5 year implementation period - livestock growth trendline 1	202 072	20 207	11 747	8 460	58%
Scenario 2: 4 year implementation period - livestock growth trendline 1	202 072	20 207	11 865	8 343	59%
Scenario 3: 5 year implementation period - livestock growth trendline 2	217 825	21 783	11 747	10 035	54%
Scenario 4: 4 year implementation period - livestock growth trendline 2	217 825	21 783	11 865	9 918	54%

In terms of the financial performance of the measure, typical investments of EUR 800,000 to EUR 900,000 for a plant yield a payback period of between 10 and 11 years. The cumulative gross profit for the entire measure (involving a few facilities) is estimated to be between EUR 3 million to EUR 3.3 million.

It should be noted that if the same assessment was done for manure management of farms with dairy and non-dairy cattle, the resulting biogas produced will be even higher because dairy cows produce 17.3 tonnes of manure per head per year, beef cattle produce 8.7 tonnes of manure per head per year, while pigs produce 1.7 tonnes of manure per head per year.

5.4.2. Summary of mitigation measures in the agriculture sector

Table 5-17 lists the potential measures in agriculture for GHG emissions reduction including, expected results, potential sources of financial support, indicators, verification sources, risks, and cumulative investments needed.

TABLE 5-17: Summary of potential agricultural measures for GHG emissions reduction

Mitigation activity	Expected results	Financial support for implantation	Indicators	Verification sources	Risks	Lump sum investment (MEUR 2012)*
Increase in organic agriculture						
Financial support for organic production area	CO2-eq emission reduction for 40% at most in comparison to conventional agriculture. *(note: Cumulative area on what is practiced organic production is expected to be 30,400 ha to 2030.)*	State budget for organic agriculture	Annual reduction of the amount of GHGs expressed in CO_{2}eq (t/year)	Monitoring and control of certified land for organic production.	Farmers need incentives to convert to organic agriculture. The prices of this products are not concurrent due to higher prices and lower yields especially during conversion period must be compensated	16.2
Re-imbursement of inspection and certification costs.		State budget for organic agriculture	Annual reduction of the amount of GHGs expressed in CO_{2}eq (t CO_{2}eq/kg yield) segregated by product type	Calculation of amount of GHGs expressed in CO_{2}-eq per kilogram product.	Extra costs for inspection are therefore barrier for farmers to convert to organic agriculture.	
Financial support for organic farmers for production of approved organic seed material.			Increase of area under organic agriculture (ha/year)		Organic material and seeds are essential to comply with EU standards and requirements.	
Co-financing of storage, packaging and processing		State budget for organic agriculture, donors	Total share under organic production in agriculture.			
Improved livestock management for less GHG-intensive enteric fermentation						
Improvement of the cattle food intake (50% of the population of the dairy cows and cattle)	Reduction of the emissions compared to the baseline scenario for 23.5%	Private farming associations.	Annual reduction of the amount of GHGs expressed in CO_{2}-eq (t/year)	Monitoring of the emissions trough the installed measurement devises	Lack of national incentives and appropriate loan options	22.5
					Lack of the financial incentives from the IPARD programme	
Improved manure management						
Introduction of system for biogas production on the major swine farms in the country (5 big farming associations)	Reduction of the emissions compared to the baseline scenario for 50.4%	Private farming associations.	Annual reduction of the amount of CH4 released from the conventional manure management (t/year)	The annual amount of biogas and electricity produced	Lack of financial resources for investment	4.7
		IPARD support	Financial benefits from production of biogas and electricity (EUR/year)	The reported emissions in the operation plans and the IPPC applications	Lack of the incentives and appropriate loan options	
		IBRD support	Production of high quality compost (t/year)	The annual amount of the compost produced	The regulation, infrastructure and the possibility of the electricity network for marketing of the produced electricity	
Introduction of systems for composting of the manure on the major swine and poultry farms (5 swine and 1 poultry)	Reduction of the emissions compared to the baseline scenario for 7.06%	Private farming associations.	Annual reduction of the amount of GHGs expressed in CO_{2}-eq (t/year)	Compliance with the legal standards (IPPC applications)	Postponed of the deathliness for IPPC applications	22
			Implementation of 6 composting plants	The marketing of the organic fertilizers		
			The annual amount of organic fertilizers produced (t/year)	Monitoring of the emissions trough the annual production of the fertilizers		

Mitigation activity	Expected results	Financial support for implantation	Indicators	Verification sources	Risks	Lump sum investment (MEUR 2012)*
Improved crop residues management						
Production of biofuels (briquettes) from crop residues (3.12 kt / year of approximately 2.8% of the predicted agricultural residues production)	Reduction of the emissions compared to the baseline scenario for 2.58%.	Private farming associations.	The annual amount of briquettes produced (t/years)	Reduction of the practices of open fire burnings of the crop residues.	The possibilities for increased transportation cost of the feedstock.	1
		Private companies interested for production of biomass from crop residues.				
		IBRD	The annual amount of the re-used crop residues (t/tear)	Improvement of the capacity of the production plants for briquettes from crop residues.	Lack of financial incentives for this type of production plants.	
		IPARD	The substitution of the usage of the ordinary biomass with agricultural residues briquettes (t/year)		Marketing of the new concept of the agricultural residues briquetted.	
Improved sprinkler and drip irrigation						
Co-financing for establishing an irrigation system.	CO_2-eq emission reduction for 9% at most in comparison to conventional agriculture.	State budget for support of agriculture, fisheries and rural development, IPARD	Annual reduction of the amount of GHGs expressed in CO_2-eq (t/year) Increase of yield production (t yield/year).	Monitoring and control od yield production.	Complicated procedures for providing subsidies .	11
			Annual reduction of the amount of GHGs expressed in CO_2-eq (t CO_2-eq/kg yield) segregated by product type.	Calculation of amount of GHGs expressed in CO_2-eq per kilogram product.		
Replacement of old and inefficient irrigation systems with micro irrigation systems (drip irrigation, underground irrigation-subirrigation, micro sprinkler and spraying).	CO_2-eq emission reduction for 42% at most in comparison to conventional agriculture.	State budget for support of agriculture, fisheries and rural development, IPARD	Annual reduction of the amount of GHGs expressed in CO_2-eq (t/year).	Monitoring and control od yield production. Calculation of amount of GHGs expressed in CO_2-eq per kilogram product.	Complicated procedures for providing subsidies.	9
			Increase of yield production (t yield/year).			
			Annual reduction of the amount of GHGs expressed in CO_2-eq (t CO_2-eq/kg yield) segregated by product type.			
Altering tillage techniques						
Reduced or conservation tillage techniques of the arable soil (227,000 ha)	Reduction of the nitrous oxide emissions compared to the baseline scenario by 88.5%	Private farming associations.	Application of the conservation tillage techniques (ha/year)	Monitoring of the agricultural practices	Rejection of conventional techniques of farmers because of the increased labour costs	No cost
		Ministry of Agriculture, Water Resources and Forestry	Annual reduction of the amount of GHGs expressed in CO_2-eq (t/year)	Monitoring of the soil quality (ha/year)		
			Soil carbon sequestration in CO_2-eq (t/year)			
Management of fertilizers						
Substitution of 7,500 t mineral with organic fertilizers for arable land	Reduction of the nitrous oxide emissions compared to the baseline scenario for 45%	Private farming associations.	Annual reduction of the amount of GHGs expressed in CO_2-eq (t/year)	Application of organic fertilizers (t/year)	Lack of national production of organic fertilizers due to insufficient composting capacity	6.8
		Ministry of Agriculture, Water Resources and Forestry	The amount of the mineral fertilizers substituted with the organic fertilizers (t/year)	Annual trading of the organic fertilizers (t/year)	Fluctuations in the prices of organic fertilizers on the market	
			The area of application of the organic fertilizers (ha/year)	Soil monitoring (ha/year) or soil testing		

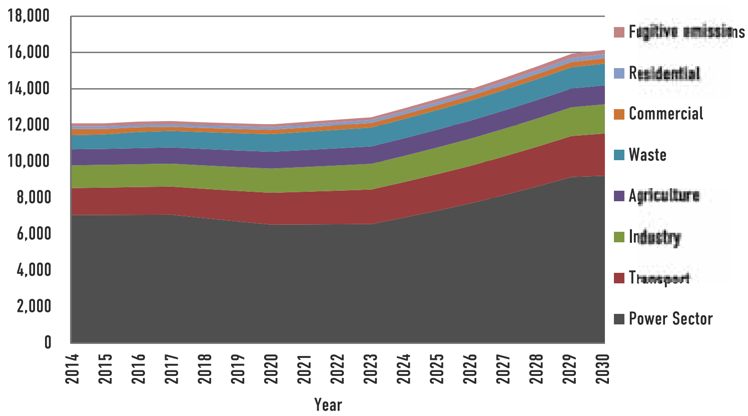
*For period 2014-2030

5.5. SUMMARY OF GHG EMISSIONS PROJECTIONS

This section summarizes the projected GHG emissions for the sectors analysed above: power generation, transport, industry (emissions related to fuel combustion), agriculture, waste, and the commercial and residential sectors. Fugitive emissions from lignite mining have been additionally calculated and included in the overall GHG emissions.

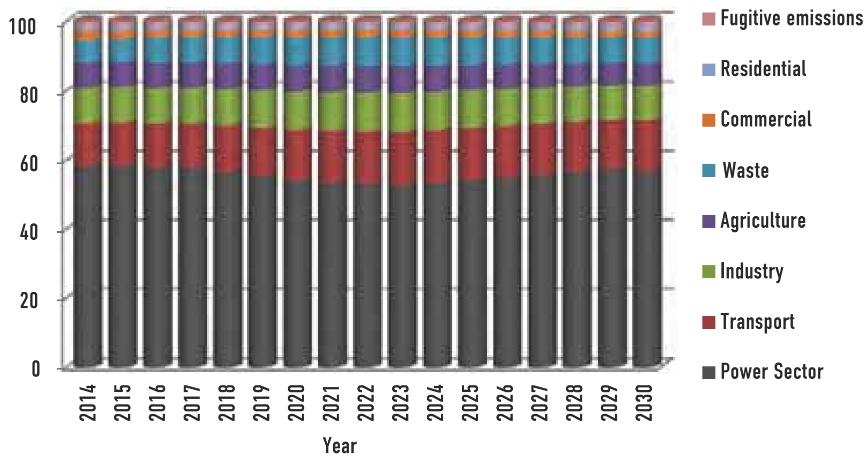
The GHG emissions under the baseline scenario are projected to change from around 12,100 kt CO_2-eq to around 16,150 kt CO_2-eq or by 33% (Figure 5-16). In the period 2014-2023 the amount of the emissions is almost the same, but after this period it is expected that there will be significant growth of the emissions in the power sector and the level of the total emissions progressively increases. The highest growth sector is the residential sector with 60% growth, followed by transport with 56% and waste with 54%.

FIGURE 5-16: Emissions Projection under Baseline Scenario [kt CO_2-eq]



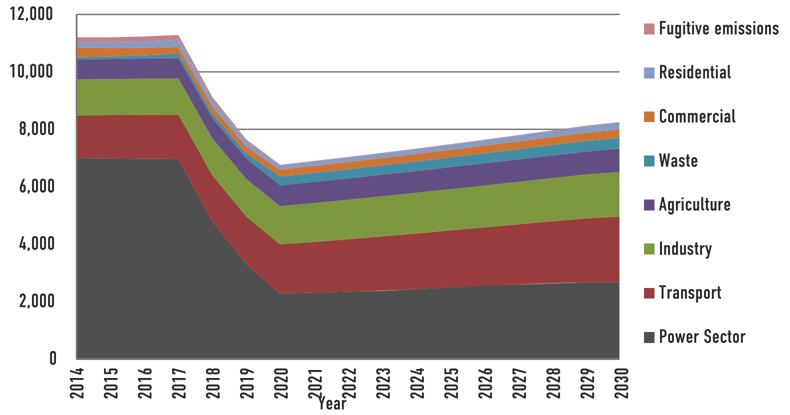
The main contributor in the total GHG emissions is projected to be the power sector with around 58% during the whole planning period (Figure 5-17). The second highest contributor is the transport sector with 12%-14% share, followed by industry with around 10%. The share of GHG emissions from agriculture and commercial sectors is decreasing from 7.3% to 6.5% and from 2.8% to 1.8%, respectively. Waste sector contributes with 6.4% to 7.4%. Fugitive emissions and Residential sector participate with around 1%.

FIGURE 5-17: Shares of sectoral emissions under baseline scenario (%)



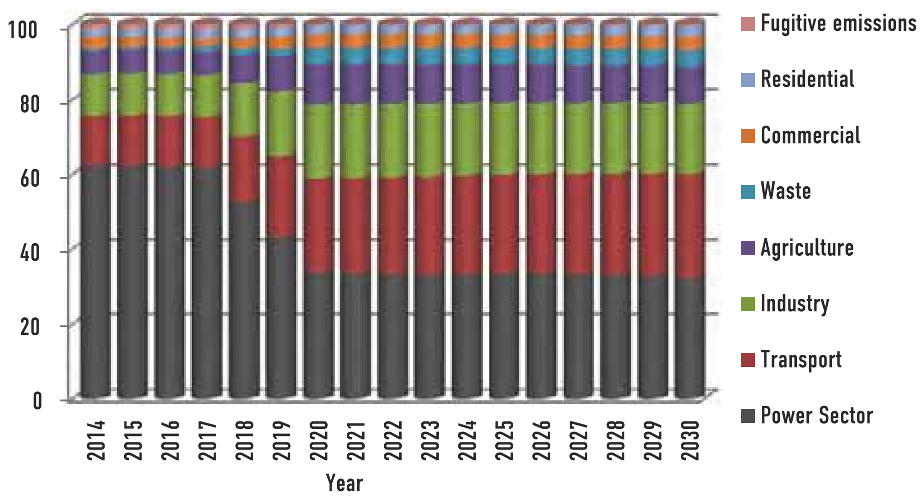
The combination of the most aggressive mitigations scenarios in energy, waste and agriculture sectors would lead to a significant drop in GHG emissions – from 11,200 kt CO_2-eq to 8,250 kt CO_2-eq (Figure 5-18). The introduction of a CO_2 price starting from 2020 will cause the closure of the existing lignite power plants and prevents entrance of new coal power plants, which is estimated to decrease the level of the GHG emissions in the power sector by more than 65%. Emissions from transport and industry sectors would be projected to decrease by 2% and 4% respectively compared to the reference scenario. The highest CO_2 emissions reduction of around 80% is in the waste sector and in the agriculture sector the reduction is around 22% during the whole period.

FIGURE 5-18: Emissions projection under the mitigation scenario [kt CO_2-eq]



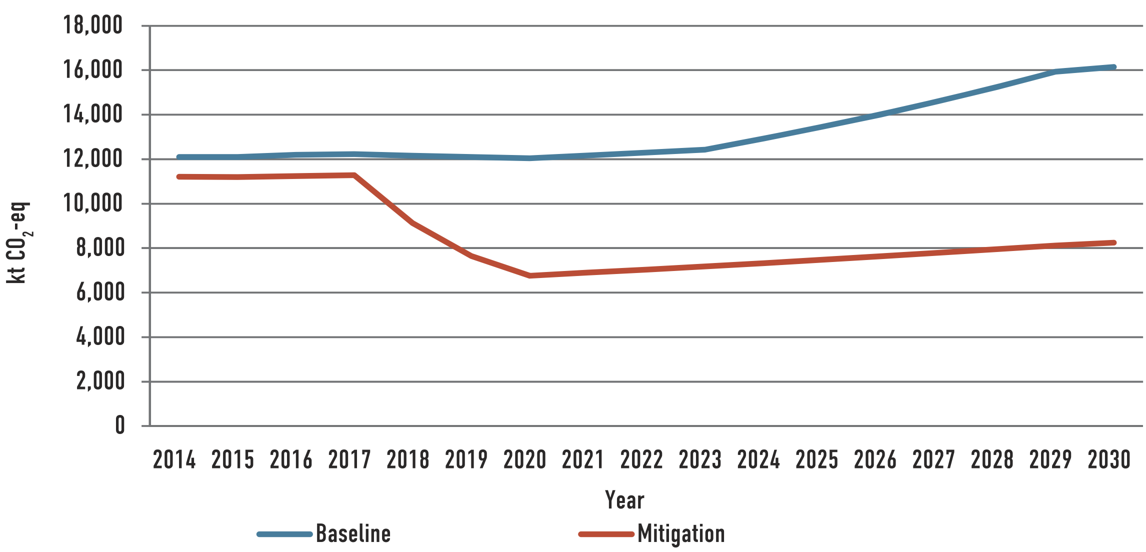
In the mitigation scenario, the power sector share in the total GHG emission would decrease from 62% in 2014 to 33% in 2030, but the sector would remain the primary contributor (Figure 5-19). The second polluter which is close to the power sector would be the transport sector with around 28% share in 2030 followed by industry with around 19%.

FIGURE 5-19: Shares of sectoral emissions under the mitigation scenario (%)



The total GHG emissions in the mitigation scenario in the period 2014-2017 are reduced by around 8%, after this period the reductions become more aggressive and in 2030 emissions would be 50% less than the baseline scenario (Figure 5-20).

FIGURE 5-20: Total emissions under the baseline and mitigation scenarios [kt CO_2-eq]



5.6. OTHER ASPECTS OF CLIMATE CHANGE MITIGATION

In most cases, appropriately selected mitigation options and their implementation will deliver benefits for some or all dimensions of sustainable development, reflecting the synergies between climate change mitigation and sustainable development. However, in a quite limited number of cases, some trade-offs are inevitable, to allow rational choices to be made. The above analysis aims to provide additional information in order to decide on which measures could and should be undertaken.

At the same time, an effective mitigation effort goes beyond technologies and practices and includes also other elements like government coordination and stakeholder involvement, job creation, R&D and innovation, and accountability for social aspects (public health improvement, socially vulnerable groups' inclusion and other social benefits).

Jobs, R&D and innovation, and accountability for social aspects

The Prioritization of the technologies and practices should generally take into account their potential to generate domestic jobs. At the same time, Low Emission Development Strategy (LEDS) technologies and practices should be included among the national R&D and Innovations priorities to allow for green growth in technology sectors within the country. Finally, the valuation of technologies and practices should take into account their social benefits.

Institutional arrangements

Institutional arrangements are an important element to facilitating the incorporation of climate change mitigation in the national strategic planning. The key institutional challenge is to build leadership, trust, and mutual accountability. Due to the multi-sectoral and inter-disciplinary nature of climate change and economic development, many different ministries within a government are relevant to establishing and implementing mitigation actions. Institutional arrangements can also help communication flows with other stakeholders such as business, NGOs and the general public. Securing and managing funds for implementing mitigation actions require institutional setups to get national budget appropriations and to co-ordinate across multiple donors and recipient activities. Summing-up, the underlying functions of the institutional framework are as follows:

- Inter-ministerial participation with clear leadership
- Defined roles and responsibilities for participating ministries and other stakeholders
- Stakeholder consultation and support of widespread engagement
- Co-ordinating funding disbursement to feed priority programmes

5.7. FOLLOW-UP ACTIVITIES

In addition to the potential implementation of mitigation measures as described in this chapter, the following follow-up activities would be necessary.

Analytical work

- **Refining of constraints and assumptions** already introduced in the model and/or introducing new constraints and assumptions in order to improve reliability and robustness of the results.
- **Estimation of job creation potential** in different sectors, as well as other contributions of the mitigation technologies to sustainable development.
- **Impact analyses of different policy instruments** for GHG emission reduction including prioritization and policy recommendations.
- In line with the EU approach in setting the GHG emission reduction national targets, the total national emissions should be divided into ETS and non-ETS emissions and various **mitigation scenarios** should be developed **for non-ETS emissions**.
- Analyses of possible targets for GHG emission limitation/reduction in different sectors.
- Specifically for the waste sector, a follow-up study should be undertaken in order **to identify the waste composition for the whole country** and to provide relevant data on types, quantities, generation, recycling and other information regarding the waste management in the country. This data will serve as a base for implementation of Tier 2 methodology by which there will be more accurate data on GHG emissions from the waste sector.

Institutional/regulatory measures

- Enabling activities for mitigation technologies transfer.
- **Crosscutting** of climate change mitigation, low emission development and sustainable development.
- Recognizing the importance of the national GHG inventory for reliable emissions projections and mitigation scenarios, it is necessary to strengthen the national inventory process by introducing a **Quality Assurance/Quality Control layer in the GHG Inventory team structure**.
- Institutionalized scientific support of wise policy making.

Awareness raising

- **Raising awareness of national policy-makers from different sectors** about international GHG emission reduction endeavours and particularly EU climate policy.
- Support to stakeholders' engagement and social marketing in order to facilitate **participatory approach in decision-making** and **behavioural changes** of the population.
- The **overall mitigation action** could be **extended to the regional level** (to include other EU candidate and potential candidate countries form the region), including capacity building for their modellers and analysts, as well as policy-makers.

5.7.1. Nationally Appropriate Mitigation Actions (NAMAs)

As part of the Republic of Macedonia's pledges for the Copenhagen Accords, the country submitted a list of NAMAs which would potentially be undertaken. Many of these NAMAs are examined above. While no NAMAs have officially been added to the registry within the UNFCCC, this is currently being explored as a part of a comprehensive assessment of the NAMAs being undertaken for key sectors. In the first phase assessment is being done at the level of City of Skopje, covering the energy sector, public buildings, and transport, all of them considered as a potential source of GHG emissions. UNDP has agreed to support the City of Skopje in preparing its Urban NAMA application. This document will consist of a package of measures and cross-sectoral interventions, leading to reducing of GHG emissions and achieving sustainable growth and healthy urban living conditions. Specifically, the following two NAMAs are being prepared for potential support:

Urban NAMA for the City of Skopje – Transport sector: The scope of this application is to build efficient, modern, economic and environmental friendly city transport system, which will interact with the citizens and assist and improve their everyday life quality. The application identifies the potential for establishment of introduction of eco-friendly public transport (tram and hybrid busses), constitution of efficient traffic management system and eco-driving areas in the city, establishment of physically separated bus lanes, promotion of the public transport and the bicycle transport and establishment of real time communication platform with the citizens.

Urban NAMA for the City of Skopje – Energy sector: This application consists of energy efficiency measures defined in the City's Sustainable Energy Action Plan targeting 21 city-administered high schools. The technology interventions to be implemented are high efficiency lighting with occupancy sensors where appropriate, improvement of the thermal insulation of the perimeter walls, seals and windows, installation of solar water heaters and if applicable correction of power factor of equipment in place. Implemented measures will be supported with introduction of energy management system by positioning automatic meter readers and deployment of software solution enabling remote overview of energy consumption in each of 20 targeted objects, and recording of climate parameters. In addition, educational activities will raise awareness among students on benefits that energy efficient and renewable energy technologies bring.

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6 COMMUNICATIONS STRATEGY FOR CLIMATE CHANGE

This section is a summary of a report developed for the TNC.
The full report is available at: http://www.unfccc.org.mk/Default.aspx?LCID=214&Control=Documents.ascx

This chapter describes the current and ongoing activities related to communication of climate change issues with a broad range of stakeholders. The need for communicating climate change related issues was described in the Second National Communication with the following text "the main objective of this Strategy shall be not only to raise the awareness about climate change, but also to mobilize and promote new partnerships in order to achieve higher level of public awareness and motivate all stakeholders (the Government, private sector, donor community, civil society, media and the general public) to take appropriate activities".

Taking this into consideration, Macedonia should follow the relevant international processes, as part of national climate change related activities and in agreement with the provisions of Article 6 of the Convention. Additionally, the European Commission Progress Report on Macedonia for 2012 (Chapter 27 Environment and climate change), strongly recommends the intensification of awareness-raising activities.

As a part of the development of the TNC, the Republic of Macedonia in partnership with UNDP engaged consultants to analyse existing communication activities and to develop a comprehensive communications strategy which was developed and has been adopted along with the TNC. The chapter also summarises the communication strategy – which is a separate document adopted along-side this TNC.

6.1. INFORMATION AND NETWORKING

Within Macedonia, MOEPP provides information and networking related to climate change on its website.

FIGURE 6-1: MOEPP Website - http://www.moepp.gov.mk
(accessed November 6, 2013)

In policy terms, the Programme of the Government of the Republic of Macedonia for the period 2011-2015 also promotes networking by encouraging international cooperation in scientific research and education.

In practice, the Hydrometeorological Service performs a variety of tasks related to information exchange and networking that involve meteorological services in the region (e.g. participation in the South-East Europe Climate Outlook Forum-SEECOF) and with disaster and risk reduction initiatives in the region. The agency also participates in global-level information exchange through its participation in WMO (e.g. the DARE project to digitalize historical meteorological and climatological data rescue, a high-priority WMO initiative).

In addition, there are a number of NGO networks active in communications activities.

Over the course of the preparation of the TNC, a number of networking events took place. These are described below:

Donor coordination in climate change area: Active coordination was established between various donors/projects (such as World Bank and USAID) working in the areas of mutual interest in order to enable consistency of results and recommendations related to creating sustainability of the process for preparation of National Communications and integrating climate change priorities into country development strategies and relevant sector programs.

Sharing lessons learned from the National Communications between non-Annex I countries – National Communications Support Programme workshop, Istanbul 2012: The workshop was very useful in terms of sharing experiences among non-Annex I countries during the preparation of the National Communications and opened windows for transfer of knowledge and cooperation among countries. The Republic of Macedonia presented good practices in the preparation of the Macedonian Greenhouse Gas Inventories.

Regional Workshop on "Mitigating GHG Emissions through Improved Waste Management Systems in Western Balkans" by Regional Environmental Centre in Belgrade, R. Serbia: A member of the project team participated in the three day conference on the topics "Mitigating GHG Emissions through Improved Waste Management Systems in Western Balkans", where the project outcomes in the waste sector were presented and a presentation was given on **Recent Developments in Regional Policies on Mitigating GHG Emissions from the Waste Sector**, outlining current situation with the methodologies for calculation of GHG and mitigation actions taken in the waste sector in all Balkan countries. At the conference, experts in the sector exchanged opinions on mitigating GHG emissions from solid waste disposal sites and wastewater treatment facilities. In addition, best available techniques and latest developments in the field were presented by participants from EU countries.

9th Annual Meeting of Environmental Civil Society Organisations: This meeting was held from 14th till 16th December, 2012 in Struga. The meeting was organized by Macedonian Green Centre, with support of USAID, Milieukontakt Macedonia, UNDP and the MOEPP. The annual meeting was held in framework of the USAID project for Municipal Climate Change Strategies, implemented by Milieukontakt Macedonia.

Support for preparation of the Roadmap for introduction of the Monitoring, Reporting and Verification of the GHG emissions under EU ETS in the country: The project team of the Third National Communication to the UNFCCC actively participated in the bilateral project for introduction of Monitoring, Reporting and Verification under the EU ETS framework in the country. The purpose of the Roadmap is to support the country in deciding the best path to take in implementing the European Union Emissions Trading Scheme.

Regional Environmental Network for Accession (RENA): This project was financed by the EU and managed by the European Commission to assist beneficiary countries in exchange of information and experience related to preparation for accession. The MOEPP and the TNC team took part in many RENA workshops, trainings and meetings. The project team gained significant knowledge and expertise from all RENA activities and events and is expected to participate in the forthcoming Environment and Climate Regional Accession Network (ECRAN) as a continuation of RENA.

South Eastern European Forum on Climate Change Adaptation: This IPA project was jointly developed by the Austrian, Croatian, Macedonian and Montenegro Red Cross with the initial main purpose to raise awareness about the humanitarian consequences of climate change in the SE Europe region. The project aims to contribute to increased participation of Civil Society Organizations (CSOs) in national and regional co-operation on climate change adaptation. A member of the project team of the TNC was part of this project. Regional conferences within the project were attended by more than 70 CSOs, government officials and representatives of international organizations, and the attendants had opportunities for development of national and international CSOs networks, discuss the recent developments in the field and explore potential cooperation and future strategies to address climate change in the region.

Climate Eyes android application: Climate Eyes is an android application for exploring the CO_2 emissions, temperature, electric power consumption and other related information regarding climate change geographically displayed on a map per country location. The application was lacking information for Macedonia so the project TNC team established communication with the Climate Eyes application developers. The results obtained from TNC preparation were adapted to be used within the application. This information is now visible on the Climate Eyes interface by using an android mobile telephone or tablet computer.

PRES Conference in Rhodes, Greece: This even took place from 29 September to 2 October 2013 on Rhodes, Greece and was the 16th Conference for Process Integration, Modeling and Optimization for Energy Saving and Pollution Reduction. The aim of the conference was to review the latest development and applications of process integration for energy conservation, pollution reduction and related topics. As a result of the work done on the TNC a scientific paper was published on topic "Best Practices for Preparation of GHG Inventory for Industrial Processes" highlighting the good practices and lessons learned regarding the GHG inventory for industrial processes in the case of the Republic of Macedonia.

SDEWES Conference in Dubrovnik, Croatia: The 8th Conference on Sustainable Development of Energy, Water and Environment Systems (SDEWES) Conference, was held in Dubrovnik in the period 22 – 27 September, 2013. This conference was dedicated to the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by de-coupling growth from natural resources and replacing them with knowledge based economy. As a result of the work done on the TNC two scientific papers were submitted to the conference – the first on the GHG inventory process and the second on mitigation potential in the waste sector.

Third International Conference on Waste Management and Climate Change: On 19 and 20 September 2013, the Association of public communal service providers in the Republic of Macedonia (ADKOM) held a conference on "Waste Management and Climate Change". The TNC team submitted two papers on the topics: "Use of higher Tier methodology in calculating GHG emissions from the waste sector" and "Composting as a practice to reduce GHG emissions – a case study in Resen".

During the development of the TNC, the Project Team in cooperation with the Public Relations Office at the MOEPP, launched and regularly updated the web page www.klimastkipromeni.org.mk. The objective of this activity was to inform all stakeholders, including the general public regarding the ongoing activities, as well as regarding the results obtained during the development phase of the Communication. In this manner, a greater visibility and a higher motivation for cooperation were achieved and climate change issues were made more familiar to the national public. The web page became recognizable as a national source of information regarding climate change, and also contributed to the development of a comprehensive Communication of higher quality.

6.2.PUBLIC AWARENESS AND OUTREACH

6.2.1. Public awareness

Public awareness of climate change issues in Macedonia has been measured by Eurobarometer surveys, which are public opinion surveys conducted by the EU. Specifically, surveys conducted in 2008 and 2009 of over 1000 citizens each asked questions about knowledge and attitudes related to climate change (Eurobarometer 2008, 2009). These surveys are also important in that they constitute a baseline against which outreach and awareness-raising projects can measure change.

In terms of attitudes, the 2009 survey showed that a substantial majority of Macedonians considered that climate change was a serious, global problem. "Climate change" was perceived by Macedonians as the third most serious problem currently facing the world ("poverty, lack of food and drinking water" and "a major global economic downturn" ranked first and second, respectively). On a scale of 1 to 10 with 10 indicating that climate change was an "extremely serious problem" and 1 indicating that climate change was "not a serious problem at all", the average response given by Macedonians was 7.4 in 2009.

In terms of knowledge, a little less than half (46%) of Macedonians surveyed in 2009 felt generally well-informed about the causes of climate change. A similar percentage (49%) felt well-informed about the consequences of climate change. Fewer (35%) felt well-informed about the ways in which to fight climate change.

In terms of behaviours, Macedonians surveyed in 2008 listed several ways in which they had taken steps to address climate change. They cited reducing energy consumption (60%) and water consumption (48%) at home, environmentally friendly transportation (40%), waste recycling (25%), purchasing local products and environmentally friendly cars (both 16%) and reducing the consumption of disposable items (15%). Less than 5% each cited reducing short haul air transportation, switching to green energy tariffs and installing renewable energy. Of those surveyed, 45% would be willing to pay more for energy produced from low carbon sources, compared to 18% who would not be ready to pay more and 37% who did not know.

The 2008 survey also covered the attitudes behind choosing to act or not act to address climate change. When asked about the reasons for taking actions aimed at fighting climate change, 68% cited their "duty as a citizen to protect the environment," 63% agreed that "if everybody changed their behaviour, it will have a real impact," 44% were concerned about "the young and future generations," 18% thought acting would save money, and 12% had been directly exposed to the consequences of climate change. When asked about the reasons for *not* taking actions to address climate change, 50% of the population agreed with the statement "It is governments, companies and industries that have to change their behaviour," 47% "would like to take action but do not know what to do;" 36% agreed with the statement that changing one's own behaviour would "not have a real impact;" and 11% that it was "too expensive to take actions that fight climate change." Only 4% stated that they were "not concerned about climate change" (and 6% responded with "don't know").

When asked about satisfaction with how particular groups were responding to climate change, 69% believed that corporations and industry were not doing enough, 68% believed the government was not doing enough, 72% believed that citizens themselves were not doing enough, and 41% believed the EU was not doing enough.

6.2.2. Public outreach

Public outreach efforts related to climate change have come from several sources. Within the government, the public relations office of MOEPP provides information on climate change. At the same time, the Association of the Units of Local Self-Government of the

Republic of Macedonia has developed an "Action Plan on Development of New Policies and Promotion of Local Initiatives in Climate Change Management 2012 – 2015" which includes a number of communications-related activities and shows a significant interest on behalf of many municipalities to take action related to climate change.

There have also been activities supported by bilateral and multilateral donors that include some public outreach as a component of a larger climate-related program. For example, USAID is sponsoring the Municipal Climate Change Strategies Project – geared towards preparing municipal stakeholders for managing local climate change challenges.

This project is designed to enhance the outreach, action-research and raising awareness agenda in order to raise awareness among and engage key stakeholders at the national and local level on issues pertaining climate change (Macedonian Institute for Media and Eco Ltd 2013). Other similar projects are included in the description of capacity strengthening programs in Section 6.6 of this report.

6.3.SUMMARY OF THE "CLIMATE CHANGE COMMUNICATION STRATEGY AND ACTION PLAN"

Though there have been significant efforts to increase and improve the awareness of various stakeholders (including the general public) about climate change and to improve communication, an assessment of these efforts found a lack of targeted communications activities (Macedonian Institute for Media 2013). In order to address the issue, the TNC project team and MOEPP commissioned a Climate Change Communications Strategy and Action Plan in 2013.

The strategy makes a distinction between three broad levels of engagement **– the city** (related to municipal-level activities), **the workplace** (related to businesses) and **the household**. These groups are seen as the optimal entry point for targeting climate change communication activities. Within these groups, the researchers identified decision-makers who could influence resource consumption. In cities, these were mayors, deputies, advisors, planners and procurement officers. In workplaces, the team identified executives, business and resource managers, and division heads. At the household level, these were mostly heads of households.

The proposed strategy and action plan was therefore designed to increase the following:

1. Knowledge and awareness of the impacts of and vulnerability to climate change impacts of cities, workplaces and households;
2. Capacity to develop and implement strategies to reduce climate change vulnerability and impacts in cities, workplaces and households;
3. Proactive attitudes for mainstreaming climate change considerations into city, workplace and household routines and processes.

The content of the Climate Change Communication Strategy and Action Plan is based on expert knowledge of communication principles, best practice analysis on communicating climate change in the world and on specialist knowledge of the local and regional context. Based on international best practice, the formulation of the strategy and action plan is guided by a number of principles that are integral to a sound communication strategy as follows:

A cost-effective action plan – given the often limited funds and other resources that are available for communication activities, an action plan, implemented at the appropriate scale, and drawing together knowledge of the target audience, "sticky" messages (that is, memorable), and communication tools to meet the communication objective must be designed to have maximum effect by employing minimum resources. In the context of this communications strategy, resources are assumed to be marginal increases in resources from the MOEPP, from UNDP, potential additional donor resources.

A thorough understanding of the target audience(s) – to have impact, communication activities must be focused on specific audiences rather than general groups (i.e. 'high schools students' and 'working mothers' rather than 'the general public'). Understanding the target audience – in particular their motivations and communicative patterns – makes it possible to define desirable outcomes that are realistically achievable. There are a number of target audiences thoroughly defined as they relate to climate change within this communications strategy.

Clearly defined desirable outcomes – to generate meaningful outcomes, objectives need to be formulated with sensitivity to the status quo and make use of indicators, such as SMART[33] or QQT[34]. A clear definition of desirable outcomes makes it possible to translate often abstract messages into concrete images that are memorable and that "stick".

Sticky messages – to be retained by people and become accepted – to **"stick"**, messages must be tailored to the target audience's reality and routines. According to research on international best practice, messages must resonate with the agency of the target audience (that is, their ability to act) and be formulated as Simple, Unexpected, Concrete, Credible, and Emotional Stories (this is called the SUCCESs model).

The right mix of communications tools – to reach their target audience, and thus produce maximum impact, an appropriate and mutually reinforcing suite of communication tools needs to become inserted into existing communicative patterns. The tools of communication for high school students will be different from those for decision-makers in municipalities, business-people, etc.

[33] Specific, Measurable, Attainable, Realistic and Time-bound.

[34] *Quality, Quantity, Time.*

Simple and systematic monitoring **–** while essential for evidencing the success and cost-effectiveness of communication measures, the complexity and sophistication of any monitoring system needs to reflect its particular purpose. In the context of communications, where budgets for monitoring are frequently limited, this means that a simple yet systematic approach *that is actually implemented* will be most likely to generate meaningful evidence.

Activities planned within the communication strategy are described in Table 6-1.

TABLE 6-1: Actions planned within the "Climate Change Communications Strategy and Action Plan" for the Republic of Macedonia

#	Description	Target Audience	Proposed Implementing entity	Indicative Cost Items	Indicators of success
1	A focal point for climate change communication	All stakeholders, including key/ non-key target audiences, implementing partners etc.	MOEPP Public relations office (liaison with ZELS[3] and Chamber of Commerce)	1-2 staff people per year plus office space and travel as necessary	*Presence of focal point *# of information requests received and responded to
2	The development of a brand, using a logo and strong ('sticky') slogans	All stakeholders, including key/ non-key target audiences, implementing partners etc.	MOEPP	~EUR 5,000 – 10,000 for design, focus group testing, finalisation.	*Branding/slogans developed and tested *High ratings by test audience
3	Strengthening of internal communication at state-level	Government stakeholders	MOEPP, Ministries	Some staff time for organizing (see item #1) plus occasional costs for refreshments for meetings, brown-bag lunches, etc.	*Roundtables held *Members of mailing list *Production of Memoranda
4	Consultation and targeted capacity building of potential partners	All stakeholders via the media	MOEPP Public relations office	Included in item 1 on an ad-hoc basis.	*Consultations held with media/NGOs *Co-production of media kit *# of networking events held *Increase of climate change press stories
5	Inter-municipal portal on climate change communication focal point website	Local government professionals	ZELS /MOEPP	Creation of a bottom-up comprehensive portal is estimated to cost EUR 10,000 – 20,000. While less potent, LinkedIn user groups are free to create and only require staff time to manage (see item 1) – could be a worthwhile start before upscaling, if effective.	*Trialling of LinkedIn group *# of relevant members joined *# of independent conversations started/ replies
6	Designation of local focal points within each municipality	Municipalities	Municipalities (supported by ZELS) MOEPP	Some staff time from the focal point for climate change communication Staff time from the municipalities	*Focal point established *Focal point active
7	National workshop on best practice in urban and municipal planning	Local government professionals	ZELS /Local government executives, NGOs, researchers	Typical 1-day workshop costs: ~EUR 1,000 for venue rental plus travel costs and internal staff time (see item 1). Consultants engaged for trainings according vary. International assistance from the EU may be available from the TAIEX programme (http://ec.europa.eu/enlargement/taiex/)	*Workshop held *# of participants from different Macedonian municipalities *feedback form on workshop *# of LinkedIn/ portal conversations on workshop *# of press releases and qualitative evaluation of press coverage
8	Publication (electronic and possibly in print) of a local government manual on climate change issues	Local government professionals	ZELS / MOEPP	Costs of compiling – uncertain at this stage but likely ~EUR 20,000 Publication costs: electronic costs are minimal to non-existent; print costs vary	*# of contributions submitted for publication *# of print copies distributed/electronic downloads *Feedback by readers on quality of articles
9	Awards for excellence in local government management	Local government professionals	ZELS / MOEPP	Staff time from focal point for climate change communication in organizing (~2 months per event). Venue rental, refreshments as necessary. Prizes could be non-monetary or related to goods or cash (estimated ~EUR 30,000 would be sufficient for 1 large prize such as putting PV on a building)	*# of submission to awards *# of engaged municipalities *Quality and innovativeness of submissions

[35] ZELS is the Association of the units of Local Self-Government of The Republic of Macedonia

#	Description	Target Audience	Proposed Implementing entity	Indicative Cost Items	Indicators of success
10	Public consultations and participatory events	Local government professionals, companies, households	Municipalities, NGOs	Staff time for the focal point for climate change communication. Staff time for local municipality staff.	*Rates of participation from different societal groups *Production of an Agenda 21 (including degree of ambition)
11	Cross-sector virtual portal for businesses	Business executives and managers	MOEPP/ Chamber of Commerce	Development of a professional web-site could probably be done for ~EUR-10-15,000, including initial content. Ongoing content would require staff time.	*# number of members *cross-sectoral coverage *see Activity#4
12	Information and best practice learning events in climate relevant business and enterprise areas	Business executives and managers	Organized by MOEPP Supported by consultants / Chamber of Commerce	Staff time from focal point for climate change communication in organizing (~1 month per event). Staff time from other sponsors/ organizers. Venue rental and refreshments.	*# events held *feedback through forms *# of Macedonian best practices collected
13	Specialized workshops on financing climate change mitigation and adaptation projects	Business executives and managers	Organized by MOEPP International consultants and other stakeholders/ Chamber of Commerce	Staff time from focal point for climate change communication in organizing (~1 months per event). Staff time from other sponsors/ organizers. Venue rental and refreshments.	*# of applications to workshop (popularity and need) *# of projects concluded following workshop *feedback on workshop
14	Dedicated training course on climate sensitive resource management for businesses and enterprises	Business executives and managers	Organized by MOEPP International consultants, local specialized companies, national universities and institutes/ Chamber of Commerce	Typical 1-day workshop costs: ~EUR 1,000 for venue rental plus travel costs and internal staff time (see item 1). Consultants engaged for trainings vary. International assistance from the EU may be available from the TAIEX programme for publicly owned enterprises (http://ec.europa.eu/enlargement/taiex/)	*# of SMEs who receive a 'green audit' *# of SMEs with environmental accreditation *self-reported monitoring of environmental improvements
15	Promote climate change sponsorship by existing organizations in sectors with high public visibility	Local and national businesses in all sectors	Private sector organizations (supported by MOEPP)/ Chamber of Commerce	Staff time from focal point for climate change communication in organizing (~2 months per year). Costs of sponsorship for the sponsoring organizations.	*# and magnitude of sponsorships *Tangible results (e.g. # of solar schools) *Beneficiary and public perception of these
16	Multi-media campaign on the relationship between households and climate change	Household decision makers	MOEPP-led, implemented by specialized company	Depends on the scale of the media campaign.	*Survey questionnaire of public on popularity and effectiveness of different media
17	Enrolment in Activity #13 of popular individuals	Household decision makers	Media-led	Staff time from focal point for climate change communication in organizing (~2 months per year). Time of the popular individuals. Expense of developing and carrying out the media campaign will depend on the scale.	*Survey questionnaire of public on influence of popular individual on their behaviour
18	Climate Change Community Champions	Household decision makers, community groups (e.g. housing associations)	NGOs-led, supported by MOEPP	Staff-time from NGOs – estimated 3 months of work time for organizing 2-3 groups. Estimated – a grant of ~EUR 20,000 would yield ~5-10 community groups involved.	*# of volunteer expressions of interest *# of volunteers active after 6 months/1 year etc. *breadth and depth of activities

Works cited:

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7 OTHER RELEVANT INFORMATION

7.1. TECHNOLOGY TRANSFER

Article 4.5 of the UNFCCC urges developed country Parties and Annex II Parties to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly to developing countries, to enable them to implement the provisions of the Convention. As a non-Annex I country, the Republic of Macedonia is eligible for usage of the Technology Transfer Framework themes and financing mechanisms for technology transfer. The technology transfer framework gives many financing options for the introduction of state-of-the-art technologies to the country.

The **Technology Mechanism** was established in 2010 as an instrument for transfer of technology and technological and institutional development between the member states of the UNFCCC. The Conference of the Parties invited Parties to nominate their national designated entities (NDEs) for the development and transfer of technologies, pursuant to in order to facilitate the operationalization of the Climate Technology Centre and Network. The country is in process of selecting the most appropriate institution to be nominated. Since the MOEPP is a key national institution dealing with climate change issues, there is a high probability that this Ministry may also be nominated as the NDE responsible for Transfer of Technologies.

The **Expert Group on Technology Transfer**, which was created under the UNFCCC mechanism, has collaborated with the Global Environment Facility (GEF), the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP) and Climate Technology Initiative (CTI) on providing technical assistance to non-Annex I Parties to conduct technology needs assessments (TNAs). The secretariat has published two synthesis reports on technology needs identified by non-Annex I Parties that highlight priority technology needs identified in various sectors to reduce greenhouse gas emissions and facilitate adaptation to the adverse impacts of climate change. The reports also draw attention to specific barriers to technology transfer and suggest measures to address them.

In April 2004 Republic of Macedonia submitted its TNA report entitled "Evaluation of Technology Needs for GHG Abatement in the Energy Sector." This assessment was prepared by the Ministry of Environment and Physical Planning and was supported by UNDP-GEF under the project "Expedited Financing of Climate Change Enabling Activities."

An updated Handbook for Conducting Technology Needs Assessments was developed in 2010, as a response to a UNFCCC COP Decision. The handbook was jointly prepared by the UNDP and the UNFCCC Secretariat, with the support of the Expert Group on Technology Transfer and in cooperation with the Climate Technology Initiative.

An assessment of the bilateral development assistance projects implemented in Macedonia (MOEPP 2013) identified only one formal technology transfer project. The project title was Geothermal System Kocani, and it was dedicated to the transfer of know-how in the areas of combined heat and power and district heating. The donor country for this project was Austria, and the project was implemented in 1998. The project focused on the use of geothermal energy in order to supply the population with renewable heating energy.

7.2. SYSTEMATIC OBSERVATION

The first organized meteorological and climatological measuring and monitoring on the country's territory was initiated in 1923, although there was occasional measuring in the period between 1891 and 1898 (in Skopje) and between 1886 and 1912 in Bitola. In 1947, a decision was made to organize the Hydrometeorological Service in the Republic of Macedonia, and that same year saw the establishment of a network of metering stations that formed the basis for the current system.

Pursuant to the Law on Hydrometeorological Activities, the Government of Macedonia oversees a unified meteorological monitoring system. This system forms an integral part of the global monitoring system, and its activities are determined by the regulations and standards of the World Meteorological Organization. The meteorological monitoring system in the Republic of Macedonia consists of a national network of stations operated by professional monitoring staff. This network consists of 19 main meteorological stations and 2 meteorological radar centres for hail detection. In addition to this network, there is also a network of stations with part-time observers, consisting of 12 regular (climatological) stations, 116 rain metering stations, and 24 phenological stations, which measure periodic biological phenomena. In the past several years, the monitoring system has been upgraded with 14 automated meteorological stations (two of them are used for air traffic services).

Several types of constraints and gaps have been noted in the system of observation and monitoring. Due to increasing demands for high-quality climate-related data, there is a need to strengthen the capacity of the National Hydrometeorological Service. Capacity needs include the following:

- **General support:** providing sustainability of the Meteorological monitoring system in order to monitor the climate and its changes (variability, fluctuations and trends), developing a network of automated meteorological stations in order to upgrade the existing system by unifying certain technical and software components, in agreement with the guidelines and recommendations of the World Meteorological Organization; installing automated meteorological stations at all main meteorological stations and climatological stations and gradually replacing the classical measuring with automated measuring; installing automated meteorological stations outside of the existing meteorological network;
- **Lack of staff:** The Sector on Meteorology in the National Hydrometeorological Service struggled to implement its mandate because of a lack of staff. At the same time, there are unemployed meteorology graduates, and the educational program for meteorological technicians is no longer available. Staff shortages have brought the operation of the monitoring system to a minimum level, which has reduced the availability of climate data. This situation is likely to worsen given the trend of an aging work force in the sector and increases rates of retirement, which also hinders re-assigning staff to high-priority locations. In three locations, monitoring has actually been halted, and continuous operation of the main meteorological stations in Shtip, Bitola and Skopje in the future is uncertain. Because meteorological measuring and monitoring at these stations are both a national mandate and an international commitment (to the WMO), cut-backs represent an extremely serious problem. In particular for climate change, it seems necessary to carry out the following: the establishment of a climate change unit in order to monitor climate change and to prepare climate forecasts and reports; education of personnel in different areas; employment of expert staff (university graduates with a qualification in meteorology).
- **Lack of funding:** The budget allocated for this activity has been insufficient in previous years, resulting in late payments to observers. *Lack of funding* has also led to a reduction in the number of stations where the occasional observers work. For example, the network of rain metering stations previously consisted of 300 stations, which were reduced in 2003 from 196 to 155, and in 2012 to 116. These stations provided information that is critical to flood planning, climate monitoring and water resources monitoring, feasibility studies for the construction of key health facilities, agro-climatic zoning, forestry, biodiversity, and the environment in general.
- **Difficulties with maintenance of monitoring stations:** While the quality and the quantity of the meteorological data have improved with the use of 24-hour automated monitoring in some stations, these stations have experienced difficulties that include the following: difficulties with maintenance, calibration, procurement of sensors and procurement of other spare parts; problems with data collection and processing given the different software programs for communication with different stations; and collection, processing and archiving data that are submitted in different formats. Finally, the systems themselves are difficult to maintain due to a lack of properly trained staff and a shortage of funding for maintenance and spare parts.
- **The lack of field vehicles:** causes serious problems for the National Hydrometeorological Service. The vehicle fleet of the Service is quite old, and it cannot meet quality standards during regular work periods and during interventions when there is a defect or halt in meteorological measuring.
- **Technical/equipment needs:** establishing special – safer communication channels within the services of mobile providers; establishing a laboratory for controlling, maintenance and calibration of meteorological instruments and sensors of automated meteorological stations; providing two field vehicles for operational activities and maintenance of the meteorological monitoring system;
- **Data processing needs:** maintenance and upgrade of the climatological data database CLIDATA; digitalization of the basic climatological data and information; preservation of historical meteorological and climatological data as a national treasure; using GIS format when presenting climatological conditions for different parameters;

7.3. RESEARCH AND DEVELOPMENT

Because innovation is considered a key economic driver, especially when it leads to a competitive advantage or increasing productivity, innovation policy is determined at the national level. Research institutions are seen as the key bodies for innovation, while private sector takes over the implementation and commercialization of innovative ideas in the form of products.

7.4. RELEVANT POLICIES

The main directions of current research policy were introduced in the Programme of the Government of the Republic of Macedonia for the period 2011-2015. The priorities for country-level activities related to research and development (R&D) include increasing investments in scientific-research infrastructure; encouraging and supporting science through fiscal policy; and supporting technological development through the development of new technologies, technology transfer, innovation, continuous upgrade and transfer of knowledge, information, and ICT technologies.

More focused research policy goals are specified in the Law on Scientific and Research Activities (LSRA), which was adopted in 2008 and amended in 2012, and the Law on Encouragement and Support of Technological Development (LESTD), which was adopted in 2011. These laws emphasize the following: the development of new technologies, products and services; environmental protection and improvement; improvements in the institutional and organizational effectiveness of entities involved in technological development; support for entrepreneurship; strengthening the institutional, educational, scientific and technological infrastructure; improved communication and cooperation between entities involved in technological development; and communication and cooperation between ministries and other institutions in charge of technological development.

The Law on Higher Education that addresses R&D activities in the higher education sector was adopted by the Ministry of Education and Science in January 2013. The changes define the criteria necessary to fulfil the requirements of the Bologna process and 2012 Bucharest Communiqué 2012. These criteria should strengthen R&D and ensure monitoring of the quality of the R&D activities performed by the higher educational institutions. One of the mandatory requirements for universities is the establishment of new Faculty boards, which consist of all important stakeholders involved in educational and R&D activities. The boards are supposed to ensure that university curricula are aligned with the needs of industry. Furthermore, public universities are obligated to allocate 40% from tuition fees to R&D activities, international cooperation, capital investments and faculty and student exchanges with Top 500 world universities (as determined by the Shanghai Jao Tong University ranking).

The National Programme for Scientific R&D Activities 2012-2016 and the National Strategy for Scientific R&D Activities 2020 were prepared by the Ministry of Education and Science on the basis of broad public discussions organized in the country. They are more citizen-centric and propose new thematic priorities and new R&D targets for the country. The Innovation Strategy of the Republic of Macedonia for 2012-2020 was adopted by the Government in October 2012. The strategy was prepared by the Ministry of Economy with support from the Organization for Economic Co-operation and Development (OECD). One of the main strengths of the policy is the involvement of all relevant stakeholders from the country in its preparation.

The Law on Innovation Activity, adopted in May 2013, determines the innovation activity, as well as principles for commercialization of the results of the innovation activity, scientific research, the technical and technological knowledge, and inventions. The Law outlines the establishment of a Fund for Innovation and Technological Development, which will finance and logistically support the innovative projects in order to improve the competitiveness of Macedonian companies through development of new knowledge and innovation. The Fund will provide technical assistance and consulting services for start-ups and existing enterprises in order to increase investment in innovation, as well as financing and co-financing research and innovation projects. The Fund will be developed in two phases: the first will be funded solely by the Government, and the second phase will include additional financing from the World Bank and the EU (through pre-accession funding). The law also calls for the establishment of a new Department of Competitiveness, Entrepreneurship and Innovation in the government that, along with the Committee on Entrepreneurship and Innovation, will monitor the development and commercialization of innovations.

Other R&D-related policies include the Industrial Policy of the Republic of Macedonia 2009-2020, which was prepared by the Ministry of Economy, the government, and the World Bank and includes an area of intervention dedicated to research, development, and innovation; and the Stop Brain Drain Strategy 2013-2020, which is in the process of being developed on behalf of the Ministry of Education and Science to try to prevent brain-drain and repatriate researchers who leave the country.

7.4.1. Relevant institutions

The **Ministry of Economy** is the institution responsible for creating and implementing documents and programs regarding economic policy, industrial policy, SME competitiveness and innovation enhancement. Within the ministry, the **Department for Industrial Policy** is responsible for the creation and monitoring of industrial policy in Macedonia. This department works with the **Department for Entrepreneurship and Competitiveness of SMEs** to create the Innovation Score Board and established a detailed implementation schedule related to all areas of government activity in industrial policy, including innovation enhancement.

Other ministries also have an impact on Innovation, R&D, and technology transfer in line with their responsibilities. The **Ministry of Education and Science**, specifically the **Department for the Advancement of Science and Technological-Technical**

Development, is responsible for strategic planning in the field of science and technology. It supports and encourages the development of scientific research infrastructure in Macedonia. Research priorities related to climate change include energy, transport and ecology, agriculture, and water resource management. The ministry is also responsible for overseeing the EU Framework Program for research (FP) in Macedonia. The **Ministry of Environment and Physical Planning** as the designated entity for climate change and environmental concerns is closely associated with the international R&D activities, technological development and innovations. The **Ministry of Information Society and Administration** coordinates activities for the development of the information society and measures from relevant government strategies.

Other government entities involved in R&D include the following:

- Agency for Financial Support in Agriculture and Rural Development (IPARD)
- Agency for Foreign Investments and Export Promotion of the Republic of Macedonia, (Invest in Macedonia);
- Agency for Promotion of Entrepreneurship of the Republic of Macedonia (APERM)
- Energy Agency of the Republic of Macedonia (EARM)
- Research Center for Energy, Informatics and Materials of the Macedonian Academy of Sciences and Arts (ICEIM-MANU)
- Centre for Applied Research and Permanent Education in Agriculture (CIPOZ), Faculty of Agriculture and Food Sciences, Skopje
- Centre for Research, Development and Continuing Education: Mechanical Engineering Systems – Centre of Excellence (CIRKO-MES CE)
- Centre of Technology Transfer at the Faculty of Electrical Engineering and Information Technology (FEEIT), Ss. Cyril and Methodius University, Skopje
- Centre of Technology Transfer at the Faculty of Technology and Metallurgy (TMF), Ss. Cyril and Methodius University, Skopje

In addition to state entities, the Macedonian Academy of Sciences and Arts (MANU) is the highest scientific and research institution in the country. It deals with strategic and fundamental research and planning, advice to governmental institutions. The Research Centre for Energy, Informatics and Materials (ICEIM) within MANU is focused on the areas of energy, environment, bioinformatics and materials. The Centre was involved in the development of the previous national communications. MANU has developed all relevant strategies for the energy sector. The Centre was involved in many other national, regional and international projects related to climate change. The president of the NCCC originates from this institution.

There are also several "good practice" initiatives to establish organizations that foster innovation. For example, the first **Regional Hub for Social Innovation** opened in June 2013 at the Faculty of Computer Science and Engineering at the University of Ss. Cyril and Methodius with support from UNDP launched the first Regional Hub for Social Innovation in the country. The Hub was established to encourage development of innovative information technology solutions to social and economic problems. Projects aiming at environmental protection and mitigation of the climate change will be among the hub's priorities. The **Foundation Business Startup Centre Bitola**, which is financed by the USAID, was established to contribute to the economic development of the country through promoting entrepreneurship in small and medium enterprises (SMEs). The foundation supports potential and existing entrepreneurs in establishing or growing their businesses and provides training, exchange of information and investments in innovative projects. The **Foundation for Management and Industrial Research** (MIR) is part of a consortium that has been awarded the first project from the European Commission's Competitiveness and Innovation Framework Programme to establish the European Information and Innovation Centre in Macedonia (EIICM). The EIICM, as a part of a large European Network (Enterprise Europe Network), provides services primarily to SMEs through the dissemination of information on EU legislation, business contacts with potential European partners, facilitating technology and knowledge transfer and promoting the possibilities for participation in EU research programmes. The **Macedonia Innovation Centre** was established by the USAID Competitiveness Project in April 2010. Its main goals are, on the one hand, to assist innovators and innovative companies in adopting innovations, developing new products and services, and commercializing existing innovations and, on the other hand, to create an innovation "ecosystem" supporting innovative ventures. **The National Centre for Development of Innovation and Entrepreneurial Learning** (NCDIEL) was established in November 2009 with financial support from Austrian Development Cooperation. Located at the Faculty of Mechanical Engineering, NCDIEL supports the realization of innovative, technology-based and profit-oriented ideas through the provision of capital for start-ups and counselling and coaching of established enterprises in order to increase survivability. Finally, the

Gauss Institute – Bitola is a foundation supporting new technologies, innovations and knowledge transfer that was established in 2006. This foundation continues activities of previously active foundation Euro-regional Technology Centre – Bitola, and is considered to be one of most active organizations in the region related to innovations, technology and knowledge transfer.

7.4.2.R&D projects related to climate change

Many technology projects in Macedonia have been supported by **EU Framework Programmes** and other EU financing mechanisms. Between 2007 and 2012, the EU supported 83 projects through its 6th and 7th Framework Programmes for Research (FP6 and FP7), totalling 10,283,000 EUR in financing. This allocation amounts to approximately 5 EUR per capita for Macedonia, which is the second highest financial allocation for the Balkan region after Serbia with 7 EUR per capita. A total of 23 of these projects were related to climate change, and they are summarized in Annex 4.

EU pre-accession funding (IPA) has also supported projects on research, development, innovation and transfer of technologies related to climate change during the period 2007-2013. The total budget of the IPA Programme related to allocations for CC projects for the period 2007-2013 is estimated at 31,549,722 EUR. A list of the project is provided in Annex 4. Three projects related to climate change were funded under the EU **TEMPUS** programme for 2010-2013 (see Annex 4). It should be noted that after 2013, Macedonia cannot participate in TEMPUS without making a financial contribution, and this financial contribution has not been allocated from the national budget.

In addition, the EU **Joint Research Center** (JRC) signed a Memorandum of Understanding in September 2012 with the MoES that included climate change as one of the focal areas. Fruitful collaboration was established between the Third National Communication project team and the JRC Institute in Ispra. This enabled the use of Biophysical Models Applications (BioMA) developed by JRC to assess climate change vulnerability in agriculture in Macedonia, which represented a significant advance in research not only in the country but also in the region. Modelling in BioMA, related to anticipated reduced access to water, provided results that will be useful both for policy-makers and farmers (see more in Section 7.5).

Macedonian universities have also supported research relevant to climate change. The **University of Ss. Cyril and Methodius** in Skopje has allocated financial resources for the study of distribution of radionuclides and heavy metals in the soils and atmosphere of selected regions in Macedonia (implemented by Faculty of Natural Sciences in 2012) and for the implementation of multi-functional system for education, research and promotion of renewable energy resources (implemented by the Faculty of Electrical Engineering and Informatics 2011-2013). **Goce Delcev Stip University** has supported research into the possibility for using zeolite in the treatment of water contaminated with heavy metals (implemented by the Faculty of Natural and Technical Sciences 2008 – 2009), environmental monitoring in the town of Kavadarci and the Tikvesh region (implemented by the Faculty of Natural and Technical Sciences 2011 – 2012); and impacts of agricultural land use on biodiversity and the regional distribution of broomrapes (Orobanchaceae) in the Balkans (Faculty of Natural and Technical Sciences in 2012).

National and international NGOs have influenced the establishment of the national innovation, technology transfer and R&D infrastructure. NGOs have presented in-country findings in the field and have raised awareness regarding national best practice in many thematic areas, including climate change and sustainable development. For example, the **Macedonian Centre for Energy Efficiency (MACEF)** is a voluntary scientific organization in the field of energy efficiency. It is active within the country and abroad. It is a member of the international network of energy efficiency, RENEUER (Regional Network on Efficient Use of Resources). Also, the **Centre for Promotion of Sustainable Agricultural Practices and Rural development (CEPROSARD)** is an NGO which aims to introduce and promote sustainable rural development through research and application of best practices.

7.4.3. Education

The concept of education for climate change and sustainable development is relatively new in Macedonia. Nevertheless, sustainable development is incorporated to a varying extent in different levels of the educational system. An assessment carried out during the preparation of the Third National Communication of the educational curricula related to broader and more complex climate change issues showed that this topic is still not adequately incorporated into the national educational system.

Currently, there are only three faculties in the state university system that have graduate, post-graduate level and/or PhD programs connected to climate change and sustainable development. Furthermore, climate change is not strongly emphasized in the programmes as an educational focal point. The lists below briefly present the programs that are closely connected to climate change and sustainable development, as well as their host faculties and principal coverage.

The Faculty of Technology and Metallurgy, University Ss. Cyril and Methodius in Skopje

Undergraduate level (BS)

1. Climate change – topic in "Environmental Protection" – common subject for all curricula
2. "Impact of climate changes on the water and soil characteristics" – in curriculum: Inorganic Engineering and Environment
3. "Pollutants" – in curriculum: Inorganic Engineering and Environment
4. "Atmospheric Chemistry" – in curriculum: Inorganic Engineering and Environment

Post-graduate Level (MS)

1. Curriculum: Environmental Engineering"

Doctoral Level (PhD)

1. Curriculum: Technology
2. Curriculum: Metallurgy

Faculty of Electrical Engineering and Informatics, University Ss Cyril and Methodius in Skopje

Undergraduate Level (BS)

1. Energy and Sustainable development
2. Photovoltaic systems
3. Renewable energy sources

Post-graduate Level (MS)

1. Curriculum: Renewable energy sources (several related subjects)
2. Curriculum: Energy Efficiency, environment and sustainable development (several related subjects)

Doctoral Level (PhD)

1. Curriculum: Electrical Engineering and Informatics

Faculty of Natural and Mathematical Sciences, University Ss Cyril and Methodius in Skopje

Undergraduate level (BS)

1. Curriculum: Ecology
2. Climate change – topic in "Environmental Protection" – common subject for all curricula
3. Climatology and Climate Changes in curriculum: Geography
4. Plant ecology – in curriculum: Biology

Post-graduate level (MS)

1. Curriculum: Biology
2. Curriculum: Geography

Faculty of Management of Ecological Resources, MIT University, Skopje (private)

Undergraduate level (BS)

1. Metrology with Climatology and Global Climate Changes
2. Chemistry and application of chemical compounds in the environment
3. Environmental Impact Assessment
4. Environmental Law
5. Environmental management
6. Management of Physical Planning
7. Eco-business
8. Environmental monitoring
9. Waste management
10. Biodiversity
11. Alternative energy resources

7.5. CAPACITY STRENGTHENING

7.5.1. Capacity strengthening projects

In the time since the submission of the SNC, a variety of investment and technical assistance projects have included activities to strengthen the capacity of Macedonia to address climate change issues. In several interventions, capacity strengthening is (or was) the primary focus of the project. These projects have included the following:

- Assessing the Economic Impact of Climate Change: National Case studies for energy demand for heating and cooling, water resources related to electricity production, and agriculture; supported by UNDP.
- Support for the development of Nationally-Appropriate Mitigation Actions (NAMAs), including strengthening the analytical and institutional capacity of the key national institutions, a comprehensive assessment of NAMAs for key sectors, and support for the City of Skopje in preparing an urban NAMA; supported by UNDP.
- Roadmap for introduction of Monitoring Reporting and Verification of GHG emissions under EU ETS in Republic of Macedonia (2012); Bulgarian support under fast-track financing)
- Capacity-building to facilitate the implementation of the EU Emission Trading Scheme in Macedonia (2012–2015); supported by the Norwegian Government under G to G support.
- "Strengthening the central and local level capacities for environmental management in the area of air quality" with the Government of Finland; supported by the EU.
- Project for Energy Efficiency in the Residential Sector, Industrial Management Project, and Low Emissions Development and Clean Energy Investment; supported by USAID.
- Project for Regional exchange to the establishment of a monitoring platform for energy efficiency; supported by GIZ.
- Project for Strengthening the Administrative capacity of the Energy Department in the Ministry of Economy and the Energy Agency and Preparation of Long-term Strategy on Climate Change and Law on Climate Action (2012-2014); supported by EU IPA.
- Green Growth Program and Climate Change Analytic and Advisory Support Program; supported by the World Bank.
- Energy Efficiency Capacity Building Program in South East Europe (SEE) being implemented by the World Bank Institute Climate Change Practice: to address some of the barriers to increased implementation of EE and the use of the carbon market mechanisms.

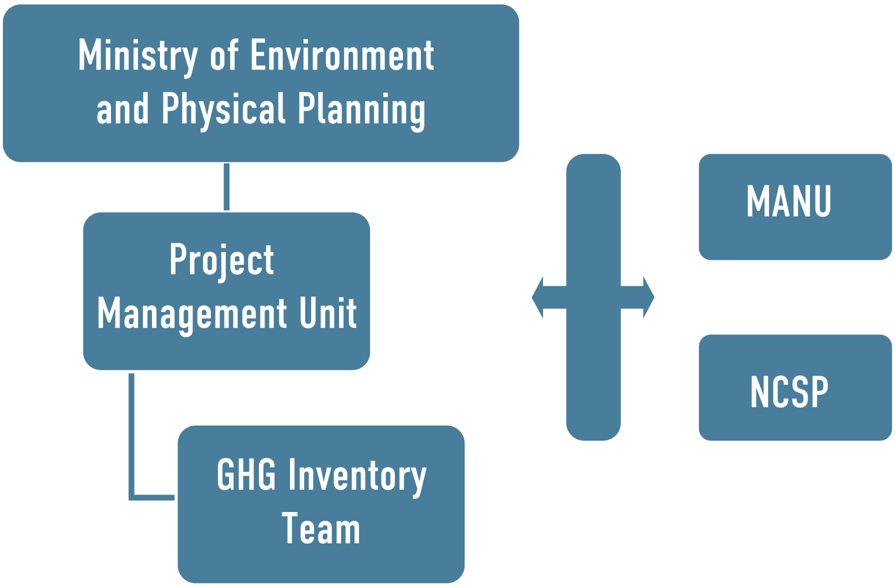
7.5.2. Capacity strengthening through the National Communications Process

Capacity strengthening has been a part of the preparation of each National Communication (the FNC submitted in 2003, the SNC submitted in 2008, the present TNC), and projects to prepare the communications have received funding from the Global Environmental Facility (GEF). Training and capacity strengthening have also been provided over the years by the National Communications Support Unit, which also coordinated support for other communications-related activities, such as the technology needs assessment and additional work to improve emission factors used in the GHG inventories. The application for support to prepare the First Biennial Update Report (FBUR) to the UNFCCC, which is in progress, also includes capacity strengthening measures.

The preparation of the GHG inventory under this TNC serves as a good example of capacity strengthening through the national communications process. The institutional structure for the development of the National GHG inventory involves the following entities (see Figure 7-1):

- MOEPP, which is responsible for supervising the national inventory process and reporting the emissions to UNFCCC
- The Project Management Unit, responsible for managing and coordinating the TNC
- The GHG Inventory Team, which is composed of three junior consultants responsible for preparing the actual inventory
- A National Technical Advisor at the Macedonian Academy of Sciences and Arts (MANU) responsible for training and transfer of knowledge to the GHG inventory team and for supervision and verification of the GHG inventory
- The National Communication Support Programme (NCSP), which has been responsible for supporting and revising the GHG inventory

FIGURE 7-1: Organizational structure of GHG inventory preparation



Over the course of the TNC preparation period, the following training activities were undertaken:

GHG inventory training and training for roster of experts and inventory review: For the TNC, a new institutional system was implemented to ensure the sustainability of the process of preparing GHG inventories. As the national stakeholder that was previously responsible for preparation of the GHG inventory and the institution with wide technical and practical capacity, the Research Centre for Energy, Informatics and Materials under the MANU was designated as responsible institution for training of the inventory team and building up of the knowledge and the technical capacity of the engaged junior experts.

Three professionals were engaged to form the GHG Inventory Team in order to ensure continuous and regular updating of the national GHG inventories and the establishment of a Monitoring, Reporting and Verification (MRV) system. Training materials were prepared for each sector, including a step-by-step process for completing inventory tables, explanations of good practices and sources of data and emission factors. The junior experts were nominated to the UNFCCC Roster of Experts for reviewing inventories of the Annex I parties by the National Focal Point to the UNFCCC. The junior experts took online courses prepared by the UNFCCC and following completion of the on-line course, they attended an additional hands-on experience with inventory review materials. At the end the junior experts underwent a mandatory examination covering both general and sector-specific aspects of inventory reviews which they successfully passed.

Furthermore the junior experts attended the additional courses required by the secretariat designed to specifically address the requirements for annual reviews in accordance with the guidelines under Article 8 of the Kyoto Protocol. The experts were trained for review of national systems under Article 5, paragraph 1, of the Kyoto Protocol and related parts of guidelines under Articles 7 and 8 of the Kyoto Protocol and technical guidance on methodologies for adjustments under Article 5, paragraph 2, of the Kyoto Protocol. The junior experts also successfully completed this part of the training.

In September the same year for the first time a Macedonian expert was part of an ERT (Expert Review Team) that reviewed national inventory submission for four Annex I parties. This was not only a good experience in the learning process regarding the inventory reviews but also it was an improvement of the proficiency in inventory compilation.

Mitigation assessment training: MANU also provided training for the national consultants preparing the mitigation assessment in non-energy sectors, waste and agriculture, in terms of using the appropriate software – GACMO.

Capacity Development Project on Nationally Appropriate Mitigation Actions (NAMAs): A member of the project team participated in the two day conference on NAMAs in Belgrade, Serbia, where the host and the donor JICA presented the results from the two years bilateral project Capacity Development Project on Nationally Appropriate Mitigation Actions in Serbia. The exchange of information in the region **has** been very helpful and valuable for the project team, the MOEPP and the UNDP national office.

IPCC Expert Meeting on the 2006 IPCC Guidelines and Software: In the processes of capacity building within the preparation of the Third National Communication to UNFCCC the junior experts attended various meetings and conferences aiming to straighten the knowledge on the methodologies given in the IPCC Guidelines and Good Practice Guidance. The project team went beyond the 1996 IPCC Guidelines and 2000 Good Practice Guidelines and built competences in the updated 2006 IPCC Guidelines that contain even more detailed descriptions on methods for emission estimation from activities in different sectors. One of the junior experts also attended the IPCC Expert Meeting on the 2006 IPCC Guidelines and Software in Bali, Indonesia.

Training for usage of BioMa framework in the Joint Research Center (JRC) in Ispra, Italy: Within the preparation of the TNC for the first time CropSyst and ClimIndices models were implemented in the BioMa framework developed by the JRC. The BioMa framework was used for assessment of vulnerabilities and measurement of the impact from adaptation measures in the sector agriculture. In cooperation with the Ministry of Education and Sciences a link was established with the department that developed the BioMa framework – MARS (Monitoring Agricultural ResourceS) Unit. One of the junior experts attended a four days training on BioMa usage and creation of specific files for parameterization of the used models. With this knowledge the junior expert worked together with the consultants who prepared the assessment of the vulnerabilities and adaptation measures in the South East Region of the Republic of Macedonia.

Introducing climate change aspects in the protection of cultural heritage: UNDP and the GIZ jointly implemented a training on "Introducing climate change aspects in the protection of cultural heritage" for representatives of relevant national institutions that work on protection of cultural heritage. The training was held on 21 November 2013 as part of the MOEPP and UNDP media campaign "The climate is changing – Adapt! Climate action days: 11-22 November 2013.

Training on the development of NAMAs: On 1 July 2013, UNDP organized this training for national counterparts: the National Climate Change Committee, governmental institutions, NGOs, City of Skopje, and other donors.

Climate Change Adaptation in Western Balkans is a joint cooperation between GIZ and the relevant government ministries in Albania, Kosovo, Macedonia, Montenegro, and Serbia. The GIZ advises the governments of the involved countries in the development and implementation of adaptation strategies with regard to climate change. Specifically, the project aims to reduce the risks of flood and drought as well as to strengthen regional cooperation in the field of integrated water resources management. As part of the Capacity Development Measures a training/study visit on Adaptation Strategies on Climate Change will be held in December 2013 in Germany.

3rd Regional workshop on Energy Planning and Modelling of Energy Systems: The ICEIM-MANU) organized a training specifically for the MARKAL model on 28 – 29 November 2013 in Skopje, for relevant participants (governmental institutions, electricity production/distribution companies, faculties (professors and MSc and PhD students).

Training on climate change and gender aspects of climate change: This training was held in Manastir, Berovo on 31 May to 2 June 2013 as a part of USAID's Municipal Climate Change Strategies Project. Milieukontakt Macedonia organised this workshop is part of the component for strengthening the capacity of the civil society organizations involved with this project. The training program was designed to provide the representative attendees of the civil organizations an understanding of climate change and the specific gender aspects of climate change.

Training of Trainers on Climate change and Municipal Adaptation Planning: From 28 October to 4 November 2013 Milieukontakt Macedonia organized this training within USAID`s Municipal Climate Change Strategies Project. The training program was carried out by trainers from USAID and from USAID Climate Change Resilient Development project. The participants of the training were Milieukontakt Macedonia member staff and the team of trainers of the project. The training focused on the successful integration of the climate resilient development concept and the participatory method of the Green Agenda as a part of the Municipal Climate Change Strategies Project.

Training for the Working groups on "Defining the priorities for adaptation on climate change": This took place in the Municipality of Bogdanci, 2 November 2013. The team of Milieukontakt Macedonia, the trainer for the Municipality of Bogdanci and experts from Washington carried out the training dedicated for working groups in the Municipality of Bogdanci. The working groups were acquainted with the specially designed training modules and the ways to apply them together with the steps of the Green Agenda process to the Municipality of Bogdanci development goals.

Adaptation to Climate Change in Agriculture Project carried out by RDN and funded by USAID carried out the following activities related to training:

Organization of informative workshop for journalists: The Rural Development Network (RDN) organised a two-day workshop for journalists on 2 and 3 July 2012 in Popova Kula winery, Demir Kapija. The journalists from written and electronic media were introduced with the objectives and activities of the RDN with special emphasis on RDN's position as an implementer to the USAID Adaptation to Climate Change in Agriculture project. They were familiarized with expert's forecasts about climate change impacts on the agricultural crops as well as with current and planned activities within the Adaptation to Climate Change in Agriculture Project.

Climate change workshops for RDN members. RDN, in cooperation with Red Cross of Republic of Macedonia, organized a workshop for its Western Macedonia membership in Resen, on 31 August 2012 with the second workshop for RDN's Eastern Macedonia membership held on 4 September 2012 in Stip. Representatives of RDN member associations, along with respective regional NEA and local government representatives received clarification of specific terms such as global warming and climate change and were familiarized with expert forecasts about general climate change effects on ecosystems, biodiversity, air pollution etc. and specific climate change impacts on agricultural crops and human health.

Two results dissemination workshops: At the workshop on 30 November 2012, approximately 40 NEA officers, MAFWE and MOEPP representatives were familiarized with the initial (six) months' project results and findings. Furthermore, over 60 farmers and farmers' associations representatives gained knowledge on preliminary project findings from utilizing climate change adaptation measures in fruit, table grape and vegetable production at three workshops held in Rosoman (fruit growers) on 7 December, Bogdanci (grape farmers) on 21 December and in Strumica (vegetable producers) on 24 December.

Climate Change Public Awareness stand and workshop at Faculty of Agricultural Sciences and Food: In the period from 12 to 14 December, 2012, the Faculty celebrated the institution's 65th Anniversary during which an International Symposium for Agriculture and Food was held. The symposium gathered numerous experts in the area of agricultural sciences and food from the Balkan countries and Slovakia. RDN had a promotional stand at the event and held a workshop on 14 December. The workshop gathered approximately 30 students and representatives from the National Hydormeteorological Directorate.

10 separate on-site demonstrations and trainings on different project-promoted agricultural adaptive practices for farmers and NEA advisors.

7.5.3. Capacity strengthening needs

The capacity strengthening needs for the various sectors are provided in detail in chapters 2 through 5 of this National Communication. Other capacity needs have been identified in the areas of innovation, R&D, and technology transfer related to climate change. Recommendations from a report commissioned on this subject (MOEPP 2013) include the following:

- Establish a National Climate Technology Centre and Network which will serve as national and regional climate change centre of excellence, with the aim of providing continuous transfer of technology, sustainable financing for R&D and innovation activities in the country as a knowledge hub and information resource.
- Nominate a National Designated Entity (NDE) to serve as a focal point on technology transfer with the UNFCCC.
- Enhance partnerships and information exchange between research institutions, academia and administrations at national and regional level and between the public and private sectors and create a centralized project database for climate change-related activities in Macedonia.
- Expand cooperation with EU initiatives such as COST Action 11011 and COST ESSEM.

7.6. FINANCIAL RESOURCES AND TECHNICAL SUPPORT

Financial resources for climate change activities come primarily from two sources: 1) bilateral and multilateral donors; and 2) the Global Environmental Facility (GEF). A number of research projects funded via bilateral and multilateral donors (especially the EU) are described in Annex 4. Additional projects funded through support from bilateral donors such as USAID are described above.

As a financial mechanism of the UNFCCC, the GEF is a key means of both financial and technical support for climate change activities. From the time that the Republic of Macedonia joined the GEF, it has received country-level grants totalling USD 11,587,900 and has leveraged USD 42,474,100 in co-financing for 11 national projects. These include five projects to address climate change. In addition, the country has participated in nine regional and global projects financed by the GEF totalling USD 26,055,000, leveraging USD 204,460,009 in co-financing. These include two projects addressing climate change.

Works cited

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ANNEX 1:
LIST OF NAMAS SUBMITTED AS A PART OF THE COPENHAGEN ACCORD

NAMA number	Goals	Actions
I. GHG emission reduction in the electric power sector		
I.1	Harmonization and implementation of EU legislation in Energy and Climate	- EU Energy and Climate Package; - Liberalization of energy markets (electricity and gas).
I.2	Ensuring stability in energy supply with investment activities for building new big hydro power plants	- HPP Boskov Most; - HPP Galiste; - HPP Cebren.
I.3	Ensuring stability in energy supply with investment activities for building new thermal power plants on gas	- CHP Skopje 230 MW; - CC gas (200-300 MW).
I.4	Increasing the share of renewable energy in the energy sector	- Small hydro power plants; - Wind power plants; - Biomass electricity and PV panels.
I.5	Improvement of energy efficiency	- Building plants for production of CHP; - Measures for reducing the losses in transmission and distribution of electricity; - Measures by the electricity consumers by introducing more efficient lamps, more; efficient electrical appliances, etc.; - Animation of interested investors with favourable legal regulations and tax relief;
II. GHG emissions reduction in the industrial energy transformation and heating sectors		
II.1	Reduction of the use of carbon intensive fuels	- Replacement of coal with liquid or gaseous fuels; - Replacement of liquid fuels with gaseous fuels.
II.2	Improvement of the energy efficiency and energy saving	- Improvement of the energy efficiency of the boiler plants with permanent maintenance; - Replacement of old equipment in boiler rooms, with regular revitalization works; - Installation of measurement-regulation equipment and automatic control systems; - Better insulation, maintaining clean heat exchange surfaces; - Utilisation of heat content in flue gases; - Reduction of losses in systems for transportation of fluids; - Heat insulation of pipelines for transport of water, steam, fuels, etc. - Reduction of specific consumption of energy in industry by introduction of up-to-date technologies and processes; - Improvements of the performances of the thermal cycle; - Improvement of the standards for construction of buildings, better insulation, use of high quality materials.
II.3	Increasing of the contribution of renewable energy sources in the country's energy balance	- Utilization of waste biomass as an energy source and as a raw material for production of briquettes and pellets; - Installation of tens of boiler units on waste biomass in the agro-industry complex, industry sector and in households; - Rehabilitation, revitalization and expanding of the geothermal system Geoterma-Kochani; - Revitalization of other systems on geothermal energy; - Introduction of solar energy systems for heating and hot water supply (in hotels, hospitals, schools, public buildings, health resorts, etc.)

NAMA number	Goals	Actions
II.4	Awareness raising of final consumers	- Reduction of energy consumption in the households with measures of energy saving; - Reduction of electricity use for heating; - Introduction of measurement equipment and charging in accordance with consumption.
III. GHG emissions reduction in transport		
III.1	Improvement of the overall efficiency in the transport sector and energy efficiency of vehicles	- Revitalization, extension and better maintenance of the road and railway infrastructure; - Extension-spreading of the electrification of the railway network; - Modernization of the vehicle fleet; - Motivation for wider use of alternative fuels and other power systems (LPG, CNG, biodiesel, hybrid vehicles, etc.)
III.2	Improvement of public and inter-city transport	- Improvement in the planning, organization and control of traffic; - Measures for the regulation of traffic in central urban areas; - Modernization of the transport equipment for public traffic; - Synchronization of the road signalization in the towns; - Introduction of electronic pay toll charging; - Introduction of electrically driven types of transport, i.e. tramway; - Railway transport – electrification of the railway network.
III.3	Harmonization of national legislation regarding the transport sector with EU directives	- EU Energy and Climate Package (biofuels); - Regulation on fuels quality in accordance with EU norms.
IV. GHG emissions reduction in the waste sector		
IV.1	GHG emissions reduction at existing landfills	- Technical improvement of the existing landfills; - Installation of methane recovery and flaring systems at selected landfills.
IV.2	Improvement of the possibilities for efficient methane collection	- Construction of regional solid waste disposal sites.
IV.3	Reduction of nitrous oxide (N_2O) emissions	- Implementation of legal measures for restriction of economic activities that include uncontrolled burning of waste; - Raising public awareness for restriction of uncontrolled burning of waste.
IV.4	Reduction of methane emissions from wastewater	- Expansion of the wastewater treatment plant network.
V. GHG emissions reduction in agriculture and forestry		
V.1	Enabling favourable pre-conditions for GHG emission reduction (laws, bylaws, institutional measures, support measures)	- Transposition and implementation of EU Common Agricultural Policy (CAP) legislation - Completion of institutional and legal reforms in the irrigation sector; - Increasing of institutional and individual capacities for applications for available EU funds; - Development of system for application of Good Agricultural Practices; - Financial support for motivating farmers to use mitigation technologies.
V.2	Introduction/ development of GHG mitigation technologies in agriculture	- Installation of methane recovery and flaring systems at selected farms; - Research support program for development of new mitigation technologies and transfer of existing ones; - Programme for introduction of practices that use agriculture potential for renewable energy and carbon sequestration; - Programmatic CDM projects
V.3	Strengthening the national and local capacities for carbon financing	- Training for CDM potential in agriculture; - Training for preparation of CDM documentation.
V.4	Education (of experts/ farmers/ decision makers) for application of mitigation measures/ technologies in agriculture	- Current curricula and syllabi upgraded with climate change mitigation issues; - Training of farmers for adopting new technologies; - Familiarization of public and institutions with the problem of climate change mitigation.
V.5	Implementation of the national strategic documents in forestry	- Forestation and re-forestation; - Prevention measures against fires; - Prevention of illegal cut.

ANNEX 2:
POTENTIAL ADAPTATION MEASURES

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Primary sector: Water resources													
Modification of existing water supply and irrigation systems to decrease water losses (drip, microspray, low-energy, measuring devices)	Policy	MAWFE, Public water management enterprises	Long-term	High budget		X	X					X	
Implementation technology for re-use of water (municipal, drainage, waste water)	Policy	MAWFE, Public water management enterprises	Medium-term	Medium budget	Finances, Technology aspect	X	X	X					
Inventory and GIS mapping the existing wells for groundwater use	Policy	MAWFE, Local municipalities, Public water management enterprises	Short-term	Low budget	Low public awareness	X	X						
Construction system for inter-basin water transfer	Policy	MAWFE, MOEPP, Public water management enterprises	Long-term	High budget	Finances, Access to International funding programs	X	X					X	
River basin management plan development including conjunctive surface and groundwater supply	Policy	MAWFE, MOEPP, Public water management enterprises, Local municipalities	Short-term	Medium budget		X	X					X	
GIS hazard events mapping and risk management (drought and flood)	Policy	MAWFE, MOEPP, Public water management enterprises, NGOs	Short-term	Medium budget	Lack of data	X	X	X	X	X	X	X	
Monitoring network improvement (surface water, groundwater, water use, water quality)	Capacity building, Policy	MAWFE, MOEPP, HMS, Public water management enterprises	Short-term	Medium budget	Finances	X	X	X	X	X		X	
Development of flood action plan and introducing Flood early warning system	Policy	National/local government, Ministry of Health, CMC, Red Cross, National public health institute, Centres for public health	Long term	EUR 50,000 (only for the plan)	Limited interest and understanding of nature of the problem; Current practice: wait for the impact then react	X		X			X	X	

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Primary sector: Agriculture - general													
Establishing a national fund for testing of adaptive measures and introduction of drought resistant species	Policy/ Legislation	MAFWE, IAS, FASF	Long term	EUR 800,000		X	X						
Subsidies for implementing adaptation measures for professional farmers	Policy/ Legislation	MAFWE	Long term	EUR 2,000,000			X						
Development a new crop varieties selection and experiment programme to increase crop adaptation to adverse impacts of climate change	Capacity building	MAFWE, IAS, FASF	Long term	EUR 2,000,000	Lack of finance, lack of concrete results despite the longstanding research activities		X						
Establishing of National center for drought and yield forecasting	Capacity building	MAFWE, IAS, FASF, NHSRM	Medium term	EUR 1,000,000		X	X					X	
Development of techniques and procedures for cultivation, fertilizer utilization and soil reclamation for the key crops in CC affected areas	Capacity building	MAFWE, IAS, FASF	Medium term	EUR 1,000,000	Lack of finance, Insufficient awareness for the key decision makers, Low interest between primary producers		X						
Development of different tillage practices for the promotion of sustainable agricultural practices.	Capacity building	MAFWE, IAS, FASF	Medium term	EUR 1,000,000	Lack of finance, Insufficient awareness for the key decision makers, Low interest between primary producers		X						
Development irrigation techniques and water supply	Capacity building	MAFWE, IAS, FASF	Medium term	EUR 1,000,000	Lack of finance, Insufficient awareness between primary producers	X	X						
Implement the "Policy for Biofuels in Macedonia", which will consider the use of biofuels as an alternative to fossil fuels in agricultural machinery.	Policy/ Legislation	MAFWE, MOEPP	Medium term	EUR 700,000	Lack of finance, obstructions about is it more important to produce food or feed for biodiesel production.		X						

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Establishing of national network for long term monitoring of agro climatic and agro-edaphic parameters as a prerequisite for efficient planning and implementation of adaptive measures	Capacity building	MAFWE, IAS, FASF, NHSRM	Medium term	EUR 1,000,000			X						
Development of criteria and identification of LUT and AEZ	Legislation, Capacity building	MAFWE, IAS, FASF, NHSRM	Short term	EUR 200,000			X						
Establishment of 15-20 phenological fields and long term financing program	Capacity building	MAFWE, IAS, FASF	Short term	EUR 700,000			X						
Inclusion of climate change adaptation measures into rural development schemes	Policy	MOEPP, MAFWE, Government	Medium term	EUR 100,000 - 300,000	Lack of commitment; Low institutional capacity	X	X		X	X			
Increased organic farming	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on ha covered	Financial, market availability, knowledge	X	X		X	X			
Increasing planting depth	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on ha covered	Knowledge constraints	X	X			X			
Primary sector: Agriculture - viticulture													
Strengthening and structural changes of the Water User Associations and Corporations.	Policy/ Legislation/ Capacity building	MAFWE, Water communities, Local government	Short term	EUR 1,000,000	Lack of finance, Lack of awareness of the importance of this measure between key decision makers.	X	X					X	
Support to the Water communities and change the system of irrigation water charge (per m3).	Policy/ Legislation	MAFWE, Water communities, Local government	Short term	No cost	Lack of awareness of the importance of this measure between key decision makers. The preparedness to change the present (traditional) system of charge for irrigation water based on the area (per hectare), which stimulates uncontrolled and irrational use of water.	X	X					X	

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Development of criteria and identification and delineation of localities with specific climatic and soil characteristics for certain varieties (terroir)	Legislation/ Capacity building	MAFWE, IAS, FASF, Hydrometeorological Service	Short term	EUR 200,000	Need for increasing of public awareness by the local government, NGO`s and scientific community.		X						
Establishment of facilities for processing of bio residues for biofuels	Capacity building	MAFWE, MOEPP, Local government	Short term	EUR 1,000,000	Low interest of primary producers.		X					X	
Establishment of early warning system (network of meteorological stations) for improved pest control and water use efficiency	Capacity building	MAFWE, Hydrometeorological Service	Short term	EUR 500,000	Need for increasing of public awareness by the local government, NGO`s and scientific community.		X						
Supporting the research and innovation for development and spreading the new production systems and measures	Capacity building/ Policy	MAFWE, Ministry of Education and Science. Institute of Agriculture Skopje, Faculty of Agricultural Sciences and Food	Short/ Medium term	EUR 2,000,000	The budget and financial means for R&D are reduced. The research network is not developed and innovations lacks.		X						
Implementation of new training systems, especially in table grape varieties (sun burns protection of grapes) and implementing of integrated viticulture production (optimization of pest control and fertilizer use efficiency)	Capacity building/ Policy	MAFWE, Institute of Agriculture Skopje, Faculty of Agricultural Sciences and Food	Short/ Medium term	EUR 1,000,000	Low interest between primary producers due to lack of awareness. The government has not adopted the regulation for professional occupation and vocational training, qualification and skills demanded.		X						
Support the establishing of facilities and logistics for production of certified seedlings and varieties more resistant to climatic stress.	Legislation/ Capacity building	MAFWE, Institute of Agriculture Skopje, Faculty of Agricultural Sciences and Food	Medium term	EUR 2,000,000	Lack of finance, Lack of awareness of the importance of this measure between key decision makers.		X						
Establishment of phenological fields in each sub region of Povardarski region and long term financing program	Capacity building	MAFWE, Institute of Agriculture Skopje, Faculty of Agricultural Sciences and Food	Medium term	EUR 1,000,000	Lack of finance, Insufficient awareness for the key decision makers, Low interest between primary producers		X						

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Financial support for implementation of modern adaptation measures, e.g. UV nets, cover crops, sprinkler irrigation	Capacity building/Policy	MAFWE (IPARD-Component V, Measure 103 –Improvement and upgrading of the existing vineyards according EU standards); MAFWE -Program for financial support of the agricultural sector	Medium/Long term	EUR 15,000,000	A system for subsidizing of these types of investments has not yet been introduced by the Government The financial sources and lending instruments are not available for the farmers.		X						
Financial support for implementation of methods and techniques for increasing of water use efficiency, e.g. pressurized irrigation systems, control systems for efficient irrigation scheduling, etc.	Capacity building/ Policy	MAFWE (IPARD-Component V, Measure 103 –Improvement and upgrading of the existing vineyards according EU standards); MAFWE -Program for financial support of the agricultural sector	Medium/Long term	EUR 11,500,000	The farmers do not have access to the water resources. A system for subsidizing of these types of investments has not yet been introduced by the Government The financial sources and lending instruments are not available for the farmers. Lack of finance, Insufficient awareness for the key decision makers, Low interest and know-how between primary producers	X	X						
Long term investments in reconstruction and extension of dams and irrigation schemes.	Capacity building/ Policy	MAFWE, Water communities, Local government	Long term	Lack of input for estimation. Each case needs feasibility study with detailed budget	Lack of finance, Lack of awareness of the importance of this measure between key decision makers. The cooperation between the central and local government and farmers NGO is unsatisfactory.	X	X					X	

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Financial support of dislocation of vineyards on a higher altitude and more appropriate/ resistant varieties to frosts.	Capacity building/ Policy	MAFWE (IPARD-Component V, Measure 101-Renewal of the existing vineyards according EU standards), Local government	Long term	EUR 11,000,000	- Possible lack of appropriate areas. Extension of the existing irrigation schemes and additional costs for pumping of water (pumping stations). - Additional investments for land preparation and foundation of vineyards. - Increased production costs as result of higher altitude and higher transport costs. - Lack of capacity and preparedness of for local governance for management, parcelisation and foundation of arable land in the hilly/ higher altitude zones.		X						
Financial support for intensification the process of establishing of new vineyards (only 2% of vineyards are renewed every year), for improvement of the age structure of vineyards	Capacity building/ Policy	MAFWE (IPARD-Component V, Measure 101-Renewal of the existing vineyards according EU standards); MAFWE - Program for financial support of the agricultural sector	Long term	EUR 21,000,000	- Lack of finance. - A system for subsidizing of these types of investments has not yet been introduced by the Government.		X						
Primary sector: Agriculture - livestock production													
Introduce genetically heat tolerant breeding animals	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on the facility	Technical and financial		X						
Adoption of special feed and feeding techniques in periods of excessive heat	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on the facility	Technical and financial		X						

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Better housing conditions by adopting proper ventilation, in-house conditioning and installation of cooling systems	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on the facility	Technical and financial		X						
Introduce continuous monitoring of farm productivity that can then be correlated with heat waves and high temperatures to ensure precise loss calculations	Technical/ investment	MAFWE, extension services, agricultural producers	Long term	Depends on the facility	Technical and financial		X						
Primary sector: Biodiversity													
Monitoring of the status of alien (and invasive) species of plants	Monitoring	Scientific Institutions, MOEPP	Continuous	EUR 100,000 - 300,000	Monitoring of alien species still not established within MoEPP			X	X				
Monitoring of the status of animal species-vectors of diseases	Monitoring	Ministry of Health, Scientific Institutions	Continuous	EUR 100,000 - 300,000	Lack of suitable research capacities; Lack of cooperation between Ministry of Health and relevant scientific institutions			X	X				
Elaboration of list of species for which "*ex situ*" conservation is necessary	Research	MOEPP, MAFWE, Scientific Institutions	Short term	Less than EUR 100,000			X		X				
Adoption of policy instruments for implementation of corridors management plans into national and regional spatial planning	Policy	MOEPP, MAFWE, Ministry of Transport and Communications, Ministry of Economy, Ministry of Local Self-government, municipalities, Makedonski sumi	Medium term	EUR 100,000 - 300,000	Lack of good cooperation between spatial planners, relevant ministries, scientists and public enterprises		X		X	X			
Case study of implementation of the ecological network concept in regional planning based on inter-sectoral approach	Policy	MOEPP, MAFWE, Ministry of Transport and Communications, Ministry of Economy, Ministry of Local Self-government, municipalities, Makedonski sumi	Short term	EUR 100,000 - 300,000	Lack of good cooperation between spatial planners, relevant ministries, scientists and public enterprises		X		X	X			
Adaptation of forestry management plans in the main forested biocorridors to provide their better functionality in terms of climate change impacts	Policy	MAFWE, Makedonski sumi	Medium term	More than EUR 300,000	Forestry sector still not transformed according to the trends in EU				X	X			
Cost-benefit study of the impact of energy production systems based on using alternative energy sources (hydrological systems, solar power, wind) on biodiversity	Research	MOEPP, MAFWE, Ministry of Transport and Communications, Ministry of Economy, Ministry of Local Self-government	Short term	EUR 100,000 - 300,000	Lack of institutional commitment; Lack of suitable research capacities in Macedonia				X			X	

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Definition of possible routes (biocorridors) for movement and migration of threatened plant and animal species by the climate change	Research	MOEPP, MAFWE, Makedonski sumi, Scientific Institutions, NGOs	Short term	EUR 100,000 - 300,000	Lack of suitable research capacities in Macedonia		X		X	X			
Determination of ecological minimum for mountain water ecosystems	Research	MOEPP, MAFWE, Ministry of Economy, Scientific Institutions	Short term	EUR 100,000 - 300,000	Lack of institutional commitment	X			X				
Hydrologic study for the vulnerability of lowland marshes, mountain mires and glacial lakes	Research	MOEPP, Scientific Institutions	Medium term	EUR 100,000 - 300,000	Lack of good hydrologic and biodiversity data	X			X				
Assessment of the impact of periodic natural and induced hydrological fluctuations on biodiversity of glacial lakes in climate change context	Research	MOEPP, Scientific Institutions	Short term	Less than EUR 100,000	Lack of capacity and knowledge	X			X				
Assessment of the impact of periodic natural and induced hydrological fluctuations on biodiversity of mountain bogs and springs in climate change context	Research	MOEPP, Scientific Institutions	Short term	Less than EUR 100,000	Lack of capacity and knowledge	X			X				
Assessment of the impact of periodic natural and induced hydrological fluctuations on biodiversity of lowland marshes and bogs in climate change context	Research	MOEPP, Scientific Institutions	Short term	Less than EUR 100,000	Lack of capacity and knowledge	X			X				
Assessment of the impact of induced floods on Tamaris shrublands, willow woodlands with poplar and Periploca in the region of Gevgelija	Research	MOEPP, Scientific Institutions	Short term	Less than EUR 100,000	Lack of capacity and knowledge	X			X				
Study of the historical and present timber line and modelling of future changes induced by the climate	Research	MOEPP, Scientific Institutions	Continuous	EUR 100,000 - 300,000	Lack of historic data				X	X			
Detailed mapping and modeling of the changes of some mountain pasture types as a pilot study for climate change	Research	MOEPP, MP, Scientific Institutions	Short term	EUR 100,000 - 300,000	Lack of suitable research capacities in Macedonia		X		X				
Detailed revision of the Macedonian protected areas system in connection to climate change adaptation.	Research	MOEPP, MAFWE, Makedonski sumi, Scientific Institutions, NGOs	Short term	More than EUR 300,000	Low institutional capacity		X		X	X			
Establishing of an intersectoral body among the administrations that have the responsibility for managing water resources and biodiversity, with a strategy for activities	Policy	MOEPP, MAFWE, Ministry of Transport and Communications, Ministry of Economy, Ministry of Local Self-government, Makedonski Sumi	Short term	Less than EUR 100,000	Low awareness for the importance of biodiversity and threats imposed by water sector	X			X				

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Primary sector: Forestry													
Develop a complete programme for adapting forestry to global climate change;	Capacity building	MAFWE, Makedonski sumi	Medium term	To be evaluated	Technical and financial				X	X	X		
Establishment of 5 monitoring stations in forest regions for the continued monitoring of climate change;	Research/ Capacity building	MAFWE, Makedonski sumi	Short term	To be evaluated	Financial					X			
Introduction of technologies for efficient biomass usage in forestry;	Technical/ investment	MAFWE, Makedonski sumi	Short term	To be evaluated	Technical and financial					X		X	
Purchasing of proper vehicles for forest fire suppression;	Technical/ investment	MAFWE, Makedonski sumi	Short term	To be evaluated	Financial				X	X	X		
Conduct a thorough biomass stocking exercise (the last one was done in 1977);	Research/ Capacity building	MAFWE, Makedonski sumi	Short term	To be evaluated	Financial				X	X			
Adaptation of the Management plans in the forestry sector to incorporate climate change factors.	Policy	MAFWE, Makedonski sumi	Short term	To be evaluated	Capacity					X			
Primary sector: Human health													
Preparation and establishment of Regional CC Health Adaptation Strategy	Policy	Centres of public health, Local and regional municipalities, Ministry of Health, Academia, Red cross, Hydrometeorological Service, CMC	Short term	EUR 20,000	Lack of supportive policies, standards, regulations, and design guidance	X	X	X	X	X	X	X	
Establishment of SE Regional intersectoral Committee monitoring the climate change adaptation process	Capacity building	Regional and local structures and municipalities – mayors, Public health institutes , Center of crisis branches	Short-term	EUR 5,000 (annually for the work of the committee)	Limited interest and understanding of nature and extent of risks and vulnerabilities – current and projected; Not seen as a big problem and the temptation is to wait for the impact then react;	X	X	X	X	X	X	X	
Enhancing of the ongoing public health activities in the region	Capacity building	National Government, Ministry of Health, Network of National public health institute and Public Health centres, Regional and local structures and municipalities	Short-term	EUR 50,000 (to add on the present public health budget + new employments)	Public health budget constraints, Luck of human capacities			X					

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Education and training of the health professionals for dealing/management with the CC impacts and adaptation measures on health sector	Capacity building	National Public Health Institute and Medical Faculty to lead training of different health professionals: Representatives of regional and local structures and municipalities – mayors, Public health institutes, Center of crisis branches	Short-term	EUR 20,000	lack of human capacities, limited interest			X					
Creation of information and data collection + research of CC health effects in the region emphasized in this study including those with limited or no data Research studies about cost of damages and health effects as well cost benefit of the adaptation measures; Establishment of integrated CC early warning and monitoring health information system including establishment of air pollution monitoring + creation and maintenance of CC health database	Capacity building	National public health institute and Medical Faculty to develop and pilot CC early warning information system, + international assistance	Short-term	EUR 150,000	Lack of supportive policies, standards, regulations, and design guidance – deficiencies, budget limitation			X					
Preventing effects or reducing risks – establishment of adaptation and resilience plans in the health care institutions + building resilience: To be an upgrade of the existing Hospital safety index and disaster preparedness plans	Capacity building	National and Local governments, Ministry of Health – to make proper plan and prioritization, secure a special budget or/and arrange fund raising	Long term with in accordance with proper prioritization and operational plans	EUR 150,000	Limited interest and understanding of nature and extent of risks and vulnerabilities + national and local budget constraints			X					
Improving the drinking water quality (and quantity) especially in rural areas	Infrastructure measure	Ministry of Health, MOEPP, Local governments – to make special operational plan and secure a special budget or/and arrange fund raising for improvement of the drinking water treatment and monitoring in rural areas	Long term with in accordance with proper prioritization and operational plans	EUR 150,000	Limited interest and understanding of nature and extent of risks and vulnerabilities + national/ local budget constraints; Lack of availability or restricted access to appropriate technologies; Prohibitive costs of identified adaptation options when budgets are limited.	X		X					

Action	Type	Stakeholders	Timeframe	Financing (EUR where mentioned)	Constraints	Water resources	Agriculture	Health	Biodiversity	Forestry	DRR	Energy	Cultural heritage
Establish/enhance an efficient system for food safety control and implementation of the HACCP in all levels of food production, transport and marketing including a transparent and regularly updated regional food safety data base	Capacity building	Ministry of Health, MAFWE, Food agency, Institute and centres for public health, Local governments	Long term	EUR 150,000	Limited interest and understanding of nature and extent of risks and vulnerabilities + national and local budget constraints		X	X					
Primary sector: Cultural heritage													
Improving the understanding of adverse impacts of climate change on cultural heritage	Research/ Capacity building	Cultural, environmental and water authorities. The municipality of the city of Skopje. Research institutions and universities.	Short term	EUR 45,000	Financial	X							X
Assessing the vulnerability of built and archaeological heritage as well as historical cultural landscapes in by rapid impact assessment	Research/ Capacity building	Ministry of Culture and National Heritage Protection Office	Short term	EUR 140,000	Financial	X							X
Establishing a monitoring program for damages on built and archaeological heritage as well as historical cultural landscapes for short term extreme weather events and long term climate change	Research/ Capacity building	Ministry of Culture and cultural authorities in close cooperation with MOEPP and relevant environmental authorities	Short term	EUR 85,000	Financial	X					X		X
Identification of tools and adaptation measures for the main categories of cultural heritage	Research/ Capacity building	Policy, researchers, site managers, conservators, architects and the public	Medium term	EUR 275,000	Financial, capacity								X
Limiting damages through implementation of a long term management strategies related to the adaptation of climate change impacts on heritage	Technical/ investment	Ministry of Culture, National Heritage Protection Office, Cultural Heritage Site Managers	Long term	EUR 110,000	Financial, capacity	X					X		X

ANNEX 3:
CLIMATE CHANGE AND IMPACT INDICATORS FOR BUILT HERITAGE AND ARCHAEOLOGICAL SITES

Climate Parameters	Meteorological Changes	Climate Indicators	Parameters	Impact Indicators	Parameters
Temperature	temperature range	mean monthly temperature	°C	stone deterioration	loss of stones/bricks
	freeze-thaw cycles	temp. above and below 0°C in 24h	number of days/y	fresco destruction	surface layer loss (μm/y)
	thermo shock	min/max temp. In 24h on surface	Δ T	deterioration of facade	surface layer loss (μm/y)
	relative humidity	range RH max.- RH min.	%	salinization	loss of stones/bricks, surface layer loss (μm/y), wash out of mortar
		mean RH	%	destruction of wall paintings, fungi and insect infection (e.g. dry rod) of wooden construction	species and wooden construction infested by fungi and insects
Water	heavy rainfall events	>200mm/day	number of events	static instability of buildings and archaeological remains	inclination (mm/y)
	long term rain periods,	total rainfall of rain period >1000mm/period	number of periods	moisture content, moisture in built material	%
	flood events	total area flooded	km²		
		height of flood	m	loss of building material and loss of collections	damage assessment report on flooding events
		duration of flood	days		
	wind driven rain	wind speed and amount of precipitation	m/sec and mm rainfall	salinization frost-damage (Winter)	loss of stones/brickssurface layer loss (μm/y), surface layer loss (μm/y)
	dry periods	periods without rain	days	risk of fire (hot summer month)	damage assessment report on fire
				sandstorm as indirect effect of reduction of vegetation cover	surface layer loss (μm/y)
Wind	Sandstorm	wind speed	m/sec	sandblast of frescos and decorated facades	surface layer loss (μm/y)
		wind driven sand, salt	colour		

non climate parameters	land use change	increasing area of settlement and infrastructure	km^2	Case specific	assessment report
	urbanization	sealed area in ratio to total area	%		
	pollutants	SO_2, No_x, pH precipitation	mg/m^3	stone recession,	surface loss µm/y
			pH	glass corrosion	colour of facades

ANNEX 4:

ADDITIONAL INFORMATION ON CLIMATE CHANGE-RELATED RESEARCH

Climate change-related research projects in the Republic of Macedonia funded through the 6th and 7th EU Framework Programmes (FP6 and FP7)

No.	Title	Program & Call	Start date/ Budget (€) for RM	Macedonian Partner
1	Eco-houses based on Eco-friendly Polymer Composite Construction Materials	FP6	01-10-2004/ EUR 250,000	FTM-UKIM, MOEPP, EUROINVEST, Studio R, ZIMRANT Skopje,
2	RISE - Renewables for Isolated Systems-Energy supply and Waste Water Treatment	FP6	3 years/ EUR 434,900	Faculty of Electrical Engineering and Information Technologies, Macedonian Academy of Sciences and Arts, Bioengineering DOO - BIG (SME), MEPSO (Transmission system operator
3	LPAMS - Production Process for Industrial Fabrication of Low Price Amorphous-microcrystalline Silicon Solar Cells,	FP6	3 years / EUR 84,000	Macedonian Academy of Sciences and Arts
4	RES INTEGRATION - Rural Sustainable Development through Integration of Renewable Energy Technologies in Poor European Regions;	FP6	3 years / EUR 150,000	Macedonian Geothermal Association;
5	EU Geo Capacity, Assessing European Capacity for Geological Storage of Carbon Dioxide	FP6	3 years / EUR 18,000	Macedonian Geothermal Association
6	RECOVER - Renewable Energy Coordinated Development in the WBC;	FP6	2 years / EUR 18,120	Macedonian Geothermal Association
7	ACCENT - Acceleration of the Cost Competitive Biomass Use for Energy purposes in the WBC;	FP6	2years/ EUR 23,120	Macedonian Geothermal Association
9	Biomass Energy Europe	FP7-ENERGY-2007-3.7-01	01-10-2008/ EUR 37,985	Macedonian Geothermal Association
10	Classification of European Biomass potential for bioenergy using terrestrial and earth observations	FP7-ENERGY-2007-3.7-01	01-10-2008/ EUR 40,018	Balkan Foundation for Sustainable Development
11	Testing Innovative Strategies for Clean Urban Transport for historic European cities	FP7-ENERGY-2007-	01-10-2008/ EUR 234,400	Faculty for Technical Sciences, University "St. Clement Ohridski", Bitola; Municipality of Skopje; Public Transport Company

12	South-East European TSO Challenges	FP7-ENERGY-2008-	01-01-2010/ EUR 156,000	Ss. Cyril and Methodius University, Faculty of electrical engineering and information technologies; Operator of Power Transmission System of Macedonia-MEPSO
13	Development and demonstration of a dynamic, web-based, renewable energy rating platform	FP7-research for SME-2011	01.10.2011/ EUR 10,000	Macedonian association for solar energy- SOLAR ,.Macedonia
14	Fiber Reinforced Composite Reflectors for Concentrated Solar Power Plants	FP7-research for SME-2011	01-01-2012/ EUR 220,000	Center for Plasma Technologies - PLASMA ltd.
15	Development of a modular, all-polymer solar thermal collector for domestic hot water preparation and space heating	FP7-SME-2010	01-01-2011/ EUR 250,000	Center for Plasma Technologies - PLASMA ltd.
16	Balkan GEO Network Towards Inclusion of Balkan Countries into Global Earth Observation Initiatives	FP7-ENV- 2010.4.1.4-1	01-10-2010/ EUR 30,000	Balkan Foundation for sustainable development
17	Strengthening and development of Earth Observation activities for the environment in the Balkan area	FP7-ENV-2010.4.1.4-1	01-10-2010/ EUR 36,885	Ss. Cyril and Methodius University, Skopje
18	Promotion and coordination of environmental research in Central and Eastern Europe for a sustainable Development with the support of the Enterprise Europe Network	FP7-ENV.2010.5.1.0-2	01-10-2011/ EUR 46,729	Foundation for Management and Industrial Research
19	Complex Research of Earthquake's Prediction Possibilities, Seismicity and Climate Change Correlations	FP7-PEOPLE-2011	01-10-2011/ EUR 68,000	Ss. Cyril and Methodius University, Skopje
20	Marine Microbial Biodiversity, Bioinformatics and Biotechnology	FP7-OCEAN-2011	01-10-2011/ EUR 290,000	InterWorks, Bitola
21	Development and demonstration of compact, multi-source heat exchanger technologies for renewable energy applications	FP7-SME Association-2011	01-01-2012/ EUR 25,000	Macedonian Association of Solar Energy, SOLAR Macedonia
22	Fiber Reinforced Composite Reflectors for Concentrated Solar Power Plants	FP7-ENV-2011	01-01-2012/ EUR 220,000	Center for Plasma Technologies - PLASMA ltd.
23	Cost-effective sensors, interoperable with international existing ocean observing systems, to meet EU policies requirements	FP7-OCEAN-2012	01-10-2013/ EUR 100,000	FTM-UCIM

Climate change-related projects in the Republic of Macedonia funded through the EU Pre-Accession Instrument (IPA), 2007-2013

No.	Title	Institution	Short Description	Duration
1	Monitoring of the environment of the town of Kavadarci and the Tikvesh area.	Faculty of Natural and Technical Sciences	Environmental protection of the Tikvesh area and the town Kavadarci	2011-2012
2	Environmental Highway Observatory (e-Highway)	Agency for State Roads	Measure 2.1 Promote and protect the environmental resources of the area	
3	Local Communities in Environmental Action (ENVI)	Municipality of Kavadarci	Environmental protection of Natural resources, sensitization and Volunteer participation of local communities in order to Improve river water quality and quality of life in cross border area	
4	Integrated Selection, Protection and Promotion of Balkan Forest Genetic Resources with Aesthetic Value (ISPROP FORGEN)	Goce Delcev University – Stip (Faculty of Agriculture)	The ultimate objective of this project is to protect the forest genetic resources of the cross-border area	2012
5	Local Communities in Environment Developing cross-border joint fire-protection plan “FIRESHIELD” tal Action	Municipality of Bitola Municipality of Prilep	Fire protection plan to mitigate the unwanted effects of fires	

Projects Related to Climate Changes and Environment Funded by the EU TEMPUS Programme, 2010-2013

No	Title	Faculty	Project Number	Duration
1	Creation of University-enterprise cooperation network for education on sustainable technologies	Faculty of Technology and Metallurgy, Ss. Cyril and Methodius University - Skopje	158989-TEMPUS-1-2009-BE-TEMPUS-JPHES	2010-2013
2	Development of Environment and Resources Engineering Learning	Faculty of Mechanical Engineering, Ss. Cyril and Methodius University - Skopje	511001-TEMPUS-1-2010-1-IT-TEMPUS-JPCR	2010-2013
3	Regional Joint Doctoral Programme in Entrepreneurship and SME Management for Western Balkan Countries	Ss. Cyril and Methodius University - Skopje	510993-TEMPUS-1-2010-1-IT-TEMPUS-JPCR	2010-2013

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ANNEX 5: RECOMMENDATIONS DERIVING FROM THE STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) PROCEDURE

On the basis of the performed SEA procedure for the Third National Communication on climate change (defined in Chapter X of the Law on the Environment), the following conclusions and recommendations have been reached:

CONCLUSIONS:

- The objectives of the Third National Communication (TNC) towards the United Nations Framework Convention on Climate Change (UNFCCC) are in line with the global environmental objectives;
- In general, the implementation of the Communication will contribute in the reduction of GHG emissions on the National level and adaptation of the most vulnerable sectors to climate change, as well as for reduction of pollution in the environmental medias and areas[35];
- Even though the objectives of the planning document in the considered sectors generally are in compliance with the already adopted sector strategies in the Republic of Macedonia, the activities for achievement of those objectives (in the TNP) are described in more details, which requires further adjustment on plan or program level;
- Depending on the selection and sensitivity of the locations where the activities for adaptation and GHG reduction have been implemented, the same may cause disruption in the quality and the conditions of the environmental media and areas on a project level. But these impacts will have a lower intensity in comparison with the condition without the implementation of the planning document;
- Vulnerability has been identified almost in all analyzed sectors, which generally refers to absence/lack of institutional capacities, legally defined and aligned competences and responsibilities, lack of continuity in collection and monitoring of the required data, insufficient knowledge/consciousness about the reasons and consequences from climate change, as well as measures for mitigation and adaptation to climate change.

RECOMMENDATIONS:

- To assess the level of implementation of the planning document i.e. to check the applicability of the proposed measures for adaptation to climate change in all sectors;
- The scenarios on changes in the climate and their impacts on the vulnerability of the sectors to be taken into consideration when preparing or changing strategic documents on spatial planning (State Spatial Plan);
- The National Board for Sustainable Development within the Government of the Republic of Macedonia, in cooperation with the ministries and institutions, to provide compliance of the measures for GHG reduction and adaptation of the most vulnerable sectors proposed in the planning document with the sectorial strategic and planning activities that cover the same timeframe, and even more with the future sectorial strategies and plans;
- To provide institutional support in implementation of the recommendations from the TNC on horizontal and vertical level, through development of an appropriate administrative structure. In this manner, implementation of the proposed adaptation measures to climate change would be provided and a system for control over the implementation of measures in the institutions, enterprises and private sector will be established;
- To provide an appropriate structure of planning and introduction of the aspects for climate change reduction, especially through institutionalization of partnerships between the state authorities and the academic sector;
- To provide continuity in the already built capacity for planning, assessments and preparation of the GHG inventory;
- Updating and maintenance of the National GHG inventory is required;

[35] Having in mind that the adaptation measures proposed in the planning document in the sectors: water resources, agriculture, health, socio-economic assessment of the vulnerability of population to risks of disasters and climate changes, tourism and cultural heritage, in general are referring to the status/conditions in the South-East Planning Region or on particular objects (like in the cases of adaptation regarding the cultural heritage, livestock and agriculture), the same measures in certain sectors cannot be fully applicable on the entire territory of the Republic of Macedonia.

- Establishment of a (financial) tool for financing the activities/measures for climate change mitigation and adaptation of the most vulnerable sectors to climate change is needed;
- The prioritization of the budget and donor financial flows to include also the indicator – if the planned activities contribute in the climate change reduction or reduces the vulnerability of the concerned sector to climate change;
- It is necessary to create an inter-sectorial prioritization of the adaptation measures to climate change and reduce GHG emissions, as proposed in the planning document and the Action Plan, which is also part of this planning document;
- It is necessary to provide a full implementation of the Communications strategy for climate change and the action plan, as part of the planning document;
- The implementation of the TNC should be in accordance with the measures for reduction of the impacts and the recommendations proposed in the SEA Report, which should be an integral part of the planning document.