EUROPEAN UNION
European Social Fund

OPERATIONAL PROGRAMME
GOOD GOVERNANCE

Republic of Bulgaria

Advisory Services on a National Climate Change Adaptation Strategy and Action Plan

Appendix 1: Assessment of the Agriculture Sector

August 17, 2018

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DISCLAIMERS

This report was produced by the World Bank team to provide advisory support to the Ministry of Environment and Water (MoEW) in Bulgaria. The findings, interpretations, and conclusions expressed in this report do not necessarily reflect the views of the Executive Directors of the World Bank or of the Government of Bulgaria or its MoEW.

ACKNOWLEDGEMENTS

The team would also like to thank the Government of Bulgaria, in particular Ms. Atanaska Nikolova (Deputy Minister of Environment and Water), Ms. Boriana Kamenova (Director of the MoEW's Climate Change Policy Directorate) and Ms. Veronika Dacheva (Expert in the MoEW's Climate Change Policy Directorate), and other experts in government institutions; as well as the members of the National Expert Council and the National Coordination Council on Climate Change, and furthermore the participants of the Inception Workshop, the Stakeholders Consultation Meetings, the Sector Consultation Sessions, the National Stakeholders Consultation Workshop, and the Sector Prioritization Sessions, for their excellent cooperation and support in spoken and written form; and express appreciation for the comments and suggestions as well as the open exchange of ideas. The contribution of Antony Thompson (Country Manager) in the preparation and negotiation of the Advisory Program is also acknowledged here.

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Abbreviations and Acronyms

APSB	Association of Agricultural Producers in Bulgaria
AR5	Assessment Report 5
BAS	Bulgarian Academy of Sciences
BFSA	Bulgarian Food Safety Agency
CAP	Common Agricultural Policy
CBA	Cost-Benefit Analysis
CC	Climate Change
CCA	Climate Change Adaptation
CCMA	Climate Change Mitigation Act
Cefas	Centre for Environment, Fisheries, and Aquaculture Science
CFP	Common Fisheries Policy
CO_2	Carbon Dioxide
CoM	Council of Ministers
COP 21	Conference of the Parties
Defra	Department for Environment, Food, and Rural Affairs
DG CAA	Directorate General “Civil Aviation Administration”
EEA	European Environment Agency
EMEPA	Enterprise for Management of Environment Protection Activities
EMFF	European Maritime and Fisheries Fund
ESIF	European Structural and Investment Funds
EU ETS	European Union Emissions Trading System
EU	European Union
ExAAA	Executive Agency Automobile Administration
ExAEMDR	Executive Agency for Exploration and Maintenance of the Danube River
ExAMA	Executive Agency Maritime Administration
ExARA	Executive Agency Railway Administration
ExEA	Executive Environment Agency
ExFA	Executive Forest Agency
FRMP	Flood Risk Management Plan
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GSM	Global System for Mobile Communication
GVA	Gross Value Added
IFR	Institute of Fishery Resources

INCA	Regional Weather Forecasting
INDC	Intended Nationally Determined Contribution
IOS-PIB	Institute of Environmental Protection – National Research Institute
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LRF	Federation of Swedish Farmers
LU	Livestock Unit
M&E	Monitoring and Evaluation
MAFF	Ministry of Agriculture, Food and Forestry
MC	Ministry of Culture
MCA	Multi-Criteria Analysis
MCCIP	Marine Climate Change Impacts Partnership
MEc	Ministry of Economy
MEn	Ministry of Energy
MEx	Ministry of Exterior
MF	Ministry of Finance
MH	Ministry of Health
MI	Ministry of Interior
MoEW	Ministry of Environment and Water
MRDPW	Ministry of Regional Development and Public Works
MTITC	Ministry of Transport, Information Technology and Communications
NAAS	National Agricultural Advisory Service
NAFA	National Agency for Fisheries and Aquaculture
NAPCC	National Action Plan on Climate Change
NECCC	National Expert Council on Climate Change
NGO	Non-Governmental Organization
NGPA	National Grain Producer Association
NIMH	National Institute for Meteorology and Hydrology
NPV	Net Present Value
NRL	National Reference Laboratory for diseases on fishes, marine mollusks and crustaceans
NRN	National Rural Network
NSI	National Statistical Institute
NTEF	National Trust EcoFund
ODR	Provincial Advisory Centre

RBMP	River Basins Management Plan
RCP	Representative Concentration Pathway
RDP	Rural Development Program
SFA	State Fund Agriculture
SMART	Specific, Measurable, Achievable, Realistic, and Timely
SO	Standard Output
UAA	Utilized Agricultural Area
UMTS	Universal Mobile Telecommunications System
UNFCCC	United Nations Framework Convention on Climate Change
WGII	Working Group II
ZAMG	Central Institute for Meteorology and Geodynamics

Glossary[1]

Climate change refers to a change in climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods.
Global warming refers to the gradual increase, observed or projected, in global surface temperature, as one of the consequences of radiative forcing caused by anthropogenic emissions.
Adaptation is the process of adjustment to actual or expected adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities. In some natural systems, human intervention may facilitate adjustment to expected climate and its effects.
Mitigation (of climate change) is a human intervention to reduce the sources or enhance the sinks of greenhouse gases (GHGs).
Vulnerability to climate change is the degree to which any system is susceptible to, and unable to cope with, the negative impacts that climate change imposes upon it. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.
Resilience is the opposite of vulnerability and is defined as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, capacity for self-organization, and capacity to adapt to stress and change.
Risk is the potential for consequences where something of value is at stake and where the outcome is uncertain, recognizing the diversity of values. Risk is often represented as probability or likelihood of occurrence of hazardous events or trends multiplied by the impacts if these events or trends occur.

[1] Definitions are based on WGII AR5 (IPCC 2014)

Executive Summary

1. **This sector assessment report aims to inform on the key vulnerabilities of Bulgarian agriculture related to climate change and proposes a series of adaptation options to prevent or minimize the effects they can cause.** Besides agriculture, separate assessment reports have been prepared on the forestry, biodiversity and ecosystems, water management, energy, transport, urban environment, human health, and tourism sectors. The findings and recommendations of the macroeconomic analysis and the nine sector assessment reports will be consolidated to formulate the National Climate Change Adaptation Strategy and Action Plan.

Climate change will be the greatest driver of Bulgarian agriculture

2. **Agriculture plays a key yet disproportionate role in the socioeconomic fabric of rural Bulgaria.** The agricultural sector generates 4.4 percent of the country's total gross value added (GVA) and provides employment to 5.8 percent of the labor force (second highest rate in EU-28). More generally, the country remains predominantly rural, and while the rural space is richly endowed with natural resources, it is marked by lower incomes, limited job opportunities, an ageing farm population, higher rates of poverty (the majority of the rural population is at risk of poverty or social exclusion), and an ensuing urban-rural divide in social and living standards.

3. **Climate change will be a significant factor in future development of Bulgarian agriculture; the first negative impacts are already a reality.** The frequency and intensity of climatic adverse events have increased during the last decades: three distinct periods of droughts have been experienced and more frequent floods caused by prolonged and intense rainfalls are being regularly encountered, yet difficult to predict. Temperature increases from 2°C to 5°C and significant changes in precipitation patterns are projected by the end of this century. Climate change scenarios for Bulgaria indicate an increased frequency of climatic adverse events, such as longer droughts, heat waves, heavy rainfalls, and floods.

4. **Agriculture is one of the most vulnerable sectors of the Bulgarian economy.** The agriculture sector is highly vulnerable to the impacts of climate change, as a provider of adequate food, pillar for economic growth, deliverer of ecosystem services, and provider of a safe living environment for rural communities. Bulgarian agriculture is inextricably tied to climate, as three-quarters of agricultural outputs is derived from crops. Agricultural land occupies one-third of Bulgaria's total area, from which 86 percent of the utilized agricultural area (UUA) is used mainly to grow cereals and industrial crops. The impact of extreme weather events and anomalies on agricultural productivity and the overall economy was best witnessed in the drought year 2007: the share of agriculture to the gross domestic product (GDP) dropped to 4.7 percent compared to 2006 (6.2 percent) and 2008 (6.0 percent). The crops that experience the most severe impacts are typically rain-fed crops grown in the traditional summer season, such as maize, sunflower, fruits, and vegetables.

5. **However, the impact of climate change is not equally distributed in the Bulgarian agriculture sector.** Overall, the livelihoods of rural population will be affected by the changing climatic conditions. The impacts of climate change may be positive or negative, but those currently encountered are predominantly negative. More important, the risk of the impacts of climate change is not equally distributed. There are regional differences in the likelihood of

negative impacts from droughts and floods, as well as differences in the vulnerability, resilience, and adaptive capacity of rural dwellers to climate change. These differences are further accentuated by the pronounced dual farm structures and lopsided land distribution that clearly characterize the agriculture sector in Bulgaria. Furthermore, the bipolar farm structures are associated with substantial differences in resilience and adaptive capacity:

1) *Large-scale commercial farms* mostly have very specialized production systems and are thus economically highly vulnerable to the impact of frequent and long periods of drought and floods upon crop yields and farm profits. At the same time, large-scale farmers have better resources to adapt: they have access to financing and thereby sufficient funds are available for investments for the installation of irrigation systems and climate-resilient farming practices and technologies.
2) *Smallholders practicing (semi-)subsistence farming* are socially and economically vulnerable to adverse climate events, as they are self-sufficient or supplying local communities, while living in geographical and social isolation. However, due to their more diversified production, stronger social relations, and off-farm income diversification, smallholders tend to display more intrinsic resilience.

Policy and institutional environment exhibits gaps on climate change adaptation

6. **Public awareness of climate change adaptation (CCA) in the Bulgarian agriculture sector is limited.** Policy makers have exclusively focused on identifying measures for climate change mitigation in agriculture. Besides missing an overall vision and strategy for the Bulgarian agriculture sector, there is no specific legislation that deals with CCA. Missing systematic studies on the impact of climate change in the Bulgarian agriculture and fisheries sector explain that, overall, the farming community lacks sufficient information on CCA requirements.

7. **The vulnerability to climate change is worsened by insufficient agricultural extension services and inadequate information flows from results of research, policy, and market developments related to the farming community.** While individual sectors of agriculture are represented at the national level by associations and despite a relatively large network of research institutes, the missing agriculture extension services lead to knowledge gaps among the farming community about the vulnerabilities and options to improve resilience to climate change.

8. **Bulgaria is missing a risk management framework for agriculture.** The insurance sector lags the EU-28 average, with the participation rate of 2.1 percent per capita income compared to 7.6 percent in case of most European countries. Bulgarian agriculture insurance is limited to hail, while losses from drought and floods are not covered. Given the lack of access to credit, smallholders try to diversify their production to reduce revenue variability, rather than purchase insurance.

9. **The Ministry of Agriculture, Food, and Forestry (MAFF) could benefit from better leveraging the financial inflows under the European Union (EU) Common Agricultural Policy (CAP).** Accession to the EU opened tremendous financial opportunities for the Bulgarian agriculture sector. With the CAP reform 2013, a minimum of 30 percent of the

financial allocations need to be earmarked for mainstreaming climate mitigation and adaptation actions. However, Bulgaria's policy programming has not yet adequately addressed the risks and vulnerabilities to climate change. For example, financial allocations for knowledge transfer, training and advisory services are limited. Policy makers have also abandoned the use of rural development funds to invest in modernizing and rehabilitating 'off-farm' irrigation systems. More importantly, as the national threshold for receipt of direct payments have been set at 1 hectare, nearly 55 percent of Bulgarian farmers fall out of the scope of EU support.

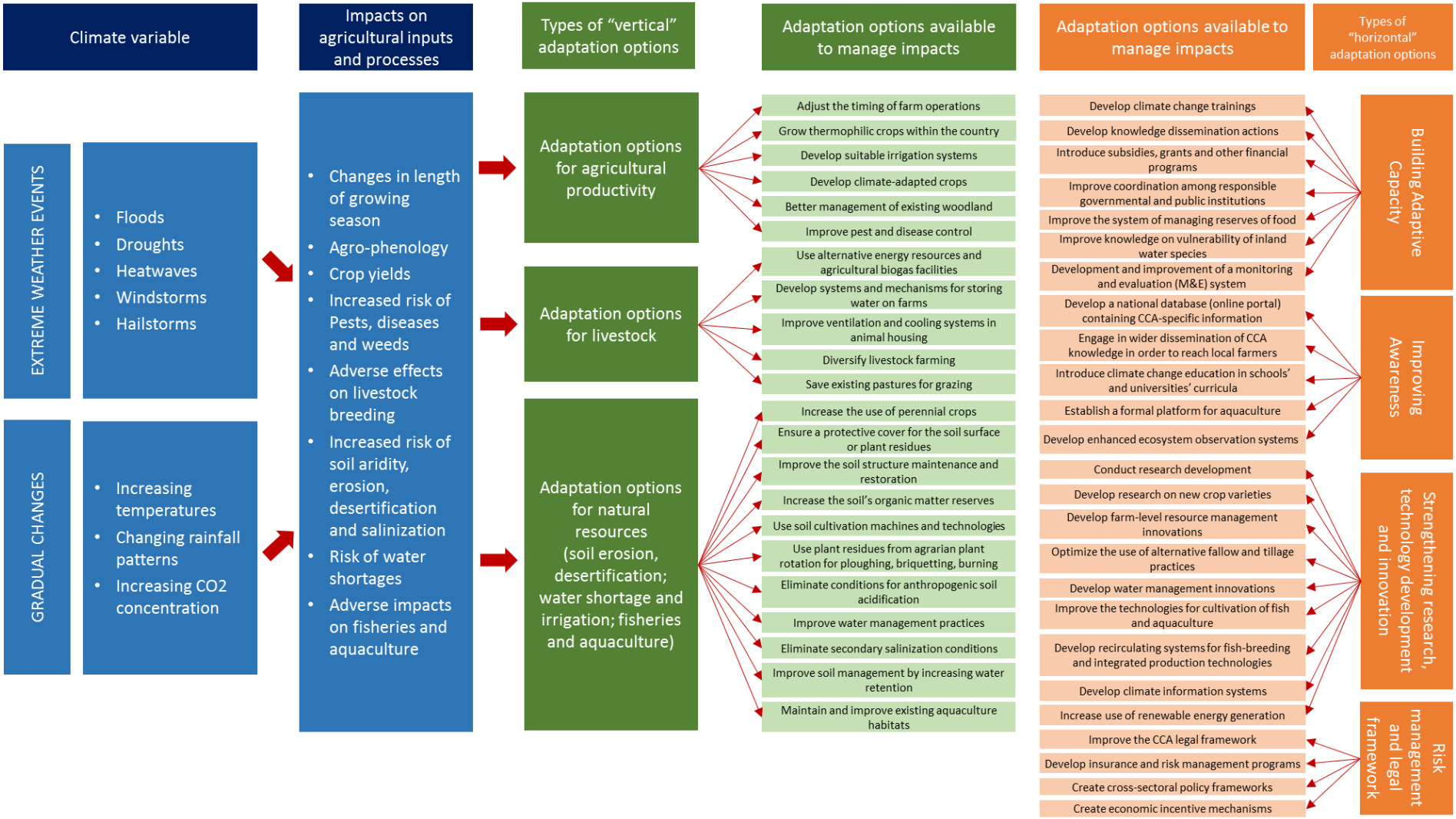
Opportunities for mainstreaming CCA actions

10. **Adaptation actions need to be undertaken at both the national and farm level.** The MAFF will need to take the lead to develop climate action within the agriculture sector, while coordinating with all relevant ministries, governmental organizations and stakeholders. Alignment with EU and international policies and commitments is of paramount importance. There is a comprehensive suite of adaptation measures, divided into horizontal and vertical options. Horizontal options cover the whole farming sector while vertical options address subsectors of agriculture. While ***Table 1*** provides an overview, the report shows how these options are prioritized based on stakeholder consultations and a cost benefit analysis (CBA).

Table 1. Horizontal and vertical adaptation options

Horizontal Adaptation Options	
Building adaptive capacity	Trainings, knowledge dissemination, financial programs, coordination among institutions, development and improvement of monitoring and evaluation (M&E), and knowledge enhancement in relation to vulnerabilities of inland water species
Improving awareness	CCA database, climate change education, platform for aquaculture, and development of observation systems for fishery
Strengthening research, technology development and innovation	Develop research on new crop varieties, conduct research development, increase the use of renewable energy generation, and water management innovations
Risk management and legal framework	Develop insurance and risk management programs and improve the legal framework in agriculture and inland fisheries and aquaculture
Vertical Adaptation Options	
Adaptation options for crop productivity	Adjust the timing of farm operations, grow thermophilic crops, develop suitable irrigation systems, improve management of existing woodland, and improve pest and disease control
Adaptation options for livestock	Develop systems and mechanisms for storing water on farms, adapt farms and facilities, improve ventilation and cooling systems, diversify livestock farming, and save existing pastures for grazing
Adaptation options for natural resources (soil erosion and desertification, water shortage and irrigation, fisheries and aquaculture)	Increase the use of perennial crops, protect soil surface, maintain and restore soil structure, increase the soils' organic matter reserves, use soil cultivation machines and technologies, improve water management practices, eliminate secondary salinization conditions, improve soil management, and maintain and improve existing aquaculture habitats

Figure 1. Simplified Illustration of Impacts of Climate Change and Identified Adaptation Options



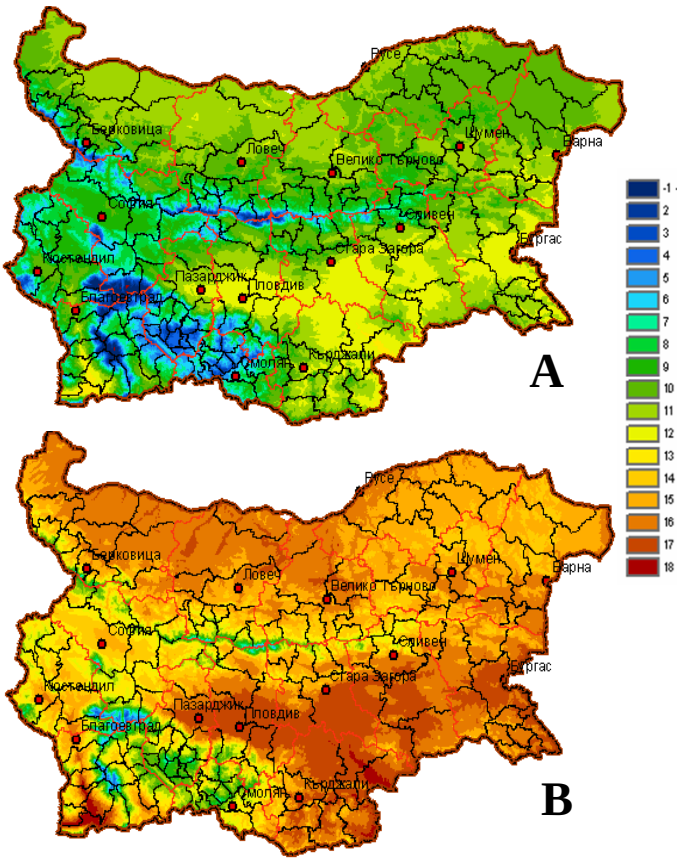
Source: World Bank design.

Introduction – Climate Change in Bulgaria

11. **Bulgaria is situated in one of the regions that are particularly vulnerable to climate change** (mainly through temperature increase and extreme precipitation) and to the increased frequency of climate change-related extreme events, such as droughts and floods. The risks inflicted by climate change-related events may lead to loss of human life or cause considerable damage, affecting economic growth and prosperity, both nationally and transboundary.

12. Consensus exists in the scientific community that **climate change is likely to increase the frequency and magnitude of extreme weather events**. Over the past decades, in Bulgaria this frequency has increased significantly. The most common hydrometeorological and natural hazards are **extreme precipitation and temperatures, storms, floods, wildfires, landslides, and droughts.** The number of deaths and victims due to natural hazards is considerable, indicating weather and climate vulnerability. The vulnerability of Bulgaria's population and businesses to the impacts of climate change is accelerated by a relatively high degree of poverty in the most affected areas, the continuing concentration of the country's population in several industrial and urban regions, and various consequences of the transition from a state-controlled economy to a free-market economy. A growing body of evidence suggests that **economic losses from climate- and weather-related disasters** have also been rising.

Figure 2. Average Year Temperature for 1961–1990 (A); Pessimistic Climate Scenario for Average Year Temperature for 2080 (B)



Source: NIMH-BAS.

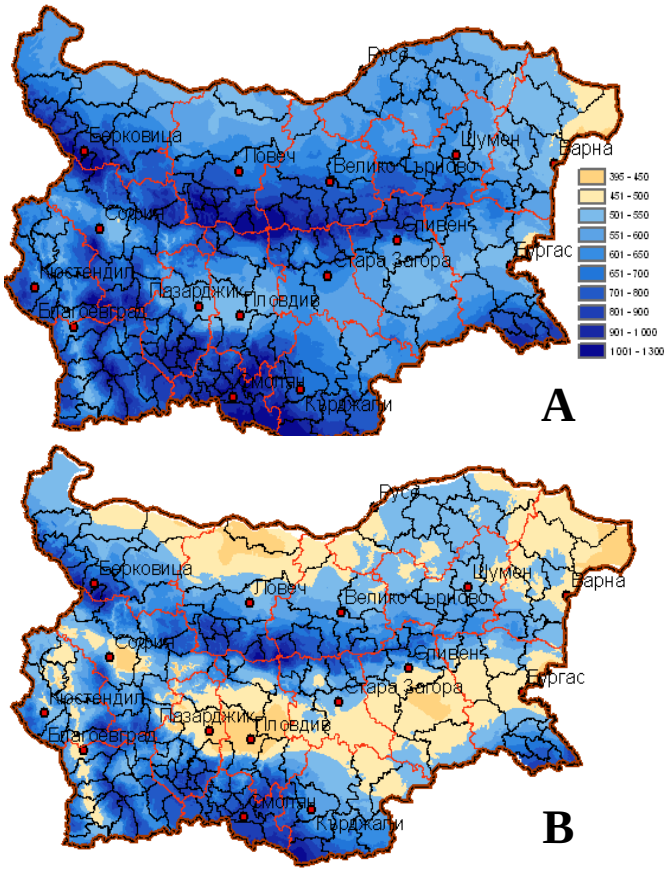
13. Scientific projections indicate that global temperature will rise between 1.8°C and 4°C by 2100, with the temperature increase in Europe expected to be even higher than the estimated global average.

14. Research conducted by the Department of Meteorology, National Institute of Meteorology and Hydrology at the Bulgarian Academy of Sciences (NIMH-BAS), projects an **increase in annual air temperature in Bulgaria of 0.7°C to 1.8°C by 2020**. Even warmer temperatures are expected by 2050 and 2080, with projected increases of 1.6°C to 3.1°C and 2.9°C to 4.1°C, respectively. Generally, the temperature increase is expected to be more significant during the summer season (from July to September).

15. In terms of the **expected changes in rainfall patterns**, a reduction in precipitation is likely, leading to a significant reduction of the total water reserves in the country. In this regard, projections suggest a decrease in precipitation by approximately 10 percent by 2020, 15 percent by 2050, and up to 30 to 40 percent by 2080. In most climate change scenarios, rainfall during the winter months is likely to increase by the end of the century, but significant decrease in rainfall during the summer months is expected to offset this increase.

16. According to the available climate change scenarios for Bulgaria, there is a **trend toward increased frequency of extreme events and disasters**, as demonstrated by frequent occurrences of heavy rainfalls, heat and cold waves, floods and droughts, hurricane winds, forest fires, and landslides.

Figure 3. Precipitation per Year for 1961–1990 (A); Precipitation per Year for 2080, According to the Pessimistic Scenario (B)



Source: NIMH-BAS.

17. **Biodiversity, land and aquatic ecosystems, as well as water resources, agriculture, and forestry sectors are expected to be affected by the anticipated changes.** These changes would furthermore affect society and its citizens as well as the economy as a whole.

18. Climate change impacts do not affect all people and territories equally due to different levels of exposure, existing vulnerabilities, and adaptive capacities to cope. The **risk is greater for the segments of the society and businesses that are less prepared and more vulnerable**.

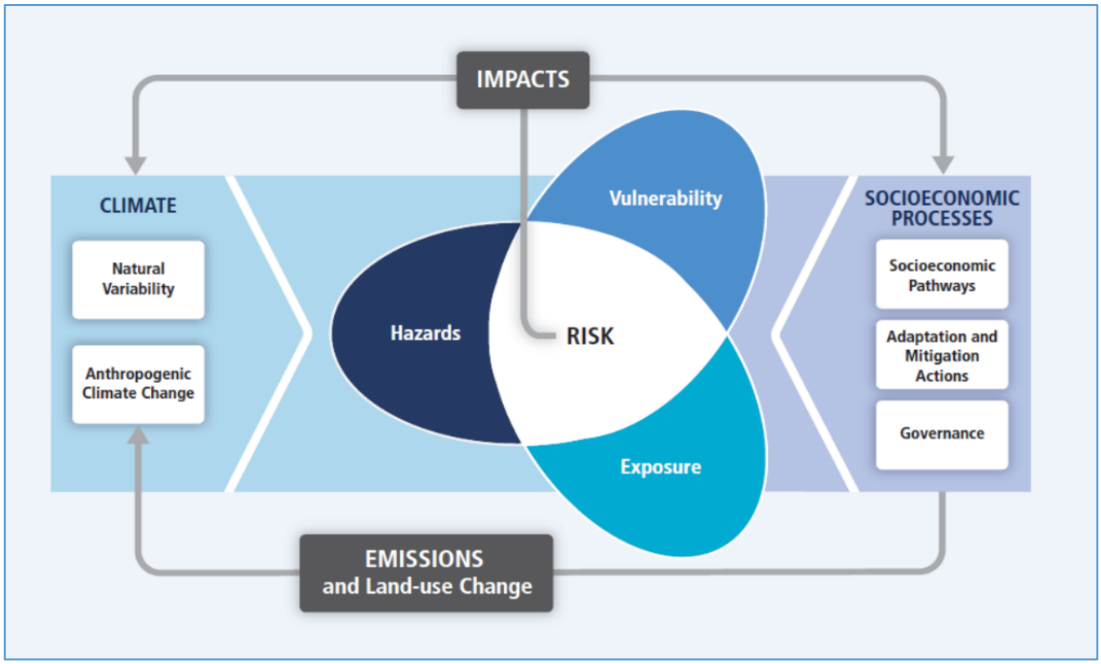
19. **Bulgarian agriculture is very likely to face significant challenges due to climate change.** Droughts and floods are expected to increase significantly and lead to increased negative impacts on agriculture. With the farming sector contributing significantly to the Bulgarian economy and growing agricultural vulnerability to climatic adverse events, it is expected that the livelihoods of many Bulgarians will be increasingly affected. Thus, the Bulgarian agriculture sector is likely to play a critical role when it comes to the implementation of effective climate adaptation measures.

20. **This report aims to inform on vulnerabilities to the Bulgarian agriculture sector and at identification of adequate CCA options.** The report is part of a set of nine sectoral assessment reports considered under the climate adaptation support program for Bulgaria, which will form the baseline for the National CCA Strategy and Action Plan. The report follows

the general logic and structure as proposed for all sectors and is divided into three parts: (1) part one of the report (Chapter 1) focuses on the climate change risks and vulnerabilities' assessment, (2) part two comprises a gap analysis of the policy, legal, and institutional context (Chapter 2), and (3) part three focuses on the identification and prioritization of adaptation options (Chapter 3). This sector assessment was carried out during March–November 2017, as a combination of quantitative and above all, qualitative analysis. Several workshops have been organized as part of an ongoing consultation process, bringing in the wealth of expertise of various stakeholders.

21. **The report uses the terms and definitions of risk, vulnerability and adaptation options as introduced by WGII AR5** (IPCC 2014). Risk of climate-related impacts results from the interaction of climate-related hazards with the vulnerability and exposure. Changes in both the climate system (left side in ***Figure 4***) and socio-economic processes including adaptation and mitigation (right side of ***Figure 4***) are drivers of hazards, exposure, and vulnerability. This understanding reveals the importance of the adaptation options. When they are properly identified and timely implemented, vulnerability, hazard, and/or exposure will be reduced, and thus the risk will be mitigated.

Figure 4. General Concept of WGII AR5



Source: IPCC 2014.

Chapter 1. Risk and Vulnerability Assessment and Analysis

1.1. Sector Characteristics and Trends

1.1.1. The broad rural development context

22. **Rural areas play an important socioeconomic role in Bulgaria.** Rural areas[2] cover 53.7 percent of the total territory and 37.1 percent of the total population live in predominantly rural regions.[3] Population density in these predominantly rural areas is 39.3 inhabitants per square kilometer, which is lower than the EU-28 average of 52.6 inhabitants per square kilometer and reflects the significant number (compared to other European Union [EU] countries) of less densely populated, smaller settlements that exist in Bulgaria, rather than large-scale urban centers.

23. **More than half of Bulgaria's rural population is at risk of poverty or social exclusion.** Low wages and limited job opportunities have created stable patterns of poverty in the rural areas. The constant level of the long-term unemployed, which is almost three times higher in the rural areas, is an alarming indicator. While rural incomes in Bulgaria are low, the gap with urban areas is widening. Gross domestic product (GDP) per rural capita in Bulgaria is approximately 45 percent of the average for EU-28 and around 30 percent of that generated in Bulgaria's urban areas. Over 51.4 percent of the rural population is estimated to be at risk of poverty or social exclusion – the highest incidence of rural poverty in EU-28. This is a major concern and continues to be driven by a range of factors, including (a) the high share of rural pensioners retiring with low pensions, (b) low labor productivity (Bulgaria is the lowest of EU-28) and low incomes that prevail in communities of subsistence farmers, and (c) limited employment opportunities in other sectors (secondary and tertiary) outside of agriculture and forestry.

24. **Bulgaria's rural areas are challenged by the rapid decline and ageing of population.** The major reason for this population loss in rural areas lies primarily in the negative population growth and the emigration of the rural population from their birthplaces. In particular, the youth and potentially active farmers progressively move away from rural settlements, while seeking employment in urban centers of Bulgaria or elsewhere. Because of steady out-migration, the population structure in the rural areas shows an unfavorable age dependence ratio, as the share of people above 65 years of age is above 25 percent (***Table 2***). In 2013, 36.7 percent of the farmers in Bulgaria were of retirement age (65) and those ages 55 to 64 years accounted for a quarter of all farmers; in comparison, almost one in three farmers in the EU were aged above 65. It is estimated that during the period of 2010–2014 overall the rural population declined by 10 percent, which is double of the national average of 5 percent. Furthermore, Bulgaria's working-age population is projected to decline by 40 percent in 2050.

[2] In 2010, the European Commission (EC) agreed on a new typology of predominantly rural, intermediate and predominantly urban regions based on a variation of the previously used Organisation for Economic Cooperation and Development (OECD) methodology.
[3] European Commission Statistical Factsheet for Bulgaria published in April 2016 – main figures for 2014.

Table 2. Age Structure of Population per Urban and Rural Areas in 2013

	Total Population	<14 years		15-64 years		>65 years	
Rural Areas	1,954,002	264,606	13.5%	1,178,268	60.3%	511,128	26.2%
Urban Areas	5,291,675	731,534	13.8%	3,653,598	69.0%	906,539	17.1%

Source: NSI 2014.

1.1.2. Significance of agriculture in the rural economy

25. **Agriculture plays a key yet disproportionate role in the socio-economic fabric of rural Bulgaria.** A significantly higher proportion of national gross value added (GVA)[4] (13.6 percent) and employment (33.9 percent) is generated in predominantly rural areas in Bulgaria by the primary sector compared to averages of 4.4 percent and 13.9 percent respectively in the EU-28. The fisheries and aquaculture sector is relatively small (less than 0.5 percent of the GDP[5]), but nevertheless it provides high employment levels at the regional level, especially in coastal areas where it has a significant contribution to local economies. Employment in agriculture and its share in total employment decreased over 2010–2015 by 1.1 percent annually. In 2015, 5.8 percent of the total population was employed in agriculture compared to 4.2 percent in EU-28.

Box 1. Utilized Agricultural Area (UAA) in Bulgaria

According to the 2013 Farm Structure Survey (Eurostat 2015), the total area of utilized agricultural area (UAA) in Bulgaria is around 4.65 million hectares, representing approximately 42 percent of the total territory. Between 2007 and 2013 the share of the irrigated UAA significantly increased by 35.8 percent; however, total irrigated land was only 3.4 percent of the total UAA, less than the EU average of 5.8 percent. In 2013, of the total UAA:

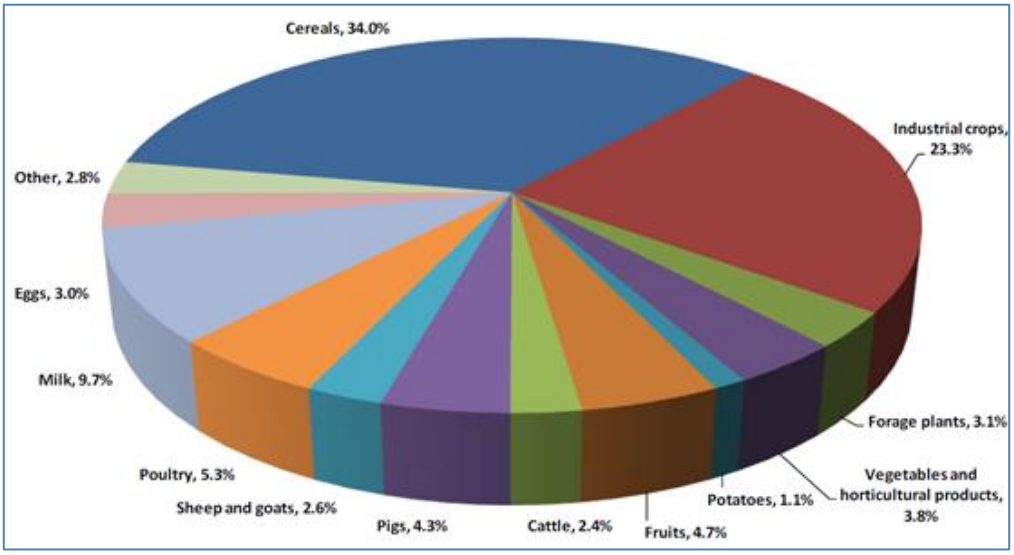
- 70.5 percent (3.27 million hectares) was arable land: cereal grains, particularly wheat and spelt, as well as grain maize are the most important crops; field-grown vegetables, and horticultural products are also important;
- 27.3 percent (1.27 million hectares) was permanent grassland and meadow;
- 2.0 percent (95,000 hectares) was permanent crops, notably orchards and vineyards; and
- 0.1 percent (5,200 hectares) was kitchen gardens: these are defined as small plots of arable l and or permanent crops growing products intended mainly for own consumption.

26. **Bulgaria's agriculture output is dominated by crop production.** More than two-thirds of Bulgaria's agriculture land is utilized for arable crops (***Box 1***). Since 2007, livestock production in Bulgaria has shown a significant decrease in the total number of animals. In 2013, the total livestock density in EU-28 equaled 0.7 livestock unit (LU) per hectare of UAA; the grazing livestock density reached 1.0 LU of grazing livestock per hectare. Across EU-28, Bulgaria, Slovakia and the Baltic countries registered the lowest (equal or less than 0.3 LU per hectare) livestock densities. These countries also reported the lowest grazing livestock densities

[4] GVA is a baseline context indicator for the structure of the economy that is calculated by Eurostat for all EU Member States - it is defined as the value of output (at basic prices) less the value of intermediate consumption (at purchasers' prices).
[5] According to data of the Interim Assessment of Operational Program for development of Fisheries Sector in Bulgaria (2007–2013), Final Report

with the values equal to or less than 0.5.[6] These trends are reflected in both the breakdown of agricultural holdings by farm type ***(Table 3)*** and the components of average agricultural output in recent years ***(Figure 5).***

Figure 5. Components of Agricultural Output (2013–2015 average)



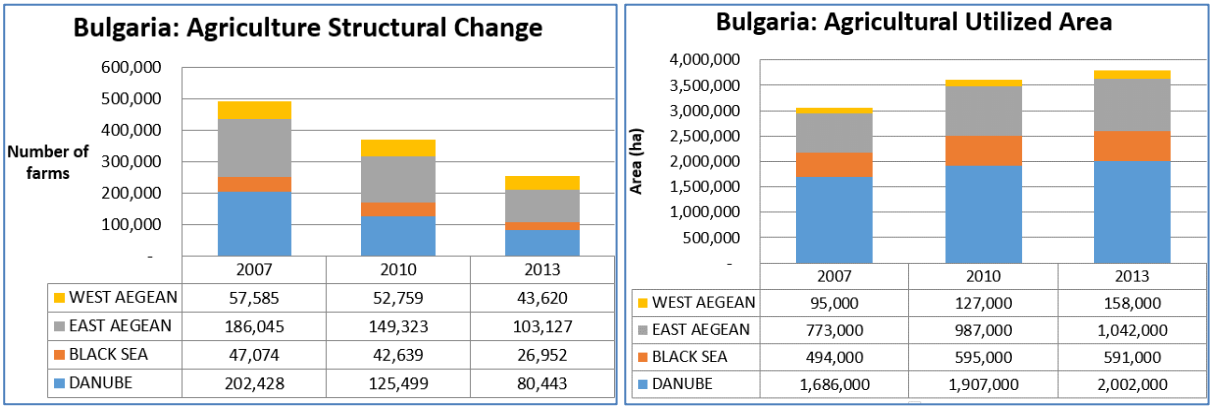
Source: EC 2016.

27. **Despite significant agricultural potential, the average yields in Bulgarian farming are low, underlining a less than optimal use of production factors.** Certain traditional agricultural sectors (such as fruit, vegetables, and livestock) are underperforming and experiencing structural difficulties. Average agricultural yields are much lower compared to Bulgaria's neighbors within and outside the EU: for tomatoes, 28 ton per hectare compared to 60 ton per hectare in Turkey; for sunflower, 1.7 ton per hectare compared to 2 ton per hectare in Hungary or 4.3 ton per hectare in Greece; and for apples, 6.7 ton per hectare compared to 18.7 ton per hectare in Greece, 8.2 ton per hectare in Romania, and 16.5 ton per hectare in Turkey. The key determinants for lower productivity in Bulgarian crops are inefficient usage of inputs, poor farming practices and challenges with natural conditions.

28. **Bulgaria has witnessed a structural transformation and farmland concentration.** The total number of farms in Bulgaria has shrunk to one-third compared to the year 2000. This structural transformation happened much faster than in the other new member states. Among the main reasons for this structural change are the gradual farm consolidation, modernization of technologies, and introduction of new machinery in cereal production following EU accession ***Figure 6***. There are currently 254,410 registered agricultural holdings in Bulgaria; the average size of agricultural holdings increased from 5.2 hectares in 2005 to 18.3 hectares in 2013, a bit higher than EU-28 average of 16.1 hectares.

[6] Eurostat Statistics. *Agri-environmental indicator - livestock patterns* http://ec.europa.eu/eurostat/statistics-explained/index.php/Agri-environmental_indicator_-_livestock_patterns

Figure 6. Change of Farms and Land Area Utilized by Agriculture since EU Accession



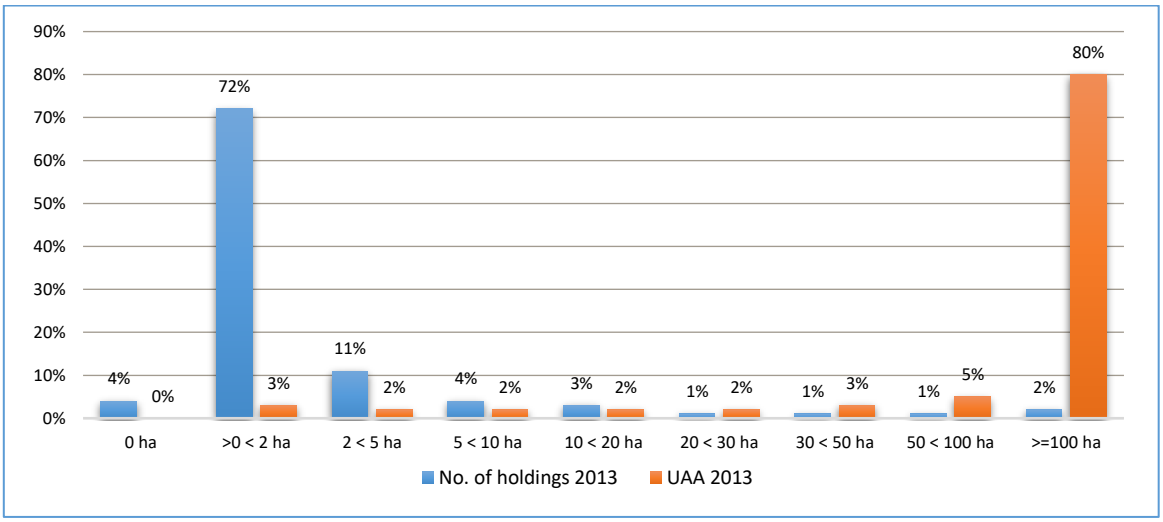
	2007	2010	2013
WEST AEGEAN	57,585	52,759	43,620
EAST AEGEAN	186,045	149,323	103,127
BLACK SEA	47,074	42,639	26,952
DANUBE	202,428	125,499	80,443

	2007	2010	2013
WEST AEGEAN	95,000	127,000	158,000
EAST AEGEAN	773,000	987,000	1,042,000
BLACK SEA	494,000	595,000	591,000
DANUBE	1,686,000	1,907,000	2,002,000

Source: Data from Farm Structure Survey 2013.

29. **The Bulgarian agriculture sector is characterized by polarized farm structure.** The share of small agricultural holdings is much higher than EU-28 average. Small farms are important in terms of providing employment in rural areas. Smallholders are dominant in the less-favored mountainous areas and in areas with intensive vegetable, fruit and tobacco growing. Smallholders are crucial to preserve the landscape and local culture. They provide most jobs and incomes in the sector and thus have a vital contribution to a balanced social and territorial development of the country. About 72 percent of the total number of farms had a UAA of less than 2 hectares, representing approximately 3 percent of the total UAA. In contrast, less than 2 percent of the total number of farms are large commercial farms (with more than 100 hectares UAA) managing approximately 80 percent of the available UAA.

Figure 7. Number of Holdings and Utilized Agricultural Area (UAA)



Source: Data from Farm Structure Survey 2013.

- **Subsistence farms** are defined as smaller than €2,000 standard output (SO) size and have a UAA of up to 1 hectare. Subsistence farms produce mainly for own consumption and distribution within the family. In 2013, the total number of subsistence farms was 140,228, representing around 55 percent of the total holdings by SO size and generated

4 percent of the total SO. Their total number significantly decreased by 32 percent during the period 2005–2013 (***Table 3***).

- **Semi-subsistence farms** are defined as small farm holdings between €2,000 and €8,000 SO volume, with a UAA of up to 10 ha and with a potential for development in the long run. Semi-subsistence farms produce for own consumption and for market sales.
- **Semi-commercial farms** have a SO of €8,000 to €50,000. These form a slowly emerging subsector of increasingly professional 'family farms' selling between 50 percent to 100 percent of their products into formal markets. Small semi-commercial farms have a relatively diverse production structure.
- ***Medium and large commercial farms*** have an SO of over €50,000 and currently hold over 80 percent of the total UAA.

Table 3. Breakdown of Agricultural Holdings by Standard Output (€) Classification

Classification of farm type - YEAR 2013	Standard output (€)[7]	Number of holdings	Percentage of total holdings
Subsistence	< 2,000	140,228	55.11
Semi-subsistence	>2,000 < 8,000	78,934	31.02
Small semi-commercial farms	>8,000 < 50,000	26,925	10.58
Medium and large commercial farms	>50,000	8,058	3.16
TOTAL		**254,410**	**100.0**

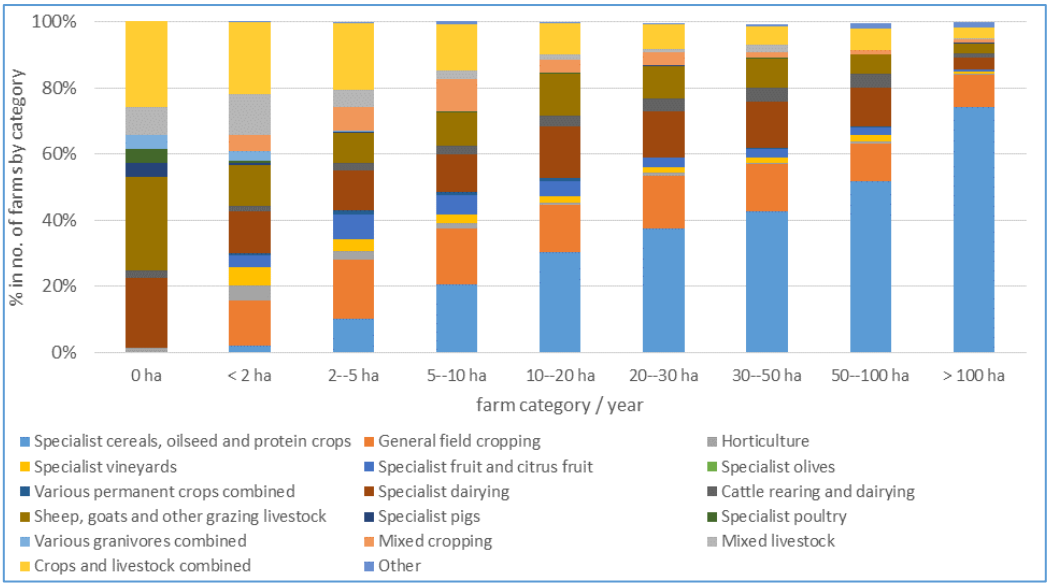
Note: The SO of an agricultural product (crop or livestock) is the average monetary value of the agricultural output at farm-gate price, in € per hectare or per head of livestock.

Source: European Commission Statistical Factsheet for Bulgaria 2016.

30. **Production systems of smallholders are more diverse and those of commercial farms more specialized.** Notably, since accession to the EU, and the implementation of the Common Agricultural Policy (CAP), the trend toward specialization on few arable crops by commercial farmers increased. Favored by direct payments, the structural changes also promoted new production systems that are less labor-intensive. Land use by smallholders remained more diversified, and their production systems provide a mix of arable crops, horticulture and livestock ***(Figure 8)***.

[7] The Standard Output (SO) of an agricultural product (crop or livestock) is the average monetary value of the agricultural output at farm-gate price, in Euro per hectare or per head of livestock.

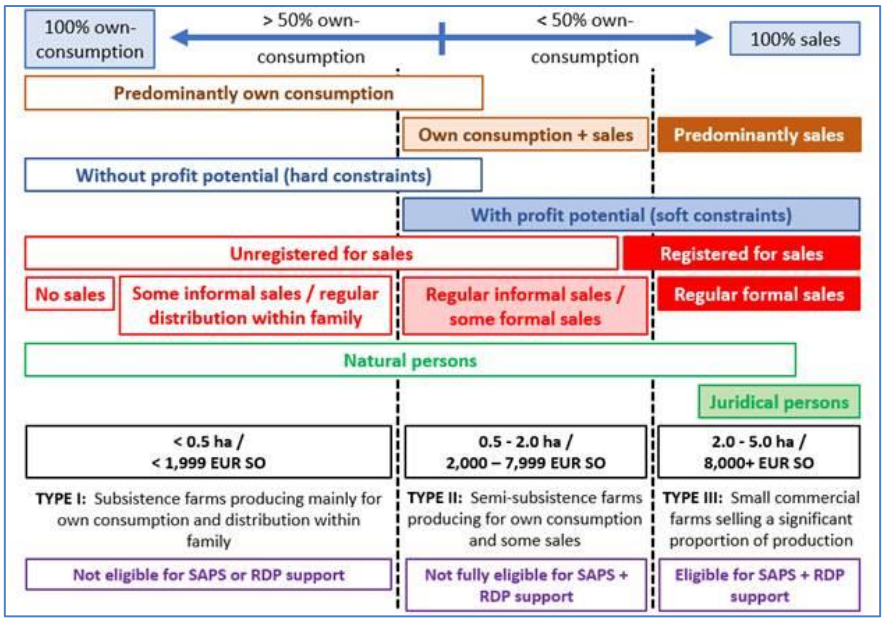
Figure 8. Agricultural Orientation by Farm Size Category (2013)



Source: Data from Eurostat – Farm Structural Survey, 2013

31. Smallholders across the whole territory of Bulgaria continue to provide a very important socioeconomic buffer in times of economic uncertainty by providing a basic livelihood for a significant proportion of the rural population, as well as a supplementary source of a cheap, wholesome food for their networks of family members in the urban areas. Furthermore, these smallholders also play an important role in maintaining the vitality of rural communities and providing important social, cultural, and environmental services (public goods) to the wider society. ***Figure 9*** provides a stylized, graphical representation of the key characteristics of the main four types of smallholder in Bulgaria identified earlier.

Figure 9. Graphical Representation of the Characteristics of Main Types of Farms



Note: The Single Area Payment System (SAPS) is a transitional, simplified income support scheme offered to the Member States who joined the EU in 2004 and 2007 (EU-12) as an option at the date of accession to facilitate the implementation of direct payments. RDP refers to the national Rural Development Program.

Source: World Bank design.

1.2. Past and Present Weather Events and their Consequences and Response Actions in the Agriculture Sector in Bulgaria

1.2.1. Changes in the baseline climate

32. Climate change will be the greatest environmental factor affecting agriculture, and agriculture is the most vulnerable sector of the Bulgarian economy. Bulgaria is situated in one of the regions that are particularly vulnerable to climate change (mainly through temperature increase and extreme precipitation) and to the increased frequency of climate change-related extreme events, such as droughts and floods. The risks inflicted by climate change-related events may lead to loss of human life or cause considerable damage, affecting economic growth and prosperity, both nationally and transboundary.

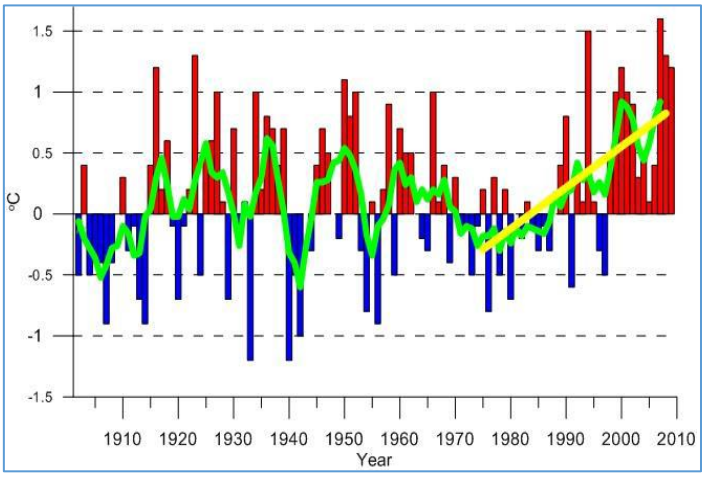
33. **Bulgaria has an overall temperate-continental climate with four seasons**. Despite its relatively small total area (EU's 16th largest country), Bulgaria has a complex climate profile, with five climatic zones: moderate continental, intermediate, continental-Mediterranean, maritime, and mountainous[8]. The country lies between the contrasting continental and Mediterranean climatic zones. Bulgarian mountains and valleys form channels or barriers for air masses and alter weather patterns over relatively short distances. The continental influence determines higher snowfalls during winter time (with a stable snow cover of about 20–200 cm during the winter), while the Mediterranean influence leads to dry and hot weather during summer. The Balkan Mountains act as a barrier: northern Bulgaria benefits on average from about 1°C cooler temperatures and receives about 192 mm more rain than the southern part of Bulgaria. The Black Sea's influence over the weather is felt mostly felt along the coastline and features a milder winter as opposed to the harsher winter conditions in the central north plains. The air humidity is between 66 and 85 percent in the different regions of the country.

1.2.2. Temperature

34. **Bulgaria is experiencing a warming up trend since the late 1970s.** About 20 out of 23 years during the period 1989–2011 show positive anomalies in terms of average temperature compared to the baseline period 1961–1990 (***Figure 10***), with a similar trend being observed for the period 2000–2014. During 1988–2014, the average annual air temperature (for areas of up to 800 m altitude) increased by 0.8°C, compared to the reference norm for the climatic period 1961–1990, varying within the range of 10.6°C up to 13.0°C. Temperature anomalies for all years after 2007 (except for 2011) were over +1°C [9] (***Figure 11***). The average annual air temperature for 2014 (for areas of up to 800-meter altitude) was 12.3°C, totaling 1.2°C above the 1961–1990 climate norm (see ***Figure 12***).

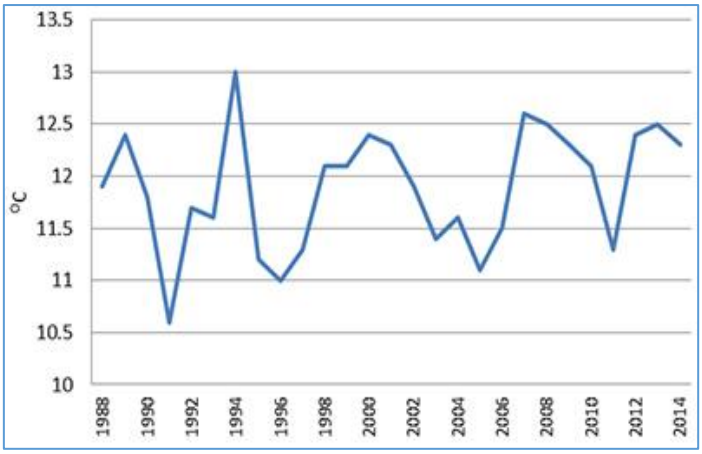
[8] Bulgaria's Sixth National Communication on Climate Change – UNFCCC 2013.
[9] National Report on the Status and Protection of the Environment in Bulgaria 2016.

Figure 10. Anomalies of Annual Temperature in Bulgaria 1901–2010 (relative to 1961–1990)



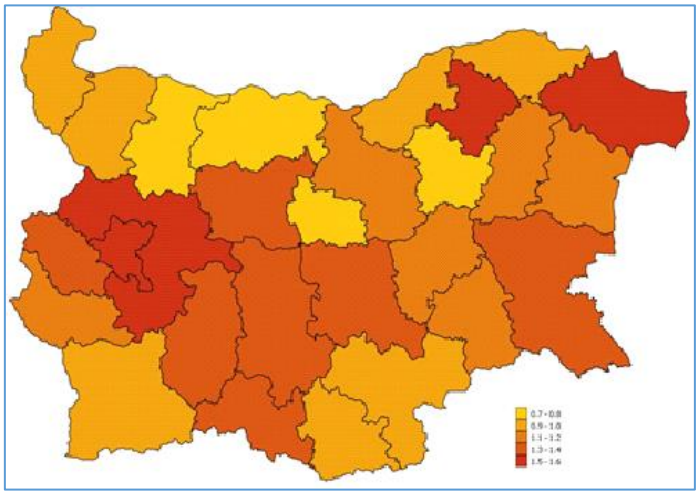
Source: Bulgaria's Sixth National Communication on Climate Change – UNFCCC 2013.

Figure 11. Average Annual Temperature fluctuations (°C) during the period 1988–2014



Source: National Report on the Status and Protection of the Environment in Bulgaria, based on NIMH-BAS data, 2016.

Figure 12. Deviation of the Average Annual Temperature (in °C) in 2014 (against the 1961–1990 Climate Norms)



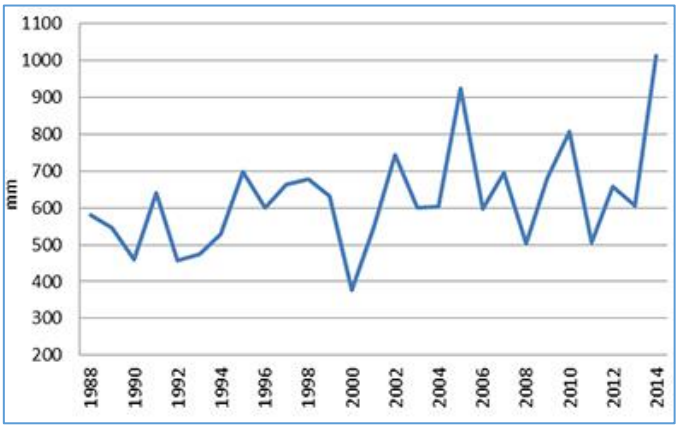
Source: National Report on the Status and Protection of the Environment in Bulgaria, based on NIMH-BAS data, 2016.

35. **Bulgaria's weather patterns over the last decade are characterized by high seasonal temperature amplitudes.** Two heatwaves of over a week have been observed in 2007 and 2011 in southwestern and northern Bulgaria, with temperatures reaching absolute maximum values of 38°C–40°C. Weather conditions turned out even worse in July 2015, with absolute maximum daily values above 34°C–35°C in almost the entire EU and absolute maximum temperatures that were well above 40°C in many areas (ICPDR 2015). Despite the general trend of higher temperatures in recent decades in Bulgaria, long cold periods have periodically occurred during the winter season. The winter months of 2012 (January and February) and of 2017 (January) recorded long periods with temperatures below minus10°C. January 2017 was the coldest month for the last 53 years for Sofia and temperatures below minus 20°C were recorded in several regions across the country.

1.2.3. Precipitation

36. **Over the last two decades, average precipitation has increased.** During 1988–2014, the average precipitation in Bulgaria ranged between 377 mm and 1,013 mm per year. The average number of days with overnight volume of precipitation above 100 mm significantly increased, by about 30 percent during 1991–2007, when compared to the baseline period of 1961–1990. Additionally, the number of cases of heavy rainfall registered in the meteorological network has increased. There were more frequent cases of cloudiness, thunderstorms and hailstorms (usually typical for spring and summer) during winter months such a January and February. Finally, a higher frequency of the average number of days with thunderstorms and hailstorms in April and September over 1991–2006 compared to the baseline period was observed.

Figure 13. Fluctuations in Average Annual Amount of Rainfall (mm) during the period 1988–2014

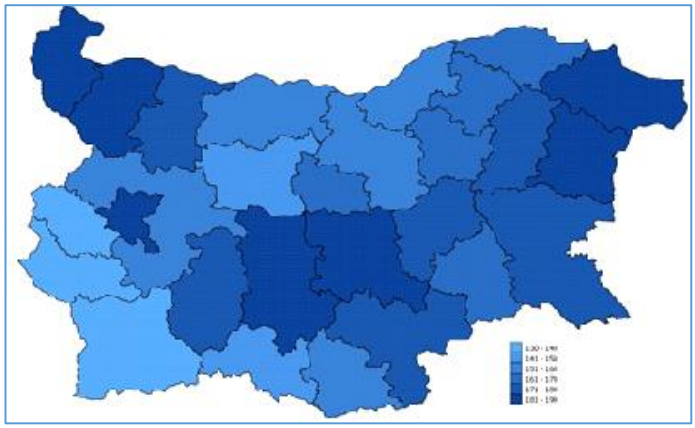


Source: National Report on the Status and Protection of the Environment in Bulgaria, based on NIMH-BAS data, 2016.

37. The average annual rainfall for 1988–2014 is 166 percent of the baseline norm for 1961–1990. The average annual precipitation in 2014 (for areas of up to 800 m altitude above sea level) was a record high 1,013 mm, surpassing the previous peak of 2005 annual average of 924 mm (***Figure 14***).

38. In 2014, most rain fell in northwestern Bulgaria (average annual rainfall of 182 percent compared to the baseline norm), central south Bulgaria (176 percent) and eastern Bulgaria (171 percent); the lowest rainfall was in southwestern Bulgaria (148 percent of the norm). Several extremely large 24-hour rainfalls have been recorded from April to October 2014 in many parts of the country, exceeding at least two times the normal average monthly precipitation rate. The regions most affected by heavy rainfalls were Kavarna, Dobrich region; Burgas; the town of Badeshte, Stara Zagora; and Staro Oryahovo, Varna district[10] (***Figure 14***).

Figure 14. Deviations of the Annual Rainfall (in percent in 2014 to the 1961–1990 climate norms)



Source: National Report on the Status and Protection of the Environment in Bulgaria, based on NIMH-BAS data, 2016.

1.2.4. Increased incidence of extreme weather events

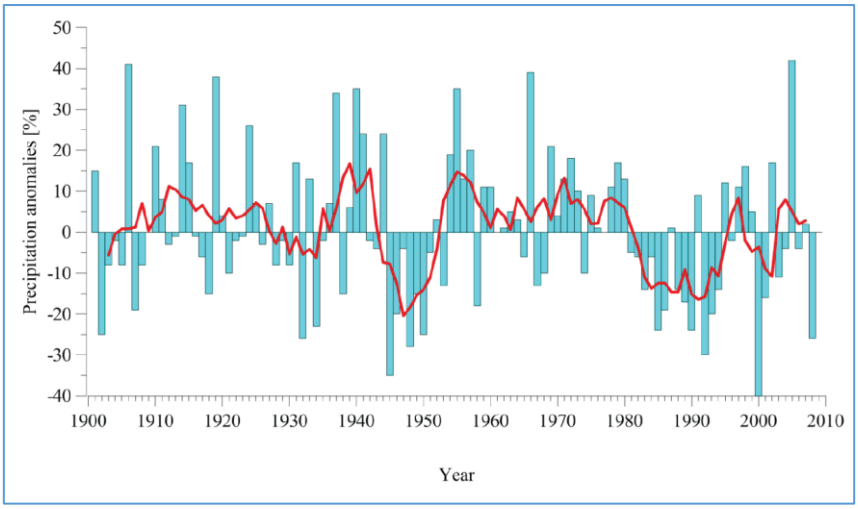
39. **During the last century, Bulgaria witnessed three distinct periods of drought**. These droughts occurred in 1902–1913, 1942–1953, and 1982–1994. With regard to the latter, low rainfall started in 1982 in eastern and southern Bulgaria. While average precipitation declined to 90 percent of what normally was observed, runoff dropped to 75 percent of the mean annual discharge. The drought continued throughout 1990. River discharge rates declined and water levels in multiannual reservoirs dropped drastically. The years 1993, 1994, and 2000 have been recorded as the driest years in the history of Bulgaria. The droughts of 2000, 2007 and 2012 led to a drop in the average maize grain yield in Bulgaria to less than 1.8 tons per hectare (Popova et al. 2014). A main characteristic of the agro-climatic conditions in Bulgaria is the water deficiency. While meteorological drought usually refers to the duration of the dry period and degree of dryness, agricultural drought links various characteristics of meteorological or hydrological drought to agricultural impacts, focusing on: soil water deficits, precipitation shortages, differences between actual and potential evapotranspiration, reduced groundwater or reservoir levels. The main danger for the Bulgarian agriculture is represented by more frequent and intense droughts. Droughts may lead to increased soil aridity, which combined with hot winds will increase the risk of wind erosion and soil degradation, including the risk of desertification and abandonment of agricultural land in the areas where soils are light and vulnerable to erosion.

40. **Bulgaria is also experiencing an increased frequency of flood events.** During the period 1991–2007, the average number of days with precipitation above 100 mm increased by 30 percent compared to the 1961–1990 baseline. The NIMH-BAS 2014 statistics highlight that in some parts of the country the precipitation within several hours amounted to what normally is expected in three months. The increased incidence of heavy rain storms, with high intensity and short duration generates increased short-term surface runoff and the risk of increased soil

[10] National Report on the Status and Protection of the Environment in Bulgaria 2016

erosion by water on sloping land – particularly in those areas with the most vulnerable soil types. As with the droughts, heavy floods cause huge economic damage and casualties. Damages from the most recent floods in the Burgas' region, in south-eastern Bulgaria, in October 2014, exceeded BGN 13 million (€6.6 million). The flood-related damages to the region's road infrastructure amount to BGN 5.4 million. Before that, in spring, floods triggered by record rainfall in northern and north-eastern Bulgaria over the summer took at least 16 lives and forced mass evacuations in the affected area.

Figure 15. Anomalies of Historic Mean Annual Precipitation Data in Bulgaria



Note: Bars measure monthly precipitation anomalies compared with period 1961–1990; red line measures moving average.

Source: NIMH-BAS 2014.

41. **In 2014, climatic adverse events have caused huge damage to agriculture.** Bulgaria is known to be one of the most hail storm-prone countries in Europe. A total of 85 hail storms were recorded during 2010–2015. According to the environmental group GermanWatch's Global Climate Risk Index (CRI) Bulgaria ranked sixth (Kreft et al. 2016) among the countries most affected by extreme weather events in 2014. The European Environment Agency (EEA) has estimated that Bulgaria recorded €1.2 billion economic losses (EEA 2017) (2013 € value) from climate-related hazards cumulated for the period 1980–2013, averaging an economic loss of €150 per capita and €11,140 per square kilometer.

1.3. Sector-Related Climate Change Risks and Vulnerabilities

1.3.1. Climate scenarios

42. Global climate change has substantially increased the probability of various recent extreme weather and climate events in Europe. Improved climate projections provide further evidence that the frequency of such events will intensify, with significant impact on ecosystems and societies. The impacts of climate change across regions in Europe are not uniform. Climate change impacts do not affect all people and territories equally due to different levels of exposure, existing vulnerabilities, and adaptive capacities to cope. Southeastern and southern Europe are projected to be hotspot regions, having the highest numbers of severely affected sectors and domains. The risk is greater for the segments of the society and businesses that are less prepared and more vulnerable. Bulgaria is situated in one of the regions that are particularly

vulnerable to climate change (mainly through temperature increase) and to the increased frequency of climate change – related extreme events, such as flash floods and droughts.

43. **Most scientific projections indicate that global temperature will rise between 1.8°C and 4°C by 2100.** The temperature increase in Europe is expected to be even higher than the estimated global average. A recent multi-hazard climate risk assessment (Forzieri et al. 2016) supported by the FP7 ENHANCE project[11] showcased that Europe could face a consistent increase in overall climate-related hazards (heat waves, cold waves, droughts, wildfires, river floods, coastal floods, and windstorms). The results were based on a set of regional climate model simulations under the SRES A1B scenario[12] with a reference period (1981–2010) and three projected periods (2020s, 2050s, and 2080s). According to the assessment, by 2080, vast areas in Spain, United Kingdom, Netherlands, Italy, France, the Balkan countries, as well as Bulgaria and Romania will be subject to *"increases in the probability of hazard occurrence of at least 20 percent for three or even four out of the seven hazards considered"* (EEA 2017). These patterns confirm the critical role of southeastern and southern Europe as hotspots of climate change impacts and vulnerabilities.

Table 4. CCA – potential direct risks and opportunities for the agriculture sector

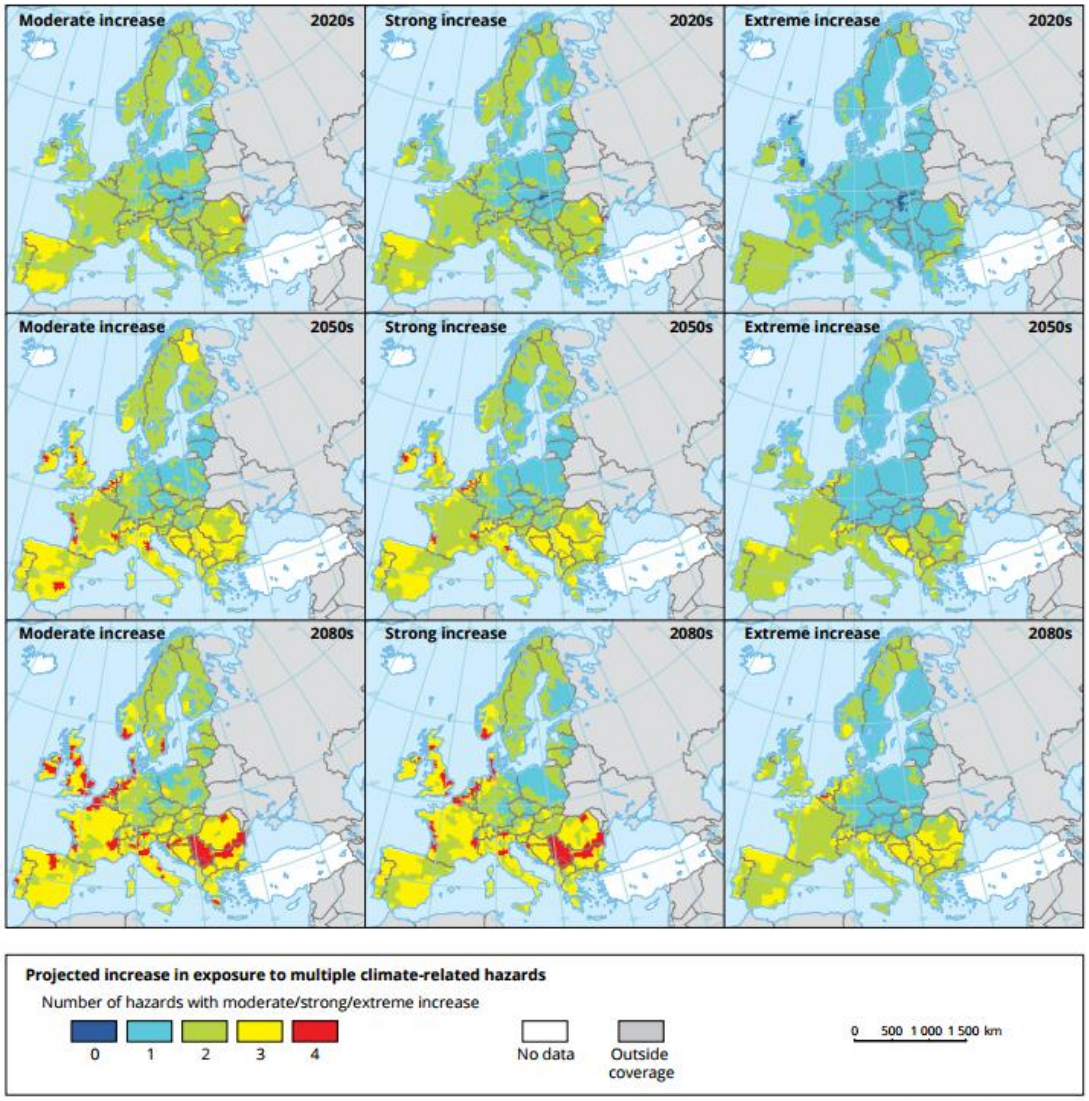
	Risks	Opportunities
Higher temperatures (incl. heat spells and heat waves)	• Crop yield changes for major crops (winter wheat, corn and sunflower)	• Potential favorable longer growing season (crop shifts)
	• Water shortage • Soil carbon losses:	• Optimize genetic potential (crops and livestock)
	• Existing pests/organisms will become stronger	• Solar farming (save electricity costs)
	• Increase evaporation and transpiration in plants	• Diversify crop types and varieties
	• Stress on animals/livestock (animal productivity decrease)	• Hybrid seed technologies
	• Different diseases on animals/ livestock	• Lower heating cost
	• New pests, viruses and fungal diseases	
	• Cost for breading	
	• Loss of crops (shorter reproductive periods)	

[11] ENHANCE project - *Enhancing risk management partnerships for catastrophic natural disasters in Europe*, funded under the FP7-ENVIRONMENT - Specific Program "Cooperation": Environment (including Climate Change), CORDIS, Community Research and Development Information Service, European Commission. The main goal of the ENHANCE project is to develop new ways to enhance society's resilience to catastrophic natural hazard impacts, by providing new scenarios and information in selected hazard cases in close collaboration with stakeholders, and by contributing to the development of new multi-sector partnerships (MSPs) to reduce or redistribute risk. http://cordis.europa.eu/project/rcn/106592_en.html

[12] Part of the Scenario Data for the Atmospheric Environment of IPCC. Key Assumptions for the SRES A1B Emissions Scenario: A future world of very rapid economic growth, low population growth and rapid introduction of new and more efficient technology.

	Risks	Opportunities
Lower temperatures (incl. cold spells and cold waves)	• Loss of crops	• Good for sensitive plants
	• Effect on plant growth (damaging roots of plants)	• Crop substitution
	• Increase energy and cost in livestock farms	
More precipitation and humidity	• Soil erosion (soil surface loss)	• Increasing soil's infiltration capacity
	• Crop failure	• Balanced mineral fertilization
	• Crop quality decrease	• Insurance on crop and livestock
	• Drainage problem	• Integrated drainage systems
	• Infectious diseases	
	• Loss of income	
	• Loss of utilized land surface	
Droughts	• Soil moisture (decomposition of soil organic matter, soil salinization)	• Improve irrigation systems
	• Desertification	• Additional land conversion pressures
	• Crop yield decrease	
	• Water shortage	
	• Lost land for pasture (pasture shortage)	
Increase of winds and storms	• Loss of crop (Morphological changes (due to exposure to wind)	• Effective pollination
	• Damage farm infrastructure and facilities	
	• Soil moisture stress, wind erosion	
	• Damage flowering period	
	• Increase water for crops	
Landslides	• Loss utilized land	• Construction of drainage systems and fortifications
	• Damage agricultural infrastructures	
	• Environmental pollution	
Floods	• Loss of utilized land surface	
	• Crop failure	
	• Loss of income	

Figure 16. Projected Increase in Multi-Hazard Exposure



Note: The maps show projected increases in hazard exposure (considering climatic events with a statistical return interval of 100 years) for three time slices (2020s, 2050s and 2080s) and for three levels: moderate (increases at least 20 %), strong (increases at least 100 %) and extreme (increases at least 1 000 %).

Sources: EEA 2017, Forzieri et al. 2016.

44. **Most climate models simulate an increase in air temperature in Bulgaria from 2°C to 5°C by the end of the century.** The projected changes in temperature and precipitation, as well as potential related climate extremes in AR5 (IPCC 2013) show, that depending on the scenario, the average air temperature will increase by 2081–2100, compared to the norm from 1961 to 1990 by 2°C (RCP2.6) to 7°C (RCP8.5), or by 3°C (RCP4.5) to 4°C (RCP6). Winters classified as cold under the current climate will occur less often in the 2020s and will probably disappear by 2080s. In contrast, hot summers will occur more often and almost every summer is expected to be unusually hot in the 2080s. In 2014, the Department of Meteorology of the NIMH-BAS conducted a research that projects an increase in annual air temperature in Bulgaria of 1.6°C–3.1°C by 2050 and of 2.9°C–4.1°C by 2080. According to the research, in general, the temperature increase is expected to be more significant during the summer season (from July to September).

45. **In most climate change scenarios, rainfall during the winter months is likely to increase by the end of the century.** However, significant decrease in rainfall during the summer months is expected to offset this increase. The projected changes in precipitation in AR5 (IPCC 2013) show fluctuations in annual rainfall averages within 10 percent (RCP2.6; RCP4.5; RCP6) and 10–20 percent (RCP8.5). All climate models predict that after 2065 and until the end of the century rainfall in the summer will decrease by 10–20 percent and according to RCP8.5 until 2081–2100 it can reach 30–40 percent. The results from the studies of water resources in Bulgaria, based on current trends of air temperature and precipitation as well as on simulation models and climate scenarios show that the overall annual river runoff is likely to decrease during this century.

46. Climate change scenarios for Bulgaria indicate an increased frequency of extreme events and disasters, such as droughts, heat waves, heavy rainfalls, and floods. The analysis of the expected extreme weather events, based on the use of temperature and precipitation indexes in AR5, shows that the number and intensity of dry and hot periods in summer will increase in the country, droughts and floods will occur with greater frequency, and torrential rainfall and dangerous natural phenomena and processes associated with these changes will occur. The northeast, southeast, and Thrace regions will be the most affected from these events.

1.3.2. Socioeconomic factors

47. **According to the European Environment Agency (EEA 2017), future climate change will interact with other socio-economic developments**, such as: (a) the ageing of the population and increasing urbanization across Europe, (b) projected decreases in population size in southern and eastern Europe, (c) and a narrowing economic gap between eastern and western parts of Europe. The agriculture, water sector, forestry, and biodiversity sectors show strong interdependencies and are also related to changing land use patterns and population change.

48. **The number of farms and farm sizes correlate with the type of production and irrigation intensity depending on the River Basin Directorate.** The highest share of irrigated land is with the farms that manage less than 2 hectares (the average size of irrigated land is between 0.1–0.2 hectare per farm), that specialize on vegetable growing and are predominantly situated in the East-Aegean region (where 40 percent of Bulgaria's farms manage 27 percent of the UAA) and West Aegean region (endowed with the two main rivers, Struma and Mesta, thus showing the highest share of irrigated area: 10 percent). The Danube River Basin region encompasses nearly one-third of Bulgaria's farms (32 percent) that manage more than half of the agricultural land (53 percent). The predominant large farms in this region specialize in cereals and oil seeds and irrigation plays a marginal role (0.7 percent). The number of large agricultural enterprises has been constant during the previous decade and there is a growing trend toward crop specialization, predominantly cereals and oilseeds. This is turn has accelerated the consolidation of farmland and growth of commercial companies.

Table 5. Change of Farm structure in Bulgaria between 2007 and 2013

		Small farms <2ha			Medium size 2-10 ha			Large 10-100 ha			Very Large >100 ha		
Years	River Basins District	Farm numbers	Total area (ha)	Irrigated area (ha)	Farm numbers	Total area (ha)	Irrigated area (ha)	Farm numbers	Total area (ha)	Irrigated area (ha)	Farm numbers	Total area (ha)	Irrigated area (ha)
2007	Danube	172,000	73,000	7,000	22,000	85,000	2,000	5,800	168,000	2,100	2,200	1,359,000	3,400
	West-Aegean	53,400	29,800	7,000	3,600	11,400	1,300	400	14,400	1,300	100	40,000	800
	East-Aegean	162,500	72,000	17,400	18,800	68,700	10,400	3,300	92,300	10,400	1,200	540,000	21,400
	Black Sea	40,500	15,700	2,100	4,400	16,000	600	1,400	44,400	600	600	417,900	2,800
2010	Danube	98,300	45,200	2,100	17,500	71,100	2,100	7,200	216,800	2,400	2,600	1,574,000	5,000
	West-Aegean	48,500	22,900	2,100	3,100	11,300	2,100	1,100	34,600	2,400	200	58,400	400
	East-Aegean	126,400	62,500	9,400	15,800	61,200	9,400	5,600	168,000	12,400	1,600	695,600	32,400
	Black Sea	35,000	13,600	1,500	4,800	19,600	1,500	1,900	60,700	1,500	900	501,700	1,300
2013	Danube	55,700	26,900	2,200	14,800	62,300	2,200	7,000	221,300	3,300	2,900	1,691,900	6,900
	West-Aegean	37,500	21,300	8,800	4,300	17,600	8,800	1,600	48,900	3,800	200	70,500	300
	East-Aegean	79,600	44,400	11,100	16,000	64,200	11,100	5,700	183,800	13,700	1,800	750,600	29,200
	Black Sea	20,300	8,400	1,200	4,100	16,600	1,200	1,700	55,600	1,700	900	510,700	3,800

Source: Agro-statistics Directorate, MAFF 2014.

49. **Substantial differences in resilience and adaptive capacity are associated with the huge polarity in farm structure.** Large-scale commercial farms face different challenges from climate change compared to small-scale subsistence farmers:

- **Large-scale farms** commonly have very specialized production systems and are highly vulnerable to the impact of frequent and long periods of drought upon crop yields and farm profits. However, the large commercial farms also employ well-informed professionals with good technical skills and normally have considerable financial resources and significant capacity to adapt their farming systems, including the diversification of cropping systems, the adoption of new agricultural technologies, and use of irrigation.
- **Smaller, subsistence farms** form the highest share of farm type and are socially and economically vulnerable to adverse climate events, as they often have fewer resources, more limited access to innovation, and less financial resilience (European Parliament 2017). Most of subsistence farms are supplying significant proportions of the household diet, producing mainly for own consumption and distribution within the family. In some cases, individual farmers and/or local communities are also highly specialized in the production of specific crops, which further increases their vulnerability. In other cases, some intrinsic resilience can be found within communities of small farmers due to their low inputs and recycling of resources, diversity of production, strong social relations, and (in some regions) alternative sources of off-farm income. The resilience and adaptive capacity of these more diverse communities has the potential to be further developed if obstacles such as low educational standards, geographical/social isolation, and lack of access to investment capital can be overcome.

50. **The vulnerability of Bulgarian agriculture to climate change is worsened by insufficient agricultural extension services and inadequate information flow from results of research.** The National Agricultural Advisory Service (NAAS) provides some irrigation-related advisory services to some 8,000 semi-subsistence farmers producing mainly vegetables under drip irrigation. Agricultural extension services including advisory services on on-farm water management is being provided to some farmer groups by private companies under contracts with farmers. However, only a small fraction of farmers benefits from this support.

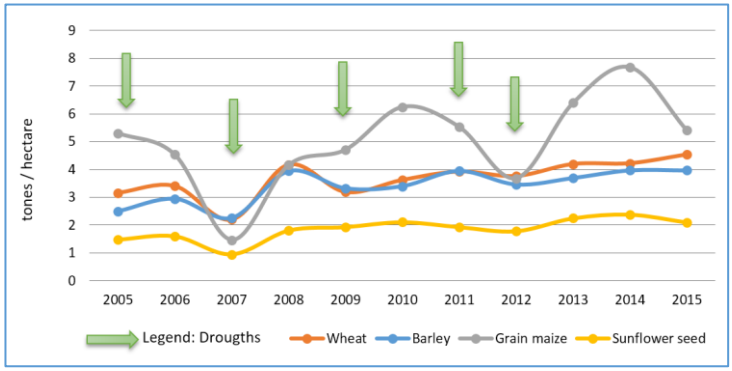
The limited number of staff and budget for agricultural extension translates into inadequate advisory services; thus, farmers benefit only marginally from the results of agricultural knowledge and research, increasing their vulnerability. Without increased governmental support for extension services, the existing network is not able to sufficiently provide climate change information and adaptation advice to subsistence farmers that is relevant to the specifics of small-scale agriculture.

1.3.3. Climate change impact on agricultural productivity[13]

51. **Weather conditions are among the main factors determining the productivity of agricultural crops.** Extreme weather events and climate anomalies have a strong impact and can compromise yields and/or reduce the quality of output. In the future, spring crops sown on infertile soils will be increasingly vulnerable, as well as the arable land in southeaster Bulgaria where the precipitations even under the current climate conditions are insufficient to ensure normal growth, development, and yield of crops. Rising concentration of CO_2 in the future might create conditions to improve the yields of major crops; however, this potential increase in yields may be hindered by the increased risk of drought, as well as shortening duration of the reproductive period due to increases in air temperatures. There will be a shift in the dates of maturity of different crops, variations of the growing periods, and changes in their yields.

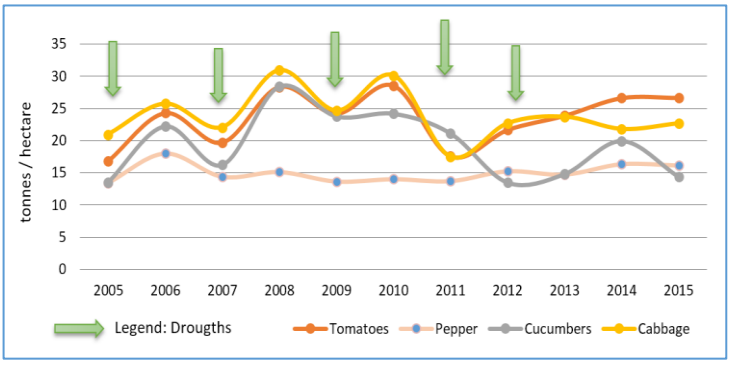
52. **Droughts recorded over the past decade have hindered high cereal yields.** The largest cultivated cereal areas are located in the northeast region and north-central region. Grain maize yields were most affected by the drought of 2012 (average decrease of 33 percent compared to the previous year – see ***Figure 17***). It is expected that given the temperature increase over time, fewer cold days may hinder vernalization in winter cereals.

Figure 17. Cereal Yields (Annual average tons per hectare)



Source: WB representation based on NSI data.

Figure 18. Vegetable Yields (Annual average tons per hectare)



Source: WB representation based on NSI data, 2016.

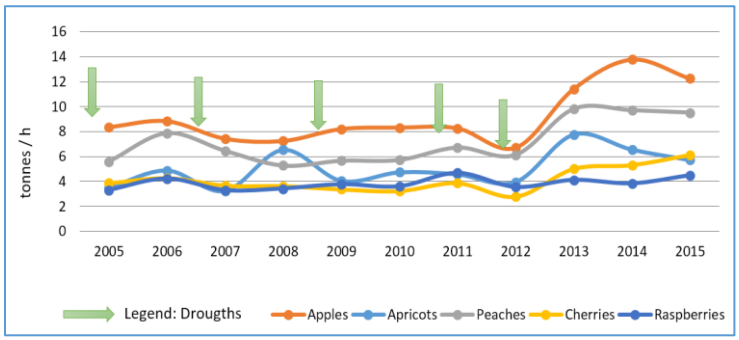
53. **Temperature is the main factor for horticulture cultivation.** Increased temperatures may require changes in cultivars and times of planting and harvesting. A significant number of horticultural holdings are located in the south-central

[13] This sub-section is based on the Risk and Vulnerability Analysis and Assessment in the Agriculture and Soils chapter of: *National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy*, developed under the EU Operational Program 'Environment 2007-2013', with financial support from the European Regional Development Fund.

region of Bulgaria and their yields are dependent on irrigation systems and water allocation. Droughts limit the availability of water resources and put pressure on horticultural production. Vegetables (particularly moisture plants such as cabbage) suffered from water shortages during the droughts of 2009, 2011, and 2012 (see ***Figure 18***). The old irrigation infrastructure was also a limiting factor in the efficiency of the productions.

54. **For fruits, drought months do not significantly impact the yields.** However, in 2012, the yields of several fruits were lower when compared to the results of the previous year (see ***Figure 19***). One reason for that was the unfavorable climate conditions during bud breaking, blooming, and harvesting. In general, warmer winters could reduce yield volumes from stone fruit species, which need a certain number of chilling units for their normal growth.

Figure 19. Fruit Yields (Annual Average Tons per Hectare)



Source: WB representation based on NSI data 2016.

55. A number of indicators have been used in assessing the impact of climate change on agriculture, such as length of crops' growing season, agrophenology, crop yields, and irrigation requirements.

56. **Changes in length of growing season**. The indicator depicts the number of days with an air temperature above a certain temperature threshold. Global warming is expected to result in an early onset of vegetation in spring and a longer period in autumn. A longer growing season would allow better distribution of individual species, especially thermophilic ones, as sufficient light and thermal resources shall better serve their growth, development, and productivity; at the same time, a prolonged growing season would improve opportunities to use agro-meteorological resources, especially with the possibility to irrigate, in terms of utilizing the potential of agricultural fields for growing new, more thermophilic species or secondary crops. A longer growing season would create conditions for a run-up in thermal potential and lead to a northward expansion, as well as pave the way for breeding new species in higher mountainous terrain. Prolonging the potential growing season would, however, also affect the spread of a number of weeds, diseases, and pests.

57. **Agrophenology.** Changes in the occurrence dates of phenological phases, and more specifically earlier fruit plants flowering or ripening, have been observed over the last years of the previous century in numerous European regions (IPCC 2013). In Bulgaria, earlier flowering of trees, a longer season for vines, and changes in the other natural crop cycles are expected. The different growth and development stages of agricultural crops (such as flowering and ripening) are particularly sensitive to weather conditions, which are also decisive with regard to final yields. In general, a longer growing season for the respective crops strongly correlates with higher yields because it allows better use of available light, thermal and water resources. In the case of cereals further contractions of interphase periods from flowering to ripening are

expected. A shorter reproductive period would also mean less time for grain filling, which would have a negative impact on yields.

58. **Crop yields**. Yields depend on the length of the growing season and crop productivity forming. The length of grain formation and ripening periods is essential for cereal and oilseed crops. Due to projected temperature rises and reduced rainfall, changes in yield volumes for major crops (winter wheat, corn, and sunflower) during the production formation periods should be closely monitored in the future. Forecasted changes in wheat, corn, and sunflower yields are presented in ***Annex 4.***

59. **Risk management is still lagging the EU-28 average.** The insurance sector in Bulgaria lags behind most of Europe, with the participation rate being 2.1 percent of per capita income compared to 7.6 percent in the case of most European countries (World Bank Group 2014). Usually, in the case of agricultural insurance, the farmer pays a premium to buy the insurance which gives him the right to an indemnity, triggered by specific events (single peril insurance) or by a fall in yields/production below a certain threshold (multi-peril insurance) (Lefebre et al. 2014). The vast majority of coverage is for hail losses, which are generally less correlated to losses from flooding and droughts. The large number of small, family-owned farms have little access to credit; financial shocks triggered by extreme events are therefore damaging and lasting. Given the lack of access to credit, in such small farms, farmers first rely on risk management strategies on-farm to reduce revenue variability, rather than purchase insurance.

1.3.4. Climate change impact on livestock

60. **Livestock breeding will be adversely affected by greater heat stress.** The most significant direct impact of climate change on livestock production comes from the increase in air temperature, which affects animal production health and well-being[14]. Heat stress on livestock is dependent on temperature, humidity, species, genetic potential, life stage, and nutritional status. The location of the animals also matters; for example, livestock in mountain regions will be more affected by the increase of temperatures than livestock located in lower areas, because livestock in lower areas are usually better adapted to high temperatures and droughts.

61. **Changes in temperature and precipitation due to climate change may affect livestock breeding in terms of reproduction, metabolism and health.** Rising air temperatures may in some cases cause stress to animals and even result in their death due to overheating, if the animals are unable to maintain a certain body temperature. Heat stress could have several negative effects on livestock production, including reduced reproductive performance in dairy cattle and decreased fertility in sows. Changes in temperature and precipitation may also result in a spread of pathogens, and parasites may influence the distribution of diseases with concomitant decrease in animal productivity and increase in mortality. Livestock diseases lead to increased mortality or indirect losses (additional costs for medication, supplementary labor costs and economics losses).

[14] During the day, livestock keep a body temperature within a range of ±0.5 °. When temperature increases more than the upper critical temperature of the range (varies by species type), the animals begin to suffer heat stress. (Henry et all 2012)

62. **Climate change may also affect the availability and quality of fodder and grazing resources**. This situation indirectly affects feeding patterns and influences the profitability of livestock farms. Rising temperatures and drought decrease the quality and quantity of forage production for grazing of the plants. Longer dry periods may reduce groundwater and affect water supply. Scarcity of water resources could affect animal metabolism, fertility, and digestion. Changes in the precipitation distribution in pasture areas would lead to less grass and thus would limit possibilities to feed livestock. Consequently, fewer pastures during certain periods of the year because of climate change could lead to overgrazing and erosion risks in those regions.

63. **Declining livestock production due to climate change adverse effects could endanger food security.** The livestock production ensures supplies of essential calories and proteins for human and is an integral component of the agricultural economy, with great importance to rural incomes. The potential decrease of the quantity and quality of livestock production because of climate change would cause negative effects throughout the economy such as decreasing farm incomes, higher unemployment, raising prices and higher consumer costs, leading to food security issues.

1.3.5. Increased risk of pests, diseases and weeds

64. **Climate change could increase the risk of further spread of numerous weeds, diseases, and pests in agriculture.** Changes in temperature, moisture and the concentration of atmospheric gases could not only stimulate growth and the generation of plants, fungi and insects, but also change interactions between pests and their natural enemies and hosts. In Bulgaria, there are 347 alien terrestrial arthropods, of which 52 species are crop pests with potential negative impact on forestry, agriculture, horticulture, and greenhouse production (UNECE 2017). Rising temperatures might shorten the reproductive cycle of many pests, which would then increase the risk for agricultural plants. Pests and diseases often lead to harvest losses; pesticides, which could have detrimental effects on the human health and the environment, are used to combat such pests. Consequently, the spread of pests and diseases could result in an increased use of pesticides and veterinary drugs that ultimately enter foodstuff. Changes in precipitation, temperature, and relative air humidity could spur the development of toxigenic micro-fungi and easily contaminate foods such as peanuts, wheat, or corn, with negative consequences. A longer growing season would provide sufficient light and thermal resources that favor a better growth, development, productivity, and distribution of thermophilic species. However, it would also simultaneously create favorable conditions for the development and increased number of generations of certain agricultural pests over one single season.

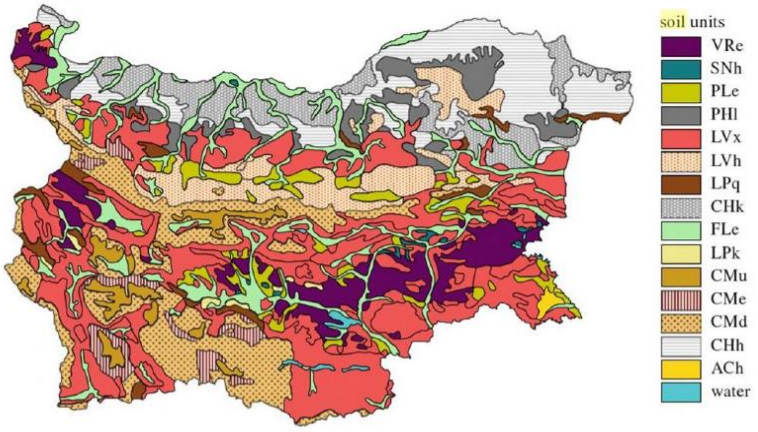
1.3.6. Impact on natural resources

Increased risk of soil erosion, desertification, and salinization

65. **Bulgaria is endowed with a diversity of fertile soils** including Chernozems in the northeast and along the entire length of the Danube River, as well as Fluvisols and Vertisols, which are clustered along the main river banks. Chernozems represent around 21 percent of the country's territory and are characterized by extremely well-balanced porosity and high water holding capacity and ion exchange capacity. Other soil classes such as Fluvisols carry excellent

attributes for irrigated crop production and have formed along the banks of the Maritza River and its main tributaries. Fluvisols are associated with Vertisols and Luvisols. While the former is typically rich in clay content, Luvisols carry a larger portion of silt material, which makes them good soils for the production of potatoes and other vegetables. Typically, a low permeability and a tendency to waterlogging are the most important limiting factors of Vertisols for irrigation. The spatial distribution of soil formation is shown in ***Figure 20***.

Figure 20. Spatial Distribution of Soil Formations in Bulgaria



FAO Classification	*Code*	*FAO Classification*	*Code*
Eutric Vertisoils	Vre	Eutric Fluvisols	Fle
Haplic Solonetzs	SNh	Rendzic Leptosols	PLk
Eutric Planosols	Ple	Humic Cambisols	Cmu
Kuvic Phaeozems	PHI	Eutric Cambisols	Cme
Chomic Luvisols	LVx	Dystric Cambisols	CMd
Haplic Luvisols	LVh	Haplic Chernozems	CHh
Lithic Leptosols	LPq	Haplic Acrisols	Ach
Calcic Chernozems	CHk		

Source: Shishkov T. and Kolev N. 2014.

66. **Soils in Bulgaria have different characteristics, fertility, and vulnerabilities to climate change.** Most types of soil do not have a high natural resistance to deteriorating physical conditions, such as rising temperatures or high-intensity rainfall. The temperature rise revealed by climate scenarios will increase the water deficit in soils with low precipitation rates, leading to an increase in the occurrence, intensity and level of impact of the soil droughts. Increased evaporation and transpiration in plants may also be expected, given the respective projections for rising temperatures, which would further exacerbate the water deficit issue during the warm period. The most serious impacts will be observed for soils with light mechanical content and partly for heavy clay soils. Most vulnerable are the soils with low capacity of moisture preservation and the regions in southeast Bulgaria, which have low precipitation levels during the warm half year even at current climate conditions.

67. **More frequent and intense droughts will likely increase soil aridity, which combined with hot winds will increase the risk of wind erosion and soil degradation.** This includes the risk of desertification, marginalization, and abandonment of agricultural land in the areas where soils are lighter and more vulnerable to erosion. Desertification is a complex phenomenon and the consequence of a set of important processes that are active in arid and semi-arid environments where water is the main limiting factor for agriculture and other land uses. Desertification occurs when certain environmental factors trigger irreversible change in the plant-soil system. Climate change itself does not trigger desertification directly, but it affects other processes (that is, the increased wind erosion of light arid soils) that trigger desertification.

68. The most common processes of soil degradation include water and wind erosion, pollution, reduction of organic matter stocks (humus), compaction, acidification, salinization, and loss of

biodiversity. Soil erosion is a process of mechanical destruction and weathering of soil by the action of water and wind and it gradually reduces the nutrients and the humus in soil. Erosion aggravates the structure, as well as the water and air regime of soil. About 65 percent of the cultivated land area is threatened by varying degrees of water erosion, while another 24 percent of the cultivated land area is threatened by wind erosion. The average annual intensity of soil erosion varies in accordance to land use, but soil losses for the agricultural land are estimated at 12,256 tons per ha (MoEW 2015) annually. Over 50 percent (Ruseva et al. 2011) of the estimated potential soil loss due to water erosion is formed in the territory of seven districts: Sofia, Lovech, Sliven, Burgas, Kardzhali, Gabrovo and Veliko Tarnovo. The increased incidence of heavy rain storms, with high intensity and short duration, will generate increased short-term surface runoff and the risk of increased soil erosion by water on sloping land - particularly in those areas with the most vulnerable soil types. About 70 percent (Ruseva et al. 2011) of the estimated potential soil loss due to wind erosion with regard to agricultural land with a slope below 3^{o} is formed in the territory of five districts – Dobrich, Burgas, Varna, Yambol and Sofia. About 35,500 ha of arable land (MoEW 2014) have been identified as affected by salinization processes, whereas 252 ha are assailed by regular soda and chlorides. These processes mainly affect the districts of Burgas, Varna, Veliko Tarnovo, Pleven, Plovdiv, Sliven, Stara Zagora, and Yambol.

69. In general, climate change will significantly impact the functions that different soil types perform and will strongly affect future land use. Significant adaptation measures for protecting agricultural lands from soil erosion, desertification, and salinization need to be developed and implemented, including soil conservation and runoff regulating measures, which are rather specific in terms of respective soil, climatic and topographic conditions.

Risk of water shortage and its link to irrigation

70. **Climate change may lead to water shortages in some regions of the country, leading to increased irrigation requirements.** Water plays a vital role in the growth of plants. Higher temperatures and lower relative humidity will increase water needs for evapotranspiration in agricultural plantations; also, increased carbon dioxide levels in the atmosphere will result in higher water use efficiency due to reduced transpiration (Kruijt et al. 2008) and an increased rate of photosynthesis (Ainsworth and Long 2005). Reduced precipitation levels, as projected by climate scenarios, would cause a sudden drop in water reserves and the accumulation of less water in irrigation reservoirs on a multiannual basis, which would then limit possibilities to use freshwater for crop irrigation. Given the higher probability of droughts over the next decades and growing water needs of industrial and urban water users, future crop irrigation needs will lead to increased competition to ensure water for agricultural irrigation and ensure stable crop production levels.

Climate change impacts on fisheries and aquaculture

71. **Bulgarian aquaculture is characterized by a range of farming systems:**[15] (a) free-extensive and semi-intensive fish farming in natural or artificial water bodies with still or

[15] According to the Multiannual National Strategic Plan for Aquaculture in Bulgaria (2014–2020)

running waters; (b) intensive fish farming in specially constructed concrete or earthen basins; and (c) fish farming in net cages and recirculation systems.

72. Cultivation of fish and other aquatic organisms in specialized basins, as well as in dams, is a widely-spread practice in Bulgaria. Fish farming in the basin farms is predominantly intensive. There are two classic types of basin farms: pools with earthen walls used primarily for carp farming (warm water basin farms) and concrete pools, primarily used for trout farms (cold water farms). Most of the earth basins were constructed more than 40 years ago. The average size of the fattening basins ranges from a few acres to several tens of acres, while basins with an area of over 50 acres are rare. Despite the large number of dams in Bulgaria, few are used for fish-farming purposes, because most of them were built for agricultural purposes and as reservoirs for irrigation. Fish breeding in net cages is applied in the inland freshwaters, mainly in large and medium size dams. In recent years, net cages have been applied in smaller water basins (less than five acres) with appropriate depth. Net cages relate to the equipment for super-intensive production.

73. **Droughts lead to reduced water levels that pose a serious threat to this type of farms.** Combined with the deterioration of water quality, this negatively affects the lifecycle of the environment of the species, decreasing the number of fish in net cages. Droughts may also decrease the smaller mountain river and stream water levels, leading to loss of species. Higher temperatures also lead to changes in the spawning period of species. For open-basin rivers this might determine the migration to deeper, colder waters. For example, sturgeon migration in the Danube[16] is vulnerable to the changing climate conditions. Sturgeon fishery is an important local income source for the communities along the Danube River and directly influences the economic well-being of the fishermen communities. Another type of risk is represented by floods, which may affect dikes and river embankments and may lead to the destruction of valuable spawning, nursery, or feeding habitats.

74. For a stylized representation of the key characteristics of the climate change and their impact on the agriculture sector (***Annex 1)***.

1.4. Conclusions

75. Bulgaria is well-endowed with natural resources, benefiting from high quality, fertile soils to produce a wide range of high-value crops, but is challenged by high levels of poverty and significant gaps in social and living standards between rural and urban areas. Agriculture is an important sector for Bulgaria, as the country benefits from a number of favorable geo-strategic, climatic, and natural endowments, which have contributed to the development of old traditions in both plant-growing, and livestock breeding. However, on-farm productivity is highly variable and commonly falls short of its potential, while the extreme polarity in farm structures and the

[16] All sturgeons migrate over long distances for feeding and spawning. Some migrate between fresh- and saltwater, whereas others remain in freshwater for their whole life. They reproduce in freshwater and have a long life as they need several years, some even decades, before they become mature and are able to spawn for the first time. While annual spawning success is highly unpredictable and depends on available habitat, suitable flow and temperature, particular spawning sites are usually frequented periodically, and migrations are predictable. Natural hybridization can occur between all species. All living sturgeons are endangered or threatened by extinction. http://www.dstf.eu/species/ The Danube Sturgeon Task Force, founded in January 2012 in the frame of the EU Strategy for the Danube Region, Priority Area 6 (Biodiversity), aims to coordinate and foster the conservation of highly endangered native sturgeon species in the Danube River Basin and the Black Sea by promoting the implementation of the Program "STURGEON 2020".

vicious circle of low productivity and low income endured by many farmers continue to limit the sector's overall performance.

76. The frequency of extreme weather and climate phenomena has increased during the last decades in Bulgaria. The most negative impacts observed to-date are (a) the increasing incidence of water deficit and drought due to the combined effect of rising temperatures and reduced precipitation, and (b) severe floods caused by prolonged and intense rainfall. Extreme weather also included hailstorm events and heat waves.

77. Climate change will have impacts on many different levels at the same time. It is evident that climate change will have an impact on aggregate and individual households' production levels and living standards. Droughts and floods are one of the most important manifestations of climate change in agriculture and cause significant variability of yields. With the farming sector contributing significantly to the Bulgarian economy and growing agricultural vulnerability to climatic adverse events, it is expected that the livelihoods of many Bulgarians will be increasingly affected.

Chapter 2. Baseline – Policy Context

2.1. State of Awareness, Understanding of Future Consequences of Climate Change, Knowledge Gaps in the Sector

78. **In Bulgaria, there is limited awareness of CCA.** Policy-making has been so far almost exclusively focused on the identification and implementation of climate change mitigation measures and not on CCA. The Bulgarian policies and principal objectives in the field of climate change mitigation and adaptation are related to the country's international and EU commitments. The Third National Action Plan on Climate Change (NAPCC) 2013–2020, outlines the framework for action in the fight against climate change for 2013–2020. The document defines a number of mitigation measures in the agriculture and forestry sectors but does not explicitly stipulate policies and actions on adapting to climate change. Climate change receives little attention on the public agenda and national public awareness of CCA is rather limited. At present, there is no specific program or initiative on CCA in the agricultural sector. Moreover, often local authorities have no climate change-related actions in their policy documents.

79. **There is a lack of systematic studies on the impact of climate change in the Bulgarian agriculture and fisheries sector.** Climate change, in general, and its impacts on the agriculture sector are the subject of research of various scientific and research institutes, including the NIMH, the Agricultural Academy, and the BAS. The NIMH developed a range of studies focusing on the potential impacts of climate change based on different scientific approaches (for example, physical modelling, econometric analysis, impacts assessment and vulnerability, risk, and adaptation). In addition, the Nikola Pushkarov Institute of Soil Science and Agroecology studies soil parameters and soil erosion and analyzes climate change impacts on soil degradation.

80. **The farmers' community lacks sufficient information on CCA, despite being represented by agricultural associations.** The interests of the agricultural businesses and farmers are represented by sectoral associations, most of which are nongovernmental, voluntary organizations. The largest associations in Bulgaria are the National Grain Produces Association (NGPA), the Association of Agricultural Producers in Bulgaria (APSB) and the Bulgarian Association of Dairy Processors. The associations actively participate in different expert groups and commissions dealing with policy development of the individual sectors; they also contribute to drafting legal acts and get involved in decision making processes. However, specific discussions on climate change effects and CCA are not widespread and many interested stakeholders are not familiar with climate change impacts on agriculture. The entire farmers' community knows about climate change, but their knowledge and experience, when it comes to CCA options and measures, is still limited. Consequently, farmers lack sufficient information and knowledge about the vulnerabilities of the agricultural sector and the opportunities for changing crops in response to climate trends.

2.2. Experience with CCA in the Agriculture Sector in Other EU Countries

81. **EU member states have developed various policies, tools, and actions related to CCA.** Three countries have been chosen to illustrate various good practices and useful tools relevant to sectoral CCA. Italy's best practice focuses on embracing digital technology to develop and implement adaptation measures. Poland provides free and accessible climate adaptation knowledge through workshops, trainings and advisory services, while Greece is highly involved in providing insurance to farmers. ***Annex 5*** describes four more best practices from the Netherlands, Austria, Sweden, and the United Kingdom.

Box 2. Italy - Embracing Digital Technology to Develop and Implement Adaptation Measures

As part of its adaptation strategy, Italy has developed various online platforms and tools to raise awareness, disseminate information, and provide real-time and personalized advisory services to help farmers combat climate change and implement the established adaptation measures. In addition, during the development of its national adaptation strategy, Italy has engaged with farmers and other interested stakeholders through the eParticipation framework. In its ongoing efforts to foster wider involvement of citizens and thereby contribute to a better understanding of nature and a deeper appreciation of its value, Italy is planning its 'First Italian Citizen Science Conference'.[17]

eParticipation framework. To explore adaptation capacity of agriculture to climate change in Northern Italy, farmers were mobilized using a preexisting online network. An online questionnaire for assessing perceptions of the impacts of ongoing changes in agriculture was designed. The results served as inputs for suggesting an array of policy actions and for setting evaluation criteria. Farmers evaluated these policy measures, using a simple user-friendly multi-criteria analysis (MCA) tool (Bojovic 2015).

Personalized and real-time Irrigation Advisory Service. The irrigation advisory service aims at providing farmers with real-life information on crops' water requirements which contributes to a better allocation of irrigation water.[18] The service is split into the following steps: (1) crop growth monitoring through weekly acquisition and analysis of high resolution satellite images, (2) local agro-meteorological data acquisition, (3) field validation through measurement, (4) elaboration of water requirement measurements at field scale by means of standard bio-physical models, (5) data quality check and integration in a dedicated Geographical Information System for irrigation management, (6) real-time distribution of personalized irrigation advice on a weekly basis directly to the farmers by means of different communication systems (including Internet, text and graphical images using Global System for Mobile Communications/Universal Mobile Telecommunications System [GSM/UMTS] handset), (7) real-time distribution of aggregated information (irrigation secondary units, district, and basin levels) to end users such as water users associations and/or water authorities.[19]

Other online platforms that have been developed by Italy include the following:

AgroScenari. The purpose of Agroscenari is to assess how to adapt some of the main Italian agricultural systems to climate changes, including viticulture, olive growing, grain crops in the hilly south-central Italy, intensive horticulture under irrigation in south-central Italy, zoo-technical grain growing in the Po Valley, and intensive fruit growing in the southeast Po

[17] This conference will be held in Rome in November (23–25 November) 2017. For more information and topics included, see http://www.citizensciencerome2017.com/
[18] http://www.agricoltura.regione.campania.it/irrigazione/prci_home.html
[19] See also, http://www.unepfi.org/fileadmin/publications/water/chief_liquidity1_Mediterranean.pdf

Valley.[20] The project is divided into short-term (5 years) and long-term (30 years) periods. The aim of the project is to propose the construction of climate change scenarios and production systems evolution, both at the local and national level.

NextData. NextData is a national system for the retrieval, storage, access, and diffusion of environmental and climate data from mountain and marine areas. The objective is to develop efficient web portals to access climatic and atmospheric composition data, past climate information from ice and sediment cores, biodiversity and ecosystem data, measurements of the hydrological cycle, marine reanalyzes, and climate projections at the global and regional scale. The collection of data and the studies will allow for obtaining new estimates on the availability of water resources and on the effects of atmospheric aerosols on high-altitude environments, as well as new assessments of the impact of climate change on ecosystems, health, and societies.[21]

RITMARE. RITMARE is the leading national marine research project, coordinated by the National Research Council and involving the scientific community working on marine and maritime issues, as well as some major industrial groups.[22] RITMARE is divided into seven sub-projects: (1) Maritime Technologies; (2) Technologies for Sustainable Fishing; (3) Planning of the Maritime Space in Coastal Waters; (4) Planning of the Deep Marine Environment and the Open Sea; (5) Observation System for the Marine Mediterranean Environment; (6) Research, Training and Dissemination Structures; and (7) Interoperable Infrastructure for the Observation Network and Marine Data.[23]

Box 3. Poland - Free and Open Climate Adaptation Seminars, Trainings and Advice

Raising awareness. As part of its efforts to raise awareness on climate change and its impacts on different sectors, Poland organized a *Film Festival 'Climate Change – Community'*. Film screenings were free of charge and held in cinema halls across the country.[24] Other initiatives include organizing the free and open online webinar series 'Food-Climate-Cooperation' with leading Polish experts and practitioners, covering the topics of climate change, permaculture, renewable energy in agriculture, cooperation between farmers and consumers and system changes needed to protect the climate.[25] Furthermore, a *Climate-Friendly Food Book*[26]was released.

Advisory services. Poland also gives special attention to the provision of advisory services. Agricultural advisory organizations are represented by advisers who mainly deal with the promotion of agricultural, economic and organizational innovations, providing constant education and solutions to the problems of agricultural practices and CCA. The advisory system is represented by the Agricultural Advisory Centre in Brwinów (with divisions in Krakow, Poznan and Radom), 16 Provincial Advisory Centers (ODRs), 16 agricultural chambers, 163 private advisory organizations, and numerous nongovernmental organizations (NGOs). The priority for the ODRs is to assist farmers and their families in making decisions that will help them achieve their goals. This is achieved by actions taken to improve the level of

[20] http://www.agroscenari.it/presentazione_EN.asp
[21] http://www.nextdataproject.it/?q=en
[22] http://www.ritmare.it/en/index.php?option=com_content&view=featured&Itemid=101
[23] http://www.ritmare.it/en/2012-10-26-10-33-11/struttura-progetto.html
[24]http://www.percorsidipace.eu/climate-change/from-poland/item/1001-film-festival-climate-change-community-future#.WU-4VpLyvIU Nine documentary films showing the consequences of climate change and overexploitation of natural resources for the environment and the life of communities in different parts of the world were presented. After the end of each day, there was a discussion with invited experts. In each city one discussion focused on modern activism, especially in the context of climate movement, and the second one on permaculture as a way of addressing problems related to climate change and environmental protection.
[25] http://www.percorsidipace.eu/climate-change/from-poland/item/995-webinars-food-climate-cooperation#.WU-70JLyvIU
[26] The book is available in Polish and can be downloaded for free at http://dlaklimatu.pl/zywnosc-przyjazna-dla-klimatu-ksiazka/

qualifications of farmers and rural inhabitants, implementing the instruments of the EU's CAP, promoting the multifunctional development of rural areas, promoting environmentally-friendly management methods and environmental protection, assisting in implementing new requirements relating to agricultural production, implementing new production technologies, protecting and cultivating cultural heritage at the village level.[27]

Training and capacity building. The Norway Vista Analysis company in cooperation with the Polish research institute IOS-PIB (Institute of Environmental Protection - National Research Institute) provide trainings on CCA in 106 Polish cities. The trainings aim to build the skills and capacity of public administration employees and help them deal with CCA. As part of the project, training workshops are held for about 500 people from each of Poland's 16 provinces. At these workshops, Norwegian experiences and best practice in relation to CCA are shared.

Box 4. Greece: Compulsory Insurance for Farmers

The Greek government is highly involved in the provision of insurance to farmers. The majority of Greek farms are covered by a public compulsory scheme.[28] This compulsory insurance is provided by the Greek Agricultural Insurance Organization that is a legal entity fully owned by the state. The insurance programs cover losses to crops caused by floods, droughts, frost, hail, windstorms, snow, excessive rainfall, and wild animals. In addition, the government often steps in after serious disasters and provides compensation to farmers on an ad hoc basis. Agricultural producers can voluntarily take out additional insurance policies from the private market to complement the public coverage. However, this does not happen very often, therefore the private agricultural insurance market is less prevalent in comparison to the public scheme.

2.3. EU CCA Legal Framework and Policies in the Agriculture and Fisheries Sector

82. **International framework defining the path post-2020.** Bulgaria is a signatory to the United Nations Framework Convention on Climate Change (UNFCCC) since June 1992 and a party to it after the ratification by the Bulgarian Parliament in 1995. It is also a signatory of the Kyoto Protocol. More recently, the Paris Agreement of 21st Conference of the Parties (COP 21) to the UNFCCC was adopted on December 12, 2015, providing a framework for global actions to address climate change after 2020. The Paris Agreement establishes *'a global goal on adaptation: enhancing adaptive capacity, strengthening resilience and reducing vulnerability to climate change*', and urges a significant increase in financial assistance for adaptation in developing countries. Through their Intended Nationally Determined Contributions (INDCs),[29] the EU and its Member States have committed to a binding target of, at least 40 percent, domestic reduction in greenhouse gas (GHG) emissions by 2030 compared to 1990. The EU Adaptation arrangements under the UNFCCC are to be reviewed in 2017.

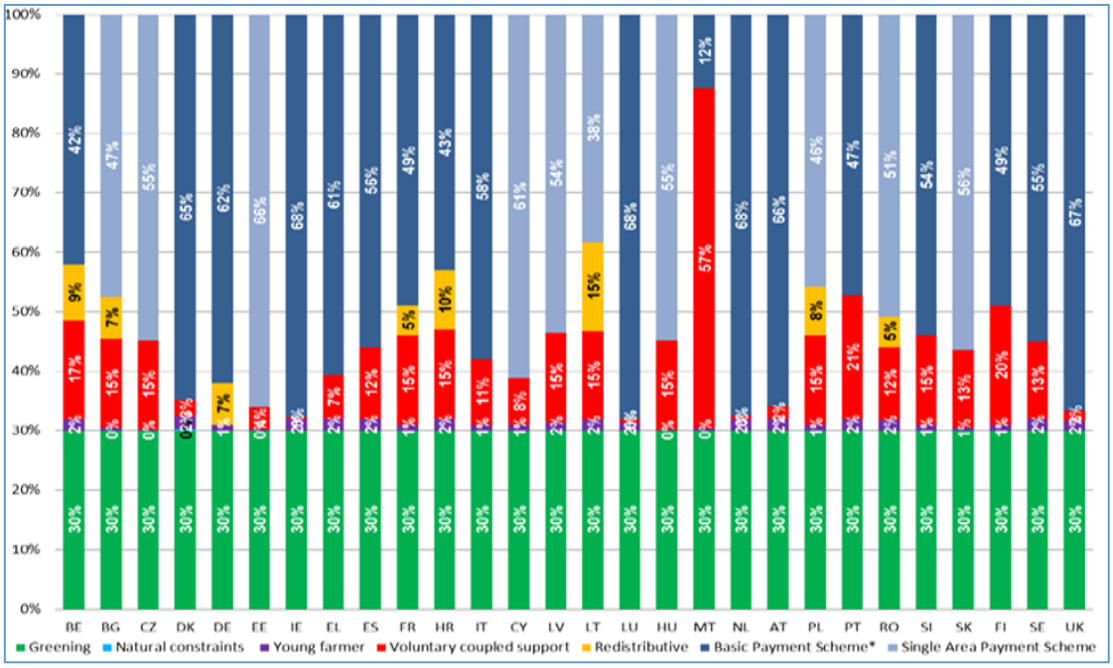
83. **The Europe 2020 Strategy**[30] **sets the scene toward smart, sustainable, and inclusive growth actions across the EU.** The strategy defines three mutually reinforcing priorities for each Member State: (a) smart growth: developing an economy based on knowledge and innovation, (b) sustainable growth: promoting a more resource-efficient, greener, and more

[27] The tasks of the CDR as specified by the Act on Agricultural Advisory Bodies of October 22, 2004.
[28] Penetration is one of the highest within the EU because of the mandatory participation for agricultural producers.
[29] http://www4.unfccc.int/ndcregistry/PublishedDocuments/Bulgaria%20First/LV-03-06-EU%20INDC.pdf
[30] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:2020:FIN:EN:PDF

competitive economy, and (c) inclusive growth: fostering a high-employment economy delivering social and territorial cohesion. The 2020 package, part of the Strategy, is a set of binding legislation to ensure the EU meets its climate and energy targets for the year 2020. The package sets three key targets: limiting GHG gas emissions by at least 20 percent compared to 1990 levels, creating 20 percent of the energy needs from renewables and increasing the energy efficiency by 20 percent. Bulgaria appears already to be well ahead of its targets in regard to reducing GHG emissions and increasing the share of renewable energy and progressing well in regard to energy efficiency.

84. **The Common Agricultural Policy (CAP) addresses the challenges of climate change.** During 2007–2013, the CAP invested around €4 billion in the Bulgarian agricultural sector and rural areas focusing on competitiveness and improving rural quality of life. The CAP reform 2013 was prepared in accordance with the priorities of the Europe 2020 Strategy.

Figure 21. Direct Payments - Overview of Allocations by Scheme (2015)



Source: EC Direct Payments, Basic Scheme, March 2016.[31]

85. **The CAP for 2014–2020 maintains the existence of two pillars:** Pillar I – direct payments and Pillar II – rural development. Under Pillar I, a new architecture for direct payments that is better targeted, fairer and greener was introduced. While member states have much freedom in tailoring the seven components of direct payments, 30 percent of their national funding allocations must address the greening element ***(Figure 21)*** which is made up of three measures,[32] namely (a) crop rotation and diversification,[33] (b) maintaining permanent grassland and (c) maintaining an ecological focus area (FA).[34]

[31] http://ec.europa.eu/agriculture/sites/agriculture/files/direct-support/direct-payments/docs/basic-payment-scheme_en.pdf
[32] http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.2.5.html
[33] For crop diversification: the farmer must cultivate at least two different crops if he has more than 10 hectares of arable land; if he has more than 30 hectares, he must cultivate at least three crops; the main crop may cover no more than 75% of the arable land, and the two main crops no more than 95%
[34] Maintaining an 'ecological focus area' of at least 5% of the arable area of the holding on farms with more than 15 hectares of arable land (excluding permanent grassland and permanent crops): edges of fields, hedges, trees, fallow land, landscape features, biotopes, buffer strips, afforested areas or nitrogen-fixing crops. This figure may rise to 7% after 2017".

86. **The EU rural development policy aims at mainstreaming climate change mitigation and adaptation activities.** It is financed by the European Agricultural Fund for Rural Development (EAFRD) worth €100 billion from 2014 to 2020, with each EU country receiving a financial allocation for the seven-year period. *"The purpose of the fund is to contribute to the implementation of the Europe 2020 Strategy (the European Union's strategy to promote growth and employment) by promoting sustainable rural development. The EAFRD is intended to help develop a farming industry which is balanced in regional and environmental terms, avoids damaging the climate, is resilient in a* context *of climate change and is competitive and innovative".*[35] Member States and regions draw up their rural development programs based on the needs of their territories and address at least four of the six common EU priorities listed in ***Figure 22.*** At least 30 percent of funding for each rural development program must be dedicated to measures relevant to the environment and climate change.

Figure 22. Priorities for the New EU Rural Development Policy Framework

Source: EU Rural Development Regulation No. 1305/2013.

87. **The Common Fisheries Policy (CFP)[36] aims to ensure that fishing and aquaculture are environmentally, economically, and socially sustainable.** The CFP sets the rules for managing European fishing fleets and for conserving fish stocks, including rules on aquaculture. Designed to manage a common resource, it gives all European fishing fleets equal access to EU waters and fishing grounds and allows fishermen to compete fairly. Its goal is to foster a dynamic fishing industry and ensure a fair standard of living for fishing communities. The European Maritime and Fisheries Fund (EMFF) is the fund for the EU's maritime and fisheries policies for 2014–2020.

88. **The EU Strategy on Adaptation to Climate Change[37] provides a framework and mechanisms to improve the preparedness of member states for current and future impacts of climate change.** The strategy helps enhance the capacity to respond to the impacts of climate change at the local, regional, national, and European level and supports the development of a

[35] http://www.europarl.europa.eu/atyourservice/en/displayFtu.html?ftuId=FTU_5.2.6.html
[36] https://ec.europa.eu/fisheries/cfp_en
[37] Adopted in April 2013, available at: http://ec.europa.eu/clima/policies/adaptation/what/documentation_en.htm

coherent approach and improved coordination at the EU level. Both agriculture and fisheries are defined as key vulnerable sectors, dependent on the impact of climate change. One of the actions identified in the strategy is directly related to the agriculture and fishery sectors, namely 'Action 6: Facilitate the climate-proofing of the Common Agricultural Policy (CAP), the Cohesion Policy and the Common Fisheries Policy (CFP)' (EC 2013). The strategy has also been considered at the stage of the preparation of the Rural Development Programme (RDP) 2014–2020.

89. A summary of various other relevant regulations or delegated and implementing acts for the agricultural or fisheries sector, part of the EU legal framework, may be found in ***Annex 6***.

2.4. Bulgarian CCA Legal Framework and Policies in the Agriculture Sector

90. **Agriculture or fisheries sectors have no specific legal acts that deal exclusively with CCA.** The key climate change mitigation legislation in Bulgaria is represented by the Climate Change Mitigation Act (CCMA)[38] and the Third (NAPCC) 2013–2020, providing for measures for climate change mitigation and for reduction of GHG emissions in different sectors. The national strategic documents or programs that directly or indirectly deal with CCA in the agriculture and fisheries sectors are briefly presented in this subchapter. An extended list of relevant documents and programs, together with regulation that directly or indirectly touches upon adaptation, is presented in ***Annex 7***.

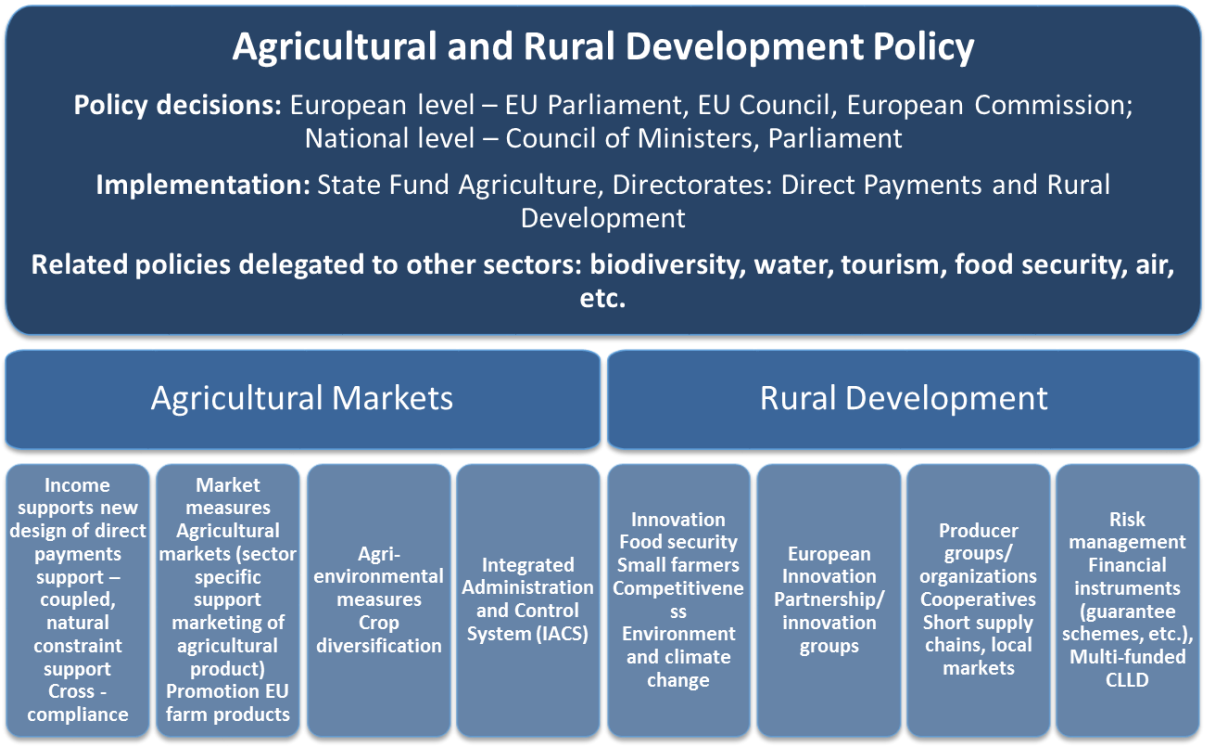
91. **The Partnership Agreement (PA) for 2014–2020 is the national strategic document outlining the framework for the management of EU structural and investment funds.** The PA identifies the adverse climate changes and insufficient adaptation as important factors for deteriorating the sustainability of agricultural holdings, with restrictive impacts on the development of the agricultural sector. It also highlights the need to shift to suitable agricultural practices adapted to climate change and improve access to irrigation water. The adverse impacts of climate change and adaptation measures against its negative effects are explicitly addressed under the third strategic priority: 'Connectivity and Green Economy for Sustainable Growth', and its sub-priority: 'Climate and Climate Change, Prevention and Risk Management'. The PA envisages additional incentives for conservation and ecosystem restoration, as well as for resource efficiency and for the development of a climate-resilient economy.

92. **Nearly one third of Bulgaria's overall financial allocation under CAP 2014–2020, is earmarked for mainstreaming CCA and mitigation activities.** Implementation of the new CAP regulations started in 2015. For direct payments, implementation choices by Member States were finalized and notified to the EC during 2014, with the rules coming into force on January 1, 2015. Bulgaria received a financial envelope of around €5.1 billion for direct payments, of which 30 percent will be linked to three environment-friendly and climate-relevant farming practices: crop diversification, maintaining permanent grassland, and conserving 5 percent of areas of ecological interest or measures considered to have at least equivalent environmental benefit.[39]

[38] Adopted in 2014, last amended SG12/03.02.2017
[39] According to EC's Bulgaria Common Agricultural Policy Note, March 2015, available at: http://ec.europa.eu/agriculture/sites/agriculture/files/cap-in-your-country/pdf/bg_en.pdf

93. **However, the total indicative amount allocated to objectives affecting CCA and mitigation is 44.6 percent of the total Rural Development Programme (RDP) budget.** The RDP addresses climate change mitigation and adaptation more directly in three out of the six rural development priorities, namely: Priority 1 - Fostering knowledge transfer and innovation in agriculture, forestry, and rural areas; Priority 4 - Restoring, preserving, and enhancing ecosystems related to agriculture and forestry; and Priority 5 - Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in agriculture, food, and forestry sectors. Direct positive impacts for CCA and mitigation are expected from the implementation of the activities under measures 10 and 11, while indirect positive impacts are envisioned for activities under measures 1, 2, 4, 8, 12, 13, 15 and 16. The RDP measures considered to have the greatest potential for climate mitigation and adaptation are listed in ***Table 6***.

Figure 23. Structure and main actors in implementing the Bulgarian agriculture policy



Source: World Bank design.

Table 6. RDP Measures with the Greatest Potential for Climate Mitigation and Adaptation

Measure	Expected Impact on Climate Change Adaptation	Indicator	Target Value	Percentage of total RDP budget
M1: Knowledge transfer and information actions	Knowledge transfer for the environmental and sustainable development of agriculture and forestry will lead to the introduction of new practices involving low-carbon, low-emission technologies and better implemented agricultural practices in irrigation, fertilization, or use of plant protection products. Knowledge-sharing events such as trainings and seminars will help raise awareness for farmers on the need for sustainable use of soil resources, application of organic fertilizers, and so on. Overall, the measure will have a positive long-term impact on the adaptive capacity and knowledge of sustainable development of natural ecosystems, including target species and habitats within the Natura 2000 network.	Number of trainees	4,800	1.14
M2: Advisory services, farm management and farm relief services	The measure envisions the provision of advisory services to farmers, contributing to leaner introduction of new practices involving low-carbon and low-emission technologies, better farm management, improved soil management and soil preservation. The advisory services are also envisioned to support the start-up and management of small agricultural companies.	Number of beneficiaries	19,425	0.68
M4: Investments in physical (tangible) assets	The measure includes several activities that protect the environment: (a) construction, reconstruction and upgrading of irrigation and drainage infrastructure (investments into the rehabilitation of the irrigation structure of agricultural farms and beyond their boundaries), (b) investments into machines and equipment for the protection of the environment, including the construction of safe facilities for manure storage, (c) improvement of the irrigation techniques and technology of farms (including reconstruction and upgrading of equipment, the introduction of effective system management, and promotion of efficient utilization of water), (d) investments into reconstruction and construction of cattle breeding facilities, (e) investments into installations for waste water treatment.	Number of agricultural holdings	3,500	28.82
M8: Investments in forest areas development and improvement of the viability of forests	Sub-measure 8.1, '*Afforestation and maintenance'*, envisions the afforestation of abandoned agricultural lands, forest areas, or areas outside forest territories, either suffering from erosion or threatened with erosion. It also includes planting of forest belts, which will help limit water erosion and improve the water balance of the surrounding territories. The recovered forests will play a role in the protection of natural disasters (especially floods). The restoration and maintenance of the green forest infrastructure will also be favorable for the areas of Natura 2000 and natural habitats for target species.			2.18

Measure	Expected Impact on Climate Change Adaptation	Indicator	Target Value	Percentage of total RDP budget
M10: Agri-environment-climate	This measure includes activities to control and improve the status of the grasslands, limit soil erosion, protect soils from pollution, and improve land management. The impact resulting from this measure is positive for CCA due to the envisaged recovery and maintenance of natural habitats and habitats of species, the protection of endangered animals and plant species, and so on. Sub-measure 10.1 '*Payments for commitments related to agri-environment-climate'* will include activities such as traditional practices for seasonal grazing (pastoralism) and sustainable use of the grass resources. Sub-measure 10.2 '*Protection of endangered local breeds and plant varieties important to agriculture*' will support the protection of the livestock breeding, semi-natural ecosystems and habitats. Activities under '*Maintaining habitats of protected species of ornithological importance in arable lands*' are aimed at conservation of species and natural habitats, including those under the National Ecological Network.	Area (hectare) of agri-environment and climate commitments. M10.1	113 000	7.65
		Area (hectare) (Green land, intermediate crops, reduced fertilization) M10.2	7,000	
M11: Organic farming	The measure addresses the promotion of organic plant production, livestock production, and beekeeping, leading to improved water management, fertilizers management, and pesticide management, and consequently to a decrease in soil and water pollution. The introduction of extensive agricultural practices will lead to a reduction in the nitrification and influx of nutrients in the natural and semi-natural ecosystems, especially in the grass communities and water habitats, with a cumulative positive impact on the flora and fauna and the natural ecosystems. This will also contribute to the support of the target species and habitats and maintaining them in a favorable conservation status.	Total (hectare)	46,000	5.20
		Area (hectare) conversion to organic farming (M11.1)	23,000	
		Area (hectare) - organic farming (M11.2)	23,000	
M12: Payments under Natura 2000 and the WFD	The measure will compensate agricultural lands within Natura 2000, forests and agricultural lands adjacent to river basins. The measure will contribute to preservation of landscapes and the biodiversity, recovery and maintenance of habitats, protection of endangered species, meadows and pastures, wetlands, and forests. It will also improve the conservation status of species and habitats in protected areas.	Area (hectare) - Natura 2000	445,000	4.79
M13: Payments in areas facing	Payments under this measure contribute to the objectives of Priority 4 '*Restoration, Conservation and Enhancement of Ecosystems Dependent on Agriculture and Forestry*' and	Area (hectare) mountains	310,000	9.45

Measure	Expected Impact on Climate Change Adaptation	Indicator	Target Value	Percentage of total RDP budget
natural or other specific constraints	Priority Area 4A "*Restoration and Conservation of Biodiversity, including in Natura 2000 areas, High Nature Farming Value*". This measure indirectly affects CCA by supporting activities for maintaining the landscape, biodiversity and improving land management practices.	Area (hectare) significant natural constraints	220,000	
M15: Environmental and climate-related services in forestry	This measure envisions the promotion of sustainable forest management and improvement in the status of forests, including the support and maintenance of biodiversity, water and soil resources, combating climate change adverse effects; actions include creating protective buffers and forest belts around the permanent water flows, excluding some of the forest stock from areas designated for logging, and so on.	Area (hectare) environmental protected	90,600	0.30
M16: Cooperation	This measure will help achieve the objectives of the European Innovation Partnership for agricultural productivity and sustainability, defined in Article 55 of Regulation (EU) No. 1305/2013. The activities planned for support are important to the enhancement of agricultural productivity, biodiversity, better management of lands and soil functionality, integrated supply chain, food quality and safety. This measure will indirectly and positively affect CCA by supporting specific innovative projects.	Number of farms participating in local/regional cooperation	280	1.12

Source: RDP 2014–2020.

94. **The National Development Program: Bulgaria 2020[40] details the objectives of the development policies of the country until 2020.** This is an integrated document focusing on the social and economic development of Bulgaria until 2020, linking the EU priorities in the context of the Europe 2020 Strategy and the national priorities of Bulgaria. Sub-priority 4.5, related to the development of the agricultural sector, targets the 'sustainable use and management of natural resources' and seeks to encourage 'the agricultural producers to provide ecological and climate-related services'. Sub-priority 3.5, related to the regional development priority area, targets 'conditions for preservation and improvement of the environment in the regions, adaptation to the on-going climate change and achieving sustainable and effective use of natural resources'. Both these sub-priorities aim at contributing to the protection of land and the fight against climate change. Sub-priority 4.6 deals with 'establishing a competitive fish sector providing sustainable management of fisheries and aquacultures.' However, there is no directly expressed connection between climate change and the development of fisheries and aquacultures.

95. **The Common Strategy for Management and Development of Hydro-melioration and Protection against Harmful Effects of Water** establishes a new framework for legal and institutional reforms and it outlines how the hydro-melioration sector should manage the infrastructure for the provision of irrigation and drainage services and oversee the infrastructure for flood protection and river corrections that protects agricultural land from the harmful effects of water. A well-performing irrigation and drainage subsector offers significant opportunities for promoting the competitiveness of agriculture as it improves productivity and reduces the loss of income for farmers in years with unfavorable climate conditions.

96. **The Third NAPCC outlines the framework for action in the fight against climate change for 2013–2020.** The document defines a number of mitigation measures in the agriculture and forestry sectors, such as increasing the knowledge of farmers on the implementation of appropriate practices leading to a reduction in emissions from the sector, introducing crop rotation practices, or maintaining permanent grass meadows and pastures which lead to the storage of carbon in the soil. The document also defines the duties of the relevant entities (ministries, agencies and local authorities).

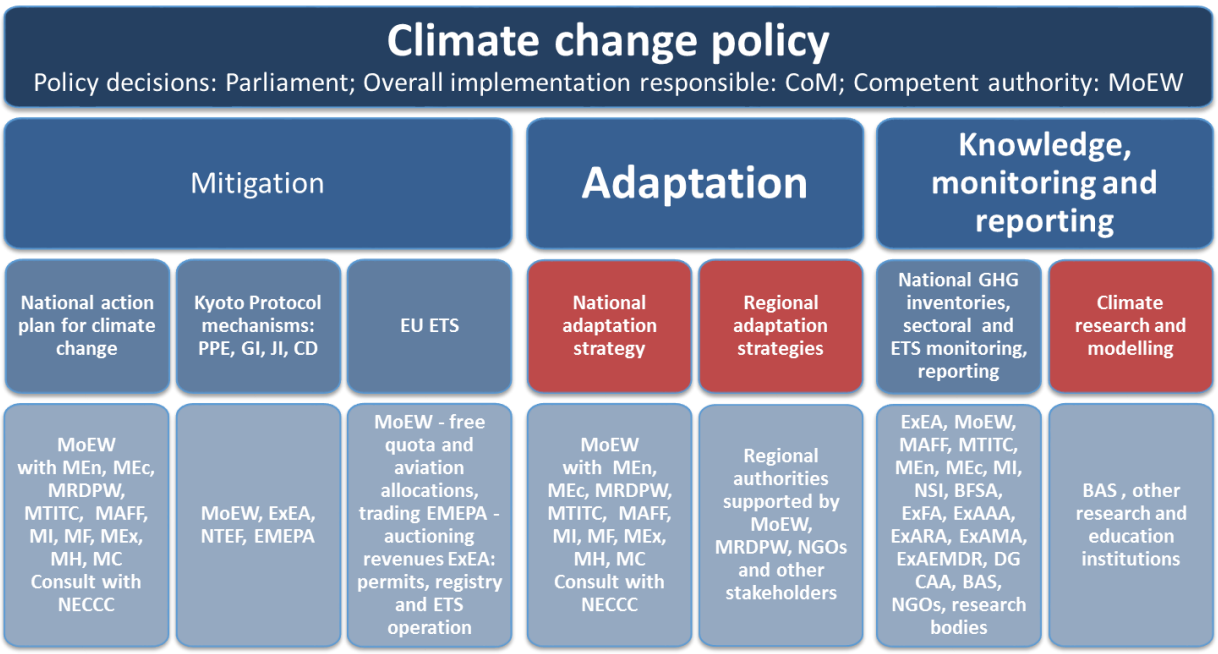
97. **The Multiannual National Strategic Plan for Aquaculture in Bulgaria (2014–2020)** has been prepared in accordance with the EC's Strategic Guidelines for the Sustainable Development of EU Aquaculture. Bulgaria's plan covers all activities related to the production of fish and other aquatic organisms and includes measures to diversify the activities of producers and opportunities for better marketed production. The plan discusses the state of the biological resources of valuable species of inland waters in Bulgaria and the Black Sea. More specifically, the plan points out that the key problem for cultivating fish in basins/ponds is the reduction of the water levels due to drought climate events. However, the plan lacks any assessment of the sector vulnerabilities in relation to climate change and does not prescribe any specific actions for mitigation or adaptation to the negative impacts of climate change.

[40] National Development Program: Bulgaria 2020, available at: https://www.eufunds.bg/archive/documents/1357828564.pdf.

2.5. Institutional Framework and Stakeholder Community in Bulgaria

98. **The climate change-related institutional framework in Bulgaria mainly focuses on mitigation**. Mitigation is addressed either by striving to meet the international obligations and agreed targets for reducing GHG emissions or by participating in mechanisms for international emissions trading, or monitoring, reporting, and verification of EU Emission Trading System emissions. The institutional framework related to CCA is an element of the overall climate change institutional framework set out in the CCMA and the related sub-legislation. Institutions and their responsibilities are illustrated in ***Figure 24***. The areas that are not yet legally mandated or sufficiently detailed are marked in red. The stakeholders listed in such areas are engaged more or less informally.

Figure 24. Structure and Main Actors in Implementing the Bulgarian Climate Change Policy



Note: All abbreviations used in this figure could be found within the Abbreviations and Acronyms section.

Source: World Bank design.

99. The **Ministry of Environment and Water (MoEW)** manages, coordinates, and monitors the environmental policy at the national, EU, and international level. It is also responsible for coordinating the policy-making process in relation to CCA. The MoEW is assisted by the National Expert Council on Climate Change and a Coordination Council on Climate Change has also been established. The work in the area of climate change is done within the specialized Directorate for Climate Change Policy.[41] The MoEW is supported by other ministries and governmental agencies, including the MAFF, the Ministry of Economy; the Ministry of Transport, Information Technology, and Communications; the Ministry of Finance; the Ministry of Interior; the Ministry of Exterior; the Ministry of Health (MH); the Ministry of Education and Science; the Ministry of Labor and Social Policy; and the Executive Environment Agency. They have responsibilities for sectoral integration of climate change actions (both adaptation and mitigation) in their respective fields.

[41] http://www5.moew.government.bg/?page_id=23699

100. **The MAFF** is responsible for the programming of the Rural Development Program (RDP) and operates various schemes supporting agriculture. The MAFF is also responsible for the development programs and strategies in the fishery and aquaculture sectors. The State Fund Agriculture (SFA) deals with administration and controls of direct payments to farmers. The Directorate for Rural Development is acting as the Managing Authority for the RDP and is responsible for the efficient programming, management and implementation of the program. One of the responsibilities related to CCA is to design appropriate measures and schemes to combat climate change for soil protection, biodiversity and water resources and to ensure the fulfilment of commitments under EU legislation and European Structural and Investment Funds (ESIF). The directorate is also in charge of the monitoring and control of the activity of the National Rural Network (NRN).

101. **The farm advisory services in Bulgaria are currently delivered by the National Agricultural Advisory Services (NAAS) and private advisory organizations.** In Bulgaria, the Agricultural Knowledge and Innovation Systems is represented by different institutions (Dirimanova 2014): (a) The MAFF with its secondary structures, including the NAAS; (b) private and independent advisors, international trade organizations, regional suppliers; (c) farm-based organizations; (d) educational and research organizations and (e) NGOs, professional associations, and foundations. The NAAS is currently the only public specialized consulting organization with expertise in the sector. Through its vocational training centers, the NAAS provides trainings for farmers, as well as public and private bodies, mainly on project management, business planning, agro-ecology, and CCA, as well as other relevant agricultural topics. It also provides information campaigns addressed specifically to farmers concerning applicable legal acts, innovation or different practices for cultivating crops and plants, and technology development. The NAAS has been chosen as a single advisory provider by the MAFF to provide advisory services to young, small-scale and subsistence farmers. As a beneficiary of Measure 1 'Transfer knowledge and information actions' of the RDP 2014–2020, the NAAS will have a key role in improving the knowledge on CCA.

102. **The Bulgarian NRN,**[42] part of the European Network for Rural Development,[43] aims to promote the exchange of information and knowledge among network members to support cooperation activities and strengthen the capacity of Local Action Groups. The NRN comprises various stakeholders involved in rural development, including CCA. It aims to facilitate the exchange of expertise and know-how and to identify transferable practices. The priority of the NRN is to facilitate information exchange and to engage stakeholders in developing the RDP 2014–2020. The NRN's activities are coordinated by the Rural Development Directorate, part of the MAFF. The NRN Managing Unit is outsourced and the external body undertaking this function is selected by the RDP Managing Authority, following a competitive tender procedure. However, to the date of writing this report, the MAFF has not clarified which company is responsible for managing the NRN for the current programming period.

[42] http://www.nsm.bg/

[43] The European Network for Rural Development was established in 2008 to support the implementation of Member States' Rural Development Programmes. Its main objectives are to improve the implementation of RDPs, increase the involvement of all stakeholders and raise awareness of the benefits of RDPs to the broader public. It also assists with the sharing of information and good practices across the EU. For more details, see https://enrd.ec.europa.eu/about/brief_en

103. **The National Agency for Fisheries and Aquaculture (NAFA)** is in charge of the cultivation of fish and other aquatic organisms. The fishery policy is carried out by the Executive Agency for Fishery and Aquaculture, a legal entity subordinated to the MAFF, and two other directorates. The Maritime and Fishery Directorate is an administrative unit of the MAFF and is acting as the Managing Authority of the Operational Program Maritime and Fishery. The Common Policy on Irrigation and Fisheries Directorate is also part of the Ministry's structure and assists it in implementing the Common Fisheries Policy and defining national priorities.

104. **The BAS** is the leading scientific institution in the country carrying out research and development activities on climate change, examining fluctuations, adaptation of the individual sectors, and so on. The Agricultural Academy of Bulgaria is a public research organization, responsible for conducting scientific and applied research in the fields of agriculture, fisheries and aquacultures, as well as the food industry.

105. **Several NGOs have had a direct effect on developing the policy in agricultural sectors**, such as the NGPA, APSB, Bulgarian Association of Organic Products, Bulgarian Association for Dairy Processors, and others. These organizations were actively involved in the consultations for programming the measures within the CAP (Pillar I and Pillar II). Most of the above-mentioned organizations are members of the Monitoring Committee of the RDP 2014–2020. The social partners (branch associations) that represent the interest of the fishery and aquaculture producers are mainly NGOs. The two largest associations in Bulgaria are the Association of Fish Products Producers BG Fish and National Association of Fish Producers. The two organizations are actively involved in consultations for the fishery and aquaculture policies and have contributed to the drafting of the current operational program.

Several other relevant research institutes or national agencies are listed in ***Annex 8***.

2.6. Financial and Human Resources in Bulgaria

106. **The financing of CCA measures requires a considerable mobilization of funds.** While preparing the EU Strategy on Adaptation to Climate Change, the European Commission estimated that the total cost of not adapting to climate change at the EU-level could reach at least €100 billion a year by 2020, rising to €250 billion a year by 2050. Thus, improved access to funding will be a key factor in strengthening resilience to climate change. Bulgaria will need to mobilize funds at all levels, including private investments (that is, corporate financing from agricultural private companies, loans from international financial institutions, or commercial banks, and so on). Regarding public finance resources, the main sources available for CCA are the funds from the EU budget and the national budget.

2.6.1. EU financial resources

107. **Over the past 10 years the main sources of funding within the Agriculture and Rural Development sector have been the CAP payments.** Under the new CAP for 2014–2020, Bulgaria has been allocated significant inflows of EU funds for the farming sector and rural areas, totaling around €7.4 billion.[44] The total planned public expenditure (European

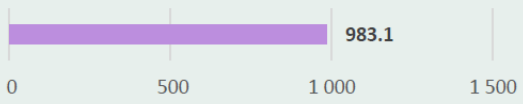
[44] Total allocation of Direct Payments and Rural Development for the period 2014–2020 (in current prices) for Bulgaria.

Network for Rural Development 2015) for the Rural Development Program 2014–2020 is nearly €3 billion, including EU and national co-financing.

108. **The rural development priorities further break down into Focus Areas (FA).** For example, Priority 4 (Restoring, preserving and enhancing ecosystems related to agriculture and forestry) or Priority 5 (Promoting resource efficiency and supporting the shift toward a low-carbon and climate-resilient economy in agriculture, food, and forestry sectors) include FAs such as reducing greenhouse gas and ammonia emissions from agriculture and fostering carbon conservation and sequestration in agriculture and forestry, protection and sustainable management of ecosystems, efficient use of natural resources, and support for conversion and maintenance of organic farming. ***Figure 25*** illustrates Priority 4 of the RDP, with a focus on the indicative budget per FA and its breakdown by selected measure, the relation between the indicative planned total public expenditure and the expected 2023 targets set by the Managing Authority for each FA. ***Figure 26*** shows the indicative planned total public expenditure per measure (comprising the EAFRD support and the national contribution). The measures illustrated in ***Figure 25*** are the complete list of measures selected within the RDP. Measures in gray were not selected by Bulgaria. The complete choice of measures by priority and FAs under the RDP 2014–2020 may be found in ***Annex 9***.

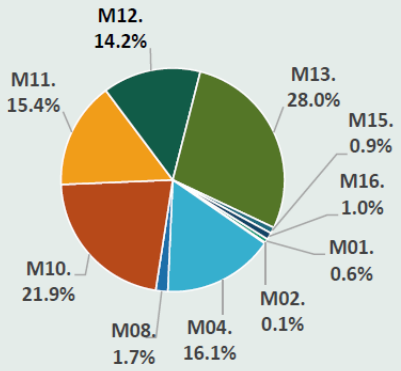
Figure 25. RDP Focus Areas for Priority 4: Planned Expenditure, Measures and 2023 Targets

P4 – Ecosystems management: Restoring, preserving and enhancing ecosystems related to agriculture and forestry

Focus Areas	Total public budget (million EUR)
4A. Biodiversity's restoration, preservation & enhancement 4B. Water management 4C. Soil erosion & soil management	

Target indicator	Value
T8 - % of forest/other wooded area under management contracts supporting biodiversity	2.6 %
T9 - % of agricultural land under management contracts supporting biodiversity and/or landscapes	12.0 %
T10 - % of agricultural land under management contracts to improve water management	2.5 %
T12 - % of agricultural land under management contracts to improve soil management and/or prevent soil erosion	1.2 %
T13 - % of forestry land under management contracts to improve soil management and/or prevent soil erosion	2.3 %

Breakdown of FA budget by measure (%)

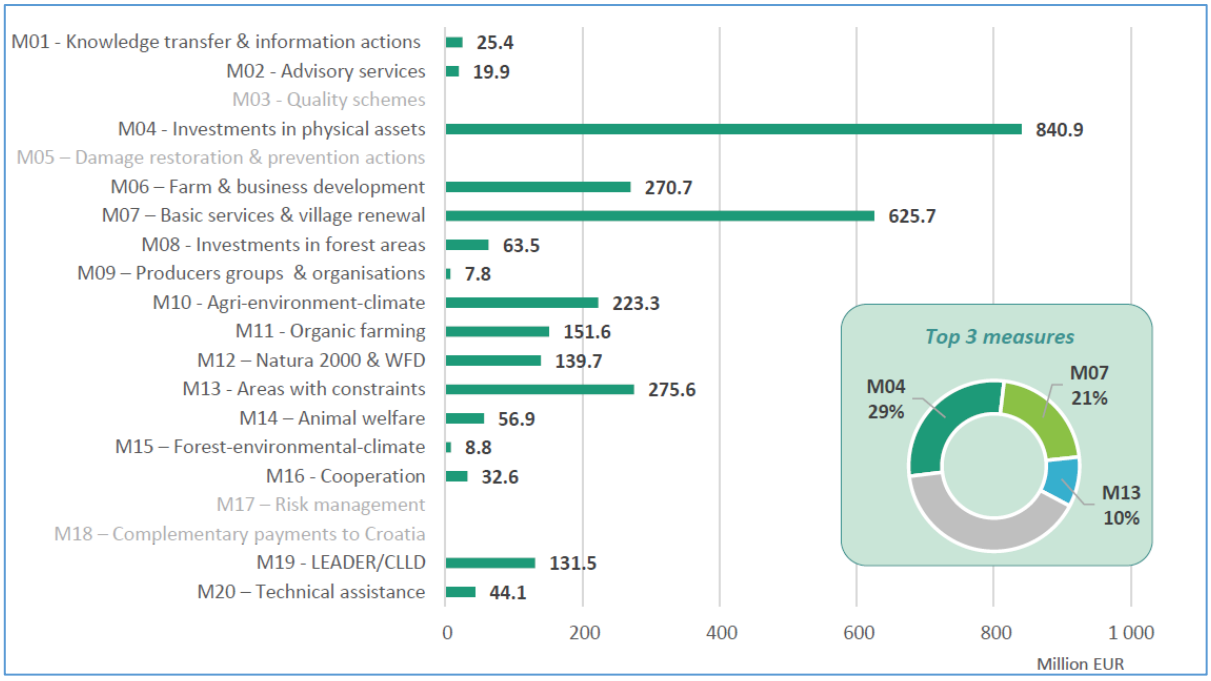


Measure	m EUR
M01	5.9
M02	1.3
M04	158.2
M08	17.1
M10	215.4
M11	151.6
M12	139.7
M13	275.6
M15	8.8
M16	9.7

Source: The European Network for Rural Development 2015.

109. **Horizon 2020 and LIFE programs.** In addition to providing funds for adaptation from structural funds, the EU budget provides support for adaptation programs and projects within the Horizon 2020 and LIFE programs. Horizon 2020 will promote research and development on CCA, while the LIFE instrument finances a wide range of projects related to environment and climate mitigation and adaptation.

Figure 26. Planned Expenditure per Measure in the RDP 2014–2020 (million €)



Source: The European Network for Rural Development 2015.

2.6.2. State budget financial resources

110. Several priorities and measures of the government policy program are funded by the state budget of the MAFF. The budget expenditures are allocated across various programs, plans and policies. Budgetary allocation is linked to carrying out specific commitments, some of which are directly or indirectly related to climate change mitigation or adaptation.

111. **The state budget program 'Agricultural land'** aims to (a) limit the degradation processes and negative environmental impacts on agricultural lands; (b) preserve and increase the productive potential of soil resources; and (c) introduce good agricultural practices and provide direct support to farmers to implement EU requirements to produce qualitative and competitive products. The total spending for the program is BGN 34,697,285 (€17.7 million).

112. **The state budget program 'Crops'** is dedicated to the conservation of crops. It also supports the introduction of new resilient crop varieties; implementation of the state policy related to the supervision and control in the field of organic production; compliance with national procedures in the field of supervision and control of organic producers, processors and traders; informing the public about the benefits of organic production.

113. **The state budget program 'Irrigation'** is carried out by the MAFF Directorate 'Irrigation, investment and concession'. The aim of the program is to create conditions for sustainable, competitive, and environmentally friendly farming by rehabilitating, expanding, and modernizing irrigation infrastructure. The yearly total spending at the end of 2016 was BGN 14,859,141 (€7.6 million).

114. **Stock breeding** is a component of the program aimed to develop and save the national genetic fund that ensures genetic resources for conservation, restoration and sustainable

management of biodiversity, as well as limit its loss and tackle emerging threats, such as new diseases. The total budget for this program is BGN 3,643,679 (€1.86 million).

115. **State aid policy in the agriculture sector** is aimed at solving specific problems for farmers by applying both compensatory and preventive measures, as well as measures to promote the competitiveness of the sector. The SFA provides financial support to agricultural producers under state aid programs. The state aids are intended to compensate the damages caused by natural disasters to prevent plant and animal diseases, to encourage farmers to insure their assets and to support farmers' production, which is vulnerable to climate change impacts.

2.6.3. Human resources

116. **Human resources involved in the development of climate change actions, policies, and programs is limited.** For example, the Directorate for Rural Development responsible for the RDP has around 70 experts and administrative staff, out of which only 6 are employees at the Department of Environment and Climate. This number is not deemed sufficient to properly manage, coordinate, and efficiently execute CCA measures. The NAAS has around 70 employees who have experience mainly in training and advisory services. The advantage of NAAS is that it has a network of branches and offices in the country. The Agricultural Academy and its structures have the necessary qualified human resources and science capacity. The total number of scientists and administrative staff is approximately 640. However, there is insufficient coordination between the research institutes and the private sector. The private sector does not allocate sufficient funds to support research in the CCA field.

2.7. Sector Participation in CCA-Specific International Cooperation or Information Exchange

117. **Bulgaria's international cooperation on climate change is led by international treaties and agreements.** As previously mentioned, Bulgaria is a signatory to the UNFCCC, the Kyoto Protocol, and the Paris Agreement of COP21. As an Annex I party of the UNFCCC, Bulgaria is considered a country with an economy in transition, and as such it is not required to contribute financially and transfer technologies to developing countries, unless it voluntary decides to do so. The country rather accepts financial and technological help, mainly within the framework of the Joint Implementation (JI) mechanism. The JI mechanism is a convenient way for Bulgaria to receive economic, technical, and expert support with GHG mitigation efforts. Bulgaria is also a member of the Intergovernmental Panel on Climate Change (IPCC), the leading international body for the assessment of climate change.

118. In the process of preparation of the National Adaptation Strategy, several recent initiatives were conducted to raise awareness and public participation for its development:

- In March 2012, the MoEW, with the support of the World Bank, organized an introductory workshop on the 'Preparation of a National Adaptation Strategy';
- In June 2013, a second workshop was organized, focusing on 'The role of insurance and financial instruments to manage the risk of climate change in Bulgaria';
- In April 2014, the MoEW organized a workshop about the 'Interaction between science and policy in the field of adaptation to climate change';

- In June 2015, the Ministry of Agriculture and Food and the World Bank hosted a high-level conference on Transforming the Agriculture and Rural Development Sector in Bulgaria.
- In October 2017, the National Expert Council on Climate Change organized a session on the National Adaptation Strategy.

119. Several recent educational projects and events focused on raising the awareness of CCA have been observed:

- In 2013, under the IPA Bulgaria-Serbia Cross-border Cooperation Program, the 'Climate change Kick-off' Click Project was organized.[45] The project aimed to raise public awareness on the impact of climate change and how to adapt to a changing climate, by developing the capacity of NGOs to participate actively in the preparation and implementation of measures and policies for adaptation.
- In 2014, Sofia University 'St. Kliment Ohridski' introduced the master program on 'Climate Change and Water Management' in their educational curricula. The program aims to prepare highly qualified specialists for the analysis and assessment of climate change and integrated water resources management.
- In 2015, the 'My Climate' Project was organized by the National Trust EcoFund with the support of the German Ministry of Environment, Water, Nature Conservation, Building, and Nuclear Safety. The project aimed to improve the public awareness in relation to climate change issues.

2.8. Bulgarian Sector-Specific Ongoing and Foreseen CCA (related) Actions

120. **An area that needs immediate attention is water management and the development of good irrigation practices.** Climate adaptation should be aimed not only at supporting existing tools and practices but also at promoting sustainable use of natural resources and arable land and reducing the vulnerability of the agricultural crops and any other negative climate change impacts that may lead to decrease in crop yields, loss of profits, and loss of competitiveness.

121. **Effective climate change adaptation requires financial and social efforts from the private sector, NGOs, government, and local communities.** Farmers usually have limited resources and they are insured at low premium, which does not cover the losses for climate change extreme events. Therefore, the farmers need investments to ensure they can cover the costs of adapting to climate change and appropriate risk management tools.

122. **Adaptation actions need to target eco-innovations and the development and introduction of more selective fishing equipment, facilities, and resource-efficient technologies.** The changes in the fisheries and aquaculture sectors caused by climate change will require enhanced adaptability and flexibility in fisheries and aquaculture policies to be able to respond effectively and adequately to climate change. There is a need for further research on and better understanding of climate change impacts on freshwater fisheries. The collection and analysis of technical, biological, and socioeconomic data in the fisheries sector is essential for

[45] Project description available at http://07-13.ipacbc-bgrs.eu/upload/docs/2015-01/2_51.pdf

the conservation and management of living aquatic resources. Data collection will support the scientific assessment of fishing fleet segments, fish stocks and the environmental impact on the marine ecosystem and marine biodiversity. The uncertainty associated with the interactions between climate change and fisheries and aquaculture in the long term require further research and studies to enable policy makers to develop and implement CCA strategies in these specific fields.

2.9. Gaps and Barriers Hindering Adequate Response in CCA Action; Interface with Climate Change Mitigation

123. **CCA actions should focus on improving the existing institutional capacity and enhancing knowledge management practices.** Based on the information provided in the previous sub-chapters, the following gaps and barriers that hinder an adequate response to CCA have been identified (the list is not exhaustive):

- *There is a high general lack of awareness and understanding of the climate change impacts on agriculture, fishery and aquaculture, and CCA*
- *Farmers and fishermen do not receive sufficient information about climate change and are not well prepared to take measures to adapt to climate change. This leads to limited direct involvement of interested stakeholders, including farmers and fishermen*
- *As agricultural extension services are missing, there are insufficient specialized trainings and knowledge-sharing activities related to CCA for farmers. Thus, there is also no formal partnership between the government, the scientific and research institutes, universities, business community, and citizens*
- *There are no specific courses focusing solely on CCA; the climate change subject has recently been included in bachelor- and master-level degrees and programs, but it is rarely an independent and separate subject taught at universities*
- *There is no dedicated Bulgarian CCA website or platform allowing up-to-date information and sharing of best practices at the national level; currently, the information published on CCA is generic, spread across numerous documents, or not publicly available and therefore difficult to access*
- *Some scientific studies and research are available, although they only represent a partial picture of climate change impacts and the need for adaptation; the results of the studies and scientific articles are usually published in specialized journals that are not widely available to farmers and other interested stakeholders;*
- *There is a high disparity between the involvement of central, regional, local agencies and governmental structures, which leads to the exclusion or limited attention to climate change policies and CCA priorities at the local and regional level*
- *A dedicated Bulgarian long-term vision strategy for agriculture is long called for*
- *A more unified and systematic basis for collecting and processing information and data is required: at present, the available information is divided between numerous directorates, agencies (NAFA, Bulgarian Food Safety Agency, Customs Agency, NSI, and so on). This prevents the development of a systematic and sector-specific analysis*

over a long period and therefore hinders the development of a reliable prognosis and conclusions for the sector development

- *There is insufficient monitoring and reporting for ecosystem conditions of the species in the Black Sea, Danube River, rivers in general and inland water*
- *Sustainable fisheries management at the national level aiming at reducing vulnerability and impacts of climate change is necessary*
- *There is a need for improved policy coherence and coordination of CCA initiatives in fisheries and aquaculture at all levels including, for example, the establishment of a working group on climate change and disasters in fisheries and aquaculture*
- *Periodic updates and revisions of the legal framework should target the inclusion of CCA measures where appropriate; the institutional arrangements for CCA should be improved by allocating clear responsibilities and mandates to different entities and avoiding the fragmentation of policies and slow decision-making processes.*

2.10. Conclusions

124. Successful adaptation to climate change is dependent on the development of sound legal and institutional frameworks and policies, informed by in-depth knowledge of the consequences of climate impacts. This chapter presents a review of the legal and institutional framework in the agriculture sector regarding climate change adaptation, both at EU and national level. Best practices of CCA initiatives in the agriculture sector in seven other EU Member States have been showcased. Relevant stakeholders in the sector (both at policy and executive level) were highlighted and their main duties and authority related to CCA presented.

Chapter 3. Adaptation Options

3.1. Identified Adaptation Options

125. **Adaptation actions need to be undertaken at both the national and farm level.** The responsibility of developing sectoral climate change policies and drafting guidelines and other regulatory documents should be undertaken by the MAFF in collaboration with all other relevant ministries, government organizations, and main stakeholders. At the same time, the policy should be consistent with EU and international policies and commitments. Local authorities, business companies, and society as a whole should also have a role to play. For example, further listed below, some adaptation actions (such as introducing innovations in the farms, growing new plants adaptive to climate change) would require the direct participation of agricultural holders and farmers.

126. **Adaptation options have been identified and grouped into 'horizontal' and 'vertical' levels.** 'Vertical' adaptation options are grouped into (1) adaptation options for agricultural productivity (crops); (2) adaptation options for livestock; and (3) adaptation options for natural resources (soil erosion and desertification, water shortage and irrigation, fisheries and aquaculture). 'Horizontal' adaptation options are further grouped into: (1) building adaptive capacity; (2) improving awareness; (3) strengthening research, technology development and innovation; and (4) risk management and legal framework (see ***Figure 1***).

127. **An initial prioritization exercise of adaptation options, using MCA, has been conducted among invited stakeholders.** The initial results indicate that the development of water management innovations and improvement of water management practices are top priorities, together with increased research development, trainings on climate change and active engagement in the wider dissemination of CCA knowledge to local farmers. The development of insurance and risk management programs has also been identified as a top priority.

3.1.1. Options for agricultural productivity

128. Several options for improving agricultural productivity have been identified. In response to agrophenology, adjusting the timing of farm operations, such as planting or sowing dates and treatments, would be important. Another important option would be increasing the thermal resources and exploring opportunities to grow more thermophilic crops within the country. Maintaining crop yields and productivity could be achieved by developing suitable irrigation systems. Climate-adapted crops should be developed, through agricultural research and experimental production aiming at optimal crop selection and development of varieties best suited and more resistant to new conditions of temperature and humidity. Better management of existing woodland, hedgerows, woody buffer strips, and trees on agricultural land is also needed, to optimize benefits providing shelter to both livestock and crops. Lastly, improving the pest and disease control could be achieved through better monitoring, diversified crop rotations, or integrated pest management.

Table 7. Adaptation options for agricultural productivity

CLIMATE CHANGE ADAPTATION OPTIONS – 'Vertical'
I. Options for agricultural productivity
1. Adjust the timing of farm operations
2. Grow thermophilic crops within the country
3. Develop suitable irrigation systems
4. Develop climate-adapted crops
5. Better manage existing woodland, hedgerows, woody buffer strips, and trees on agricultural land
6. Improve pest and disease control

3.1.2. Options for livestock

129. The identified adaptation options for livestock vary from the development of systems and mechanisms for storing water on farms, securing independent water sources and rationalizing water use to adapting farms and facilities to the changing environment by supporting the alternative energy resources and agricultural biogas facilities situated in farms. Additional options include the improvement of ventilation and cooling systems in animal housing and introduction of technologies for effective and efficient isolation and maintenance of temperature regimes; the diversification of livestock farming by introducing more heat-tolerant livestock breeds and adapting diet patterns of animals under heat stress conditions; and saving existing pastures for grazing, as well as improving the current practices for grassland management, encouraging restoration of degraded land.

Table 8. Adaptation options for livestock

CLIMATE CHANGE ADAPTATION OPTIONS – 'Vertical'
II. Options for livestock
7. Develop systems and mechanisms for storing water on farms
8. Adapt farms and facilities by using alternative energy resources and agricultural biogas facilities
9. Improve ventilation and cooling systems in animal housing
10. Diversify livestock farming
11. Save and improve existing pastures for grazing

3.1.3. Options for natural resources

130. Several adaptation options for natural resources have been identified. With regard to soil, one adaption option would be to increase the use of perennial crops that are more resistant to climate extremes. The erosive power of rain can be reduced if the soil surface is covered by a crop, stubble or mulch, as these act to dissipate the energy of the raindrop before it hits the soil. Another adaptation option for soil refers to ensuring a protective cover for the soil surface or plant residues in the periods of high rainfall (especially in the autumn-winter season) and wind erosion. Similarly, improving the soil structure maintenance and restoration and increasing the soil's infiltration capacity, as well as increasing the soil's organic matter reserves are important adaptation options. Soil cultivation machines and technologies with minimum pressure on the soil surface should be used. The plant residues from agrarian plant rotation

should be used for ploughing, briquetting, burning in special furnaces as a raw material for various industries, and so on, instead of burning them directly on the field. Water management practices should be improved by implementing management practices to ensure the effective use of water (reducing water losses), improving irrigation practices and efficiency, and recycling or storing water. Secondary salinization conditions should be eliminated, such as irrigation by highly mineralized groundwater sources, naturally or anthropogenically induced deterioration of drainage in intensively irrigated areas; disadvantageous and unsuitable structure of arable land given respective conditions of the soil and hydro-melioration infrastructure. Conditions for anthropogenic soil acidification should also be eliminated (surface over-moisturization, unbalanced mineral fertilization). Soil management should be improved by increasing the water retention to conserve soil moisture. Finally, aquaculture habitats and the fish access to spawning should be maintained and improved, while new habitats should be created in deep pools, lakes and basins.

Table 9. Adaptation options for natural resources

CLIMATE CHANGE ADAPTATION OPTIONS – 'Vertical'
III. Options for natural resources (soil erosion and desertification; water shortage and irrigation; fisheries and aquaculture)
12. Increase the use of perennial crops
13. Ensure a protective cover for the soil surface or plant residues
14. Improve the soil structure maintenance and restoration and increase the soil's infiltration capacity
15. Increase the soil's organic matter reserves
16. Use soil cultivation machines and technologies
17. Use plant residues from agrarian plant rotation as raw material for various industries
18. Improve water management practices
19. Eliminate secondary salinization conditions
20. Eliminate conditions for anthropogenic soil acidification
21. Improve soil management by increasing water retention
22. Maintain and improve existing aquaculture habitats

3.1.4 Options for building adaptive capacity

131. Building adaptive capacity could be achieved through a variety of options. First, climate change training for the administrative staff in governmental institutions should be developed (topics may include: identifying and evaluating climate risks; identifying climate change methods for preventing and reducing its negative consequences for the residents of communities, for the aquaculture, and so on). Further on, knowledge dissemination actions should be developed (organize seminars, discussions with stakeholders, create councils for monitoring CCA actions) and stakeholders should be trained (training and technological advice taking into account aspects of adapting agricultural production to the increased climate risks and preventing climate change). The introduction of subsidies, grants, and other financial programs to encourage the use of any new/good systems and practices for dealing with CCA is recommended. Coordination among responsible governmental and public institutions (MoEW,

MAFF, and other agencies) should be improved and the involvement of municipalities, regional, and sectoral administrations should be encouraged (and ensure CCA is integrated into their policies). For aquaculture, the knowledge of administration staff and stakeholders in relation to vulnerabilities of inland water species should be improved, to prevent bio-physical environment, and understand hydro- and morphology pressure on rivers and dams related to the decrease of the water levels and drought effects.

132. Most critical in ensuring the long-term success of climate adaptation initiatives, plans and actions is the development and improvement of a monitoring and evaluation (M&E) system and M&E indicators. Monitoring and reporting on the progress of implementation of the CCA options should be carried out through periodical monitoring reports based on monitoring indicators that would track and assess the relevance and efficiency of adaption actions.

Table 10. Adaptation options for building adaptive capacity

CLIMATE CHANGE ADAPTATION OPTIONS – 'Horizontal'
IV. Building adaptive capacity
23. Develop climate change trainings for the administrative staff in governmental institutions
24. Develop knowledge dissemination actions and train stakeholders
25. Introduce subsidies, grants, and other financial programs for dealing with CCA
26. Improve coordination among responsible governmental and public institutions
27. Improve the system of managing reserves of food and seed material in case of crop failures
28. Improve the knowledge of the administrative staff and stakeholders in relation to vulnerabilities of inland water species
29. Develop and improve of a monitoring and evaluation (M&E) system

3.1.5. Options for improving awareness

133. The options for improving awareness on climate change adaptation are diverse. One important option is to develop a national database (online portal) containing CCA-specific information, for raising public awareness and engaging community knowledge-sharing. Bulgaria should also engage in wider dissemination of CCA knowledge to reach local farmers; including publication of guidelines (improving the dissemination of applied research to the farm level should increase the resilience of the agriculture sector to future climate uncertainty, as well as improve agricultural efficiency overall). Information could also be disseminated through newsletters, brochures, risk maps, workshops, and so on. Climate change education in schools' and universities' curricula should be introduced. This would not only assist in raising public awareness, but also more people would be interested to contribute and participate in CCA. With regards to aquaculture, establishing a formal platform for aquaculture is recommended, where scientists and all relevant stakeholders (including but not limited to fishermen, seafood industry, seafood preparers, and consumers organizations) can discuss issues and policies related to development and conservation of aquatic resources. Finally, enhanced ecosystem observation systems should be developed, as well as research on ecosystem accounting and valuation, analysis of species, and identification and protection of vulnerable fish species, including expanding protected areas.

Table 11. Adaptation options for improving awareness

CLIMATE CHANGE ADAPTATION OPTIONS – 'Horizontal'
V. Improving awareness
30. Develop a national database (online portal) containing CCA-specific information
31. Engage in wider dissemination of CCA knowledge to reach local farmers, including publication of guidelines
32. Introduce climate change education in schools' and universities' curricula
33. Establish a formal platform for aquaculture for scientists and all relevant stakeholders
34. Develop enhanced ecosystem observation systems

3.1.6. Options for strengthening research, technology development, and innovation

134. A wide-array of adaptation options have been identified for strengthening research, technology development, and innovation. Research needs to be developed, such as research on new crop varieties, including hybrids, to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions. Additional sectoral studies to identify the nature of climate risks, vulnerabilities and opportunities associated with current climate and projected changes should also be developed. Farm-level resource management innovations need to be developed, to address the risk associated with changing temperature, moisture and other relevant climatic conditions. The use of alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies should be optimized, including crop-rotation. Water management innovations and irrigation practices to address the moisture deficiencies associated with climate change and reduce the risk of income loss due to recurring drought should be implemented (supporting building up irrigation infrastructure, mechanical innovations in farms such as the development of integrated drainage systems, land contouring, reservoirs and recharge areas, and alternative tillage systems).

135. The use of renewable energy generation should be increased: the introduction of bioenergy supply and production systems, improved manure management through capture and conversion to biogas, and the placement of wind and solar-photo voltaic infrastructure can all help to introduce low-carbon energy supply to society and, through decentralized power generation, increase resilience of current generating capacity in rural areas.

136. For aquaculture, the technologies for cultivation of fish and aquaculture in inland water should be improved, developing artificial breeding of the fish, using selective breeding, and implementing genetic improvements for higher resistance. Recirculating systems for fish breeding and integrated production technologies should be developed (cultivation of fish or other hydrobionates together with plants). Integrated production technologies are a very ecological way of cultivating fish, as the water from the fishery passes through the plants, which use a significant part of the nutrients, and then goes back to the fish.

137. Developing and improving climate information systems is recommended, including early warning systems that provide daily weather predictions and seasonal forecasts. Weather predictions over days or weeks have relevance to the timing of operations such as planting, spraying and harvesting. At the same time, information on longer-term climate change can inform farmers about future variability and the probability of extreme events. Early warning

and risk management systems could also include an historical climate data archive, an archive on climate impacts on agriculture, and using systematic meteorological observations. The prerequisite for a climate information system is the development of agro-meteorology stations, which provide daily information about temperature, precipitation, wind, soil humidity, and other agro-climate indicators related to the cultivation process.

138. Further studies and research on how climate change impacts livestock should be carried out, with the support of the Government and MAFF (including research and development on alternative livestock nutrition patterns, their general well-being and new diseases resulting from climate change). Additional research to better understand the interaction between climate change and fisheries and aquaculture is needed; this will also help policy-makers by providing insights into what adaptive strategies and policies would be most suited. Further aquaculture research is also required on issues such as new diseases and preventive treatments, aquatic animal physiology, the search for new and better adapted species, better feeds and feeding practices that are more ecosystem friendly. Finally, the systems for aquaculture observation and monitoring to improve the management and science of fish migration and timing of species life cycle should be enhanced.

Table 12. Adaptation options for research, technology development, and innovation

CLIMATE CHANGE ADAPTATION OPTIONS – 'Horizontal'
VI. Strengthening research, technology development, and innovation
35. Develop research on new crop varieties
36. Develop farm-level resource management innovations
37. Conduct research development
38. Optimize the use of alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies
39. Increase the use of renewable energy generation
40. Develop water management innovations
41. Improve the technologies for cultivation of fish and aquaculture in inland water
42. Develop recirculating systems for fish breeding and integrated production technologies
43. Develop climate information systems
44. Carry out further studies and research on how climate change impacts livestock with the support of the Government and MAFF
45. Carry out further research to better understand the interaction between climate change and fisheries and aquaculture
46. Enhance the systems for aquaculture observation and monitoring

3.1.7. Options for risk management and legal framework

139. Several adaptation options for risk management and legal framework have been identified. The existing CCA legislation should be updated to include climate change impact policies and/or adaptation actions. The legislation affecting inland fisheries and aquaculture should be updated and amended to set out appropriate framework conditions for CCA and how these framework conditions are applied in the best possible way for aquaculture in inland

waters. Cross-sectoral policy frameworks should be created, such as those for cultivation of fish in basins and cage fisheries farms.

140. Insurance and risk management programs should be developed (management strategies with respect to climate loss of crop yields and subsidized crop insurance program), as well as programs to invest in crop shares and futures to reduce the risks of climate-related income loss, and income stabilization programs. Economic incentive mechanisms are necessary, such as, for example, awards for resource users and fishermen who have put in place improved practices and sustainable use of existing resources. Finally, adequate funding through schemes should be provided to meet the fishermen's capital needs for adaptation options for fisheries and aquaculture.

Table 13. Adaptation options for risk management and legal framework

CLIMATE CHANGE ADAPTATION OPTIONS – 'Horizontal'
VII. Risk management and legal framework
47. Improve the CCA legal framework
48. Develop insurance and risk management programs
49. Update and amend the legislation affecting inland fisheries and aquaculture to set out appropriate framework conditions for CCA
50. Create cross-sectoral policy frameworks such as those for cultivation of fish in basins and cage fisheries farms
51. Create economic incentive mechanisms
52. Provide adequate funding through schemes to meet the fishermen's capital needs for adaptation options for fisheries and aquaculture

3.2. Experience with Selecting Adaptation Options in the Sector in Other EU Countries

141. Based on national adaptation planning in other country contexts, several common features emerge with respect to the selection of adaptation options. A thorough risk assessment is an important first step in the national adaptation planning process. A good understanding of the nature and possible future severity of climate change risks and opportunities is necessary at the initial stage. For instance, in the United Kingdom, one of the major research contributions underpinning the National Adaptation Program (NAP) (2013) was the U.K. Climate Change Risk Assessment. The sequence of research and publications that preceded the final U.K. National Adaptation Plan is outlined in ***Box 5***.

Box 5. Learning from International Best Practice: Sequence of Research and Publications in the United Kingdom Leading to the NAP, Highlighting the Importance of a Robust Risk Assessment as a Starting Point

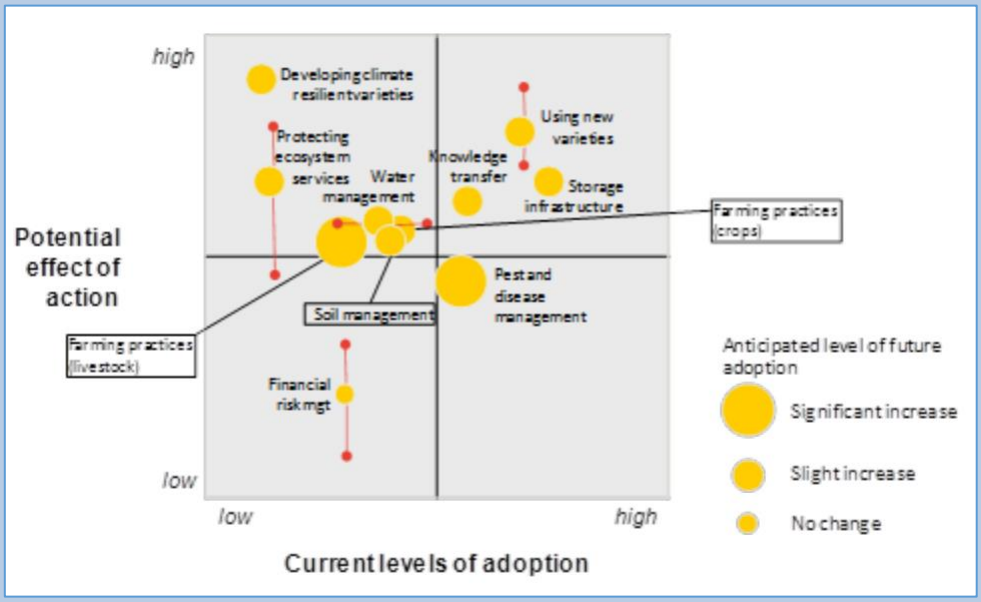
UK Climate Change Risk Assessment (Defra 2012): The first U.K. Climate Change Risk Assessment was published in 2012. It provides a comprehensive inventory and analysis of the climate risks and opportunities facing 11 key sectors, including agriculture, with an indication of their potential magnitude and significance. Attempts were made to express the size of individual risks in monetary terms (cost per year), where possible; however, due to a lack of available data it was sometimes necessary to use alternative costs (repair or adaption) to

provide estimates. This allowed for an initial comparison of the relative importance of different risks within and between sectors.

Adaptive Capacity Report (Ballard et al. 2012): The Adaptive Capacity Report takes impacts and risks derived from the Climate Change Risk Assessment and assesses whether the capacity to adapt is already in place, or is being developed in a sufficiently timely manner, for it to be realistic for policymakers to plan on the basis that the risks are likely to be managed. The Adaptive Capacity Report distinguishes between two aspects of adaptive capacity, namely structural adaptive capacity and organizational adaptive capacity.

Economics of Climate Resilience (Defra 2013): The Economics of Climate Resilience explored the drivers of behavior that hinder or promote the adoption of adaptation actions, by identifying and assessing market failures and other barriers to effective adaptation action. For each group of actions identified, the Economics of Climate Resilience provides a summary figure with details of the current and anticipated uptake of adaptation actions and associated effectiveness (an example is shown in ***Figure 27***).

Figure 27. Current and Anticipated Uptake of Adaptation and Effectiveness for the Agriculture Sector in the United Kingdom



Source: Defra 2013.

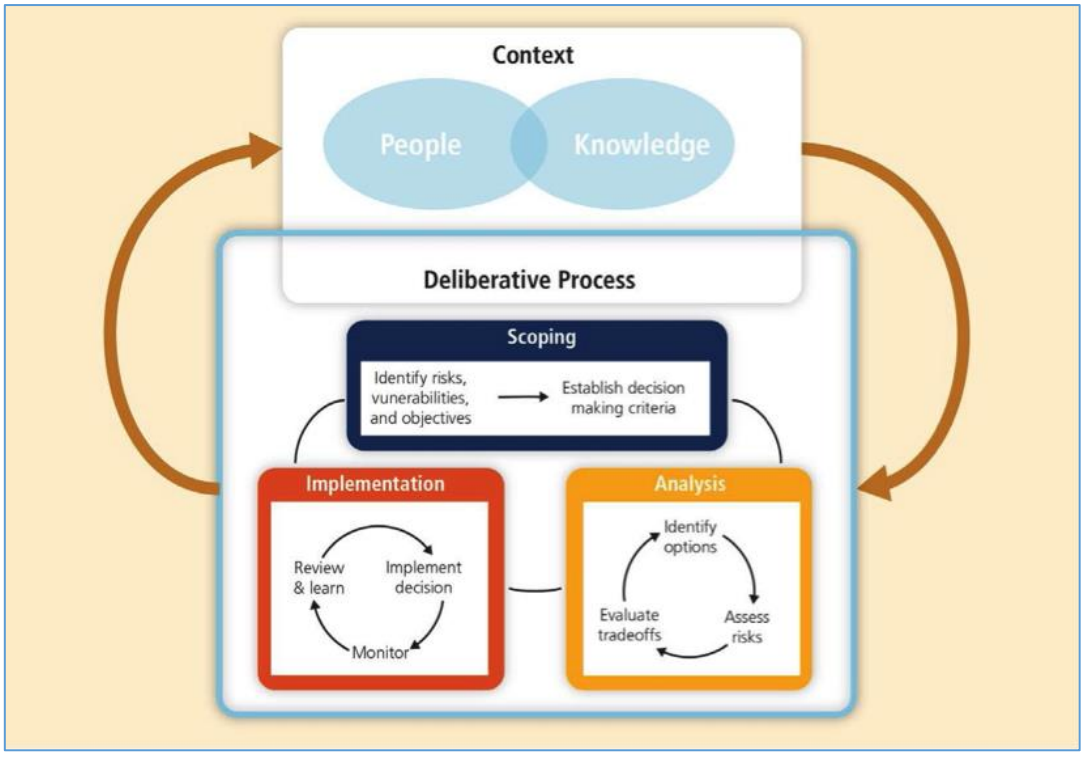
NAP (2013) (HM Government 2013): In selecting the FAs, the National Adaptation Plan was guided by the magnitude, confidence, and urgency scores assigned during the analysis underpinning the CCRA. This placed the spotlight on those risks needing urgent attention due to confident expectation of high magnitude impacts or long planning horizons, for example, large infrastructure projects. Then working in partnership with businesses, local government and other organizations, objectives, policies, and proposals were developed to address the highest magnitude risks.

142. **Priority is given to actions that address existing vulnerabilities.** It is widely proposed that the immediate imperative is to address climate variability (that is, extreme weather events) in its present form as part of the continuum of change. As such, emphasis should be placed on impacts to which individual sectors are already susceptible, while also considering how these impacts may change over time by incorporating future climate projections. Developing resilience to climate variability is a step toward adapting to climate change. The

process of understanding and developing resilience in the face of extreme weather events can help stakeholders develop a clearer understanding of adaptation needs and how to implement adaptation responses.

143. **Adaptation planning needs to be a cyclical and iterative process.** In line with international best practice (for example, IPCC 2014; see ***Figure 28***) adaptation is a continuous process, involving review, revision and redefinition. The IPCC framework, in ***Figure 28***, depicts the assessment process and indicates multiple feedbacks within the system and extending to the overall context. This cyclical approach promotes robust decision-making in the face of uncertainty, by enabling decisions to be revisited in the light of new information, for instance, the level of potential climate change impacts and associated risks. This is reflected in the cyclical publishing of the U.K. Climate Change Risk Assessment every five years. The U.K. National Adaptation Plan also recognizes that the program will inevitably evolve as knowledge grows, allowing reevaluation of policy based on the underlying evidence.

Figure 28. Framework Promoted by the IPCC, Showing the Iterative Nature of Risk Management



Source: IPCC 2014.

144. **Awareness actions feature throughout adaptation best practice.** Raising awareness about climate risks, adaptation options, and on how good climate risk management can save money, is a crucial first step in adaptation planning. Greater levels of awareness will help advance the capacity and skills in delivery teams and facilitate improved coordination, which is particularly important when dealing with complex, cross-sectoral, and national-scale impacts and trade-offs.

145. **Knowledge gaps still exist and addressing these is an important adaptation priority.** It is impractical to assume that all uncertainties associated with current and future climate risks, and the management options available, can be removed. Nevertheless, targeted

research can help reduce the uncertainties. However, it is also important to recognize that evidence gaps should not prevent action on adaptation. Understanding where the evidence gaps and deficiencies in assessment methods lie will help identify appropriate robust strategies that take full account of the uncertainties in risk.

3.3. Adaptation Options Assessed

3.3.1. Time

146. Adaptation is a long-term process, comprising various stages and approaches for implementation, and priority actions for Bulgaria's agriculture sector need to be identified. Some adaptation options identified will need to be fast-tracked and implemented in the short-term and middle term, and others in the long term. Even in areas of high vulnerability, not all adaptation measures have to start at once; some measures can be implemented at short notice, whereas others require long-term planning and preparation. The flexibility of the planned adaptive actions could be achieved through regular monitoring and interim evaluation.

3.3.2. Budget

147. **The budget is a key element for carrying out the climate change policy and adaptation measures in the agriculture sector.** The financial allocation for adaptive measures and distribution of resources among the priority actions will be based on the need assessment and economic and financial analysis. The main sources for financing adaptive actions are national (state budget), EU (grants, subsidies of the current and future CAP instruments), and private funding from financial institutions (bank credits, risk management instruments, and specialized preference financial instruments such as a credit guarantee scheme absorbing private and state funding). The Rural Development Program provides a framework to help encourage adaptation in the agricultural sector. Agri-environmental and climatic schemes have the potential to offer support for many adaptation options.

3.3.3. Cost-benefit analysis

148. Benefits for adaptation actions in the agriculture sector can be viewed temporally, as either offering short-term or long-term benefits. Actions that offer short-term benefits are those that improve resilience to extreme events or those that improve the enabling environment and governance framework to facilitate more effective adaptation in the future (for example mainstreaming climate change within sector policies and plans and building institutional capacity and knowledge networks). Actions offering longer-term benefits are linked to agricultural assets, which frequently have long life spans, and include amendments to existing or planned assets to ensure climate resilience (for instance, improved water management and renovating the irrigation infrastructure, leading to efficient use of irrigation water and conservation of soil moisture).

149. **Benefits can also be viewed in terms of the wider socioeconomic or environmental benefits they offer.** For instance, developing better and improved early warning systems would contribute to farmers being able to foresee the costs for protecting agricultural products as well as to respond in an efficient manner to unfavorable climatic events, thus reducing the loss of crops and livestock due to droughts, floods, or other weather extreme event. Saving costs helps stabilize the income and revenues for farmers.

150. The CBA for the sector (explained in more detail in ***Annex 3*** to this Appendix) focuses on the assessment of soft adaptation measures. The benefits gained as a result of their implementation are best exemplified through the quantification of saved costs in main performance indicators (crop output; crop yield; livestock production; agriculture industry output; and others). Considering the complex impact of the adaptation options on the agriculture sector, these were not separately quantified in the current CBA. The net present value (NPV) in the table below illustrates the monetary value of avoided losses because of implemented adaptation measures, while the cost effectiveness quantifies the benefits achieved in relation to the required investments/costs.[46]

Table 14. Benefits of adaptation measures in the Agriculture sector under different climate scenarios until 2050 (in €, million)

Climate scenarios	NPV (€ million)	Cost-effectiveness (Benefit/Cost ratio)
Realistic scenario +2°C	1.66	1.02
Optimistic scenario +2°C	26.34	1.26
Pessimistic scenario +2°C	-23.01	0.77
Realistic scenario +4°C	291.87	3.92
Optimistic scenario +4°C	385.53	4.85
Pessimistic scenario +4°C	198.22	2.98

151. The projection shows that on average, under the +2°C realistic scenario, the total cash flow in NPV is €1.7 million, and €291.9 million under the realistic scenario at +4°C. Under the optimistic scenario, the projected cash flow in NPV is €26.3 million under the +2°C scenario and €385.5 million under the +4°C scenario. Even under the pessimistic scenario, the future cash flow in NPV is projected at minus €23.0 million at +2°C and €198.2 million at +4°C.

152. As presented in ***Table 14***, a higher NPV for the agriculture sector under all +4°C temperature rise scenarios (realistic, optimistic, and pessimistic) is calculated. The results indicate that only under the +2°C pessimistic scenario, soft adaptation measures are inefficient (the NPV is negative with a total cash flow until 2050 of minus €23 million). This indicates that the implementation of measures would not lead to achieving positive effects under this scenario.

153. In all other scenarios, where adaptation measures are applied, the NPV is positive, showing that investment until 2050 is economically efficient.

154. Within the current analysis, the cost-effectiveness of the adaptation measures is used to quantify the effect of investments under each scenario.[47] Under the +2°C realistic scenario, the benefit/cost ratio is €1.02 (that is, the benefits achieved per Euro spent), and €3.92 under the +4°C realistic scenario. The benefit is higher at +4°C temperature rise. In that case, the

[46] The NPV of an adaptation option is given by the present value of the estimated benefits and costs. If NPV is more than zero, this indicates that the investment is efficient and incremental benefits of adaptation exceed the incremental resource costs. If NPV is <0 or B/C is <1, then the adaptation measures add no net benefit to the Urban Environment sector. If NPV is >0 or B/C is >1, then it adds positive benefits. The positive value of NPV confirms that investments for adaptation are efficient.
The benefit-cost ratio (B/C) is the ratio of the present value of benefits to the present value of costs. When the B/C ratio is more than one, the present value of the option's benefits is larger than the present value of its costs.

[47] The cost-effectiveness refers to all measures.

benefit is €4.85 per one Euro of investment under the optimistic scenario and €2.98 per one Euro of investment under the pessimistic scenario.

155. The NPV calculation shows that investments in adaptation measures are economically efficient. Investment in agriculture through implementation of adaptation measures will have a positive impact on the sector.

3.3.4. Efforts

156. **The implementation of the proposed adaptation options in the agriculture sector will require considerable effort**, time, and resources as many of them would need to be implemented simultaneously and in the short term. Efforts in relation to CCA can be divided among the roles and responsibilities of the public institutions and stakeholders.

3.3.5. Indicators for measurement

157. Indicators should be used for monitoring and assessing the implementation progress of the adaption options/measures in agriculture. Adaptation planning is an iterative process. A key part of a good M&E system is to have quantifiable indicators that are Specific, Measurable, Achievable, Realistic, and Timely (SMART). Determining reasonable indicators for climate change projects is not an easy exercise because of the long-term horizon of certain adaptation measures and of the uncertainty associated with climate change impacts. Additionally, defining realistic indicators for a CCA policy and measures requires the availability of reliable information. ***Box 6*** highlights the criteria for reviewing indicators.

Box 6. Criteria for Reviewing Indicators

- Policy relevant: the indicators shall be policy relevant, especially toward the strategy target and options
- Showcase progress toward target: the indicator shall show progress toward the 2030 target
- Broad acceptance and easy to understand. The indicator shall be easy to understand and to document
- Affordable monitoring, available and routinely collected data also ensure that the indicator can be updated regularly;
- Affordable modelling: information on cause-effect relationships should be achievable and quantifiable
- Flexibility. The indicators should not only be able to detect changes in systems and in time frames that are relevant to the decisions, but also be robust so that measuring errors do not affect the interpretation
- Utility. The collected information need to be useful and relevant for adaptive option implementation and management
- Scale and representativeness. The set of indicators needs to apply to sectoral level and be representative for the implementation measures in agriculture

158. A few groups of general indicators are presented in ***Annex 10***. The indicators are indicative and do not include specific indicators for soil matter, GHG emission, and other specific bio-physical variables, water availability, humidity, and precipitation climatic variables. Next steps should include defining the indicators in a more specific manner.

3.3.6. Institutional arrangements

159. The institutions and the main stakeholders involved in CCA are described in detail in Chapter 3, sub-chapter 3.5. The Ministry of Environment and Water (MoEW) plays the leading role in protecting the environment and setting the national climate change policies, as well as coordinating such polices with the EU and other international forums, while the MAFF, through its agencies and directorates, is responsible for the sustainable development in the agriculture and aquaculture sectors, developing sectoral policies and implementing plans for adaptive measures in these sectors. The MAFF should undertake actions toward raising public awareness and capacity building. CCA may require increasing capacity and setting up of a new unit at the ministry with responsibilities to develop sectoral climate adaption policy, coordinating with other governmental institutions and main stakeholders, and monitoring climate adaptation measures. At the local level, municipalities should include CCA into local strategic documents and programs, such as municipal development plans, urban plans, and programs for environment protection.

3.3.7. Consequences of no action/maladaptation

160. **Extreme weather events will considerably increase the risk of crop failure and increase agricultural losses.** Delaying actions for CCA will therefore put pressure on agriculture output and crop productivity, leading to low financial viability of the agricultural producers. Climate change extreme events will also continue to affect soil by depleting organic matter – a major contributor to soil fertility. The changes in the quality and availability of water resources, will also affect the agriculture sector, including food production, leading to food shortages and negative impact on food security. This further translates into loss of income and it exacerbates poverty for vulnerable households.

3.4. Cross-Cutting Issues, Trade-Offs and Synergies of Adaptation Options

161. **Coordination and interaction between different sectors (interdependencies) is complex.** Climate change impacts and consequences affect different parts of the country in a different manner. Understanding the spatial distribution of climate change risks is important to develop appropriate and effective local adaptation strategies. To better understand and be able to respond adequately and on time, there should be a detailed and systematic mapping that identifies how particular risks create cascading impacts across different sectors. Moreover, climate change also affects people differently depending on their social, cultural and economic background. Those working predominantly in the agriculture sector as well as the elderly, low-income people are more likely to feel the effects of climate change.

162. **Climate change affects a wide variety of economic and social sectors.** Climate change encompasses issues related to water, air and soil quality; urban and rural development; land use; food security; agricultural production and human health. For example, a flood can cause direct damages to crops, roads for transportation, and buildings, which would contribute to the increase of food prices and would ultimately have effects on people's lives and well-being. Higher temperatures would cause stress on animals and would increase the need for more energy for cooling. Loss of biodiversity and changes in ecosystems have direct effects on crop and animal breeding and, therefore, the introduction of new more climate resilient crops and reductions in stress due to higher temperatures for animals would have positive effects for both

biodiversity and agriculture sectors. Pests and diseases pose a significant risk to agriculture, forestry, and biodiversity sectors. Soil degradation also has negative impacts on both agriculture and forestry. Coordinated actions are therefore needed to manage the threats of outbreaks and pests' infestations and to protect the farms, the woodlands and the wider natural world. Agriculture and urban development are increasingly being considered together. Producing certain crops (vegetables, fruit and herbs) in the city (for example, on rooftop gardens) would reduce production and transportation costs because certain foods would be produced closer to the consumer and, at the same time, the introduction of such green spaces would contribute to making the cities greener and healthier by capturing dust and reducing the CO_2 emissions. Growing own fresh food alleviates household expenditures on food and reduces energy spent in transport, cooling, processing and packaging. Sustainable management of fisheries is essential for ensuring long-term viability of the sector, which supports healthy ecosystems. Fisheries is also closely related to tourism and recreational activities linked to water and fishing (including angling, boating, visiting harbors, accompanying fishermen when they fish, and so on). Recreational fishing and fishing tourism provide additional jobs and income for local fishermen and areas with tradition in fishing.

163. **Adaptation needs to be integrated into existing plans and practices, accompanied by better coordination and cooperation among stakeholders.** Adaptation to climate change is a cross-cutting issue. CCA measures should be implemented as an integral part of current and planned initiatives and projects. Achieving effective adaptation requires the adoption of an integrated approach, which takes account of social, economic and environmental considerations. Adaptation activities are therefore necessary in a variety of sectors and involve a significant number of actors in various fields and departments. The participation of a wide range of stakeholders with expertise in the agriculture sector, including farmers, industry representatives, statutory bodies, and NGOs is crucial for the development of adaptation measures and implementing such measures. Action is needed at multiple levels and political, legal, and institutional settings need to be in place to manage the interdependencies. Some of the adaptation policies and plans will be needed at a national level while others need to be implemented at a regional or local level to be most effective. The central government in Bulgaria should focus on engaging local and regional agencies and encourage them to include CCA as a priority in their policy documents. A local response should be accompanied by a broader (national) support for capacity building, sharing of best practice, funding, and so on. The involvement of various actors and stakeholders may slow down the decision-making process, may lead to fragmentation of the adaptation actions, which may lead to lack of coordination, and ultimately may make the process of adaptation slow. Therefore, an appropriate system for coordination and cooperation needs to be in place.

164. **Promoting synergies between adaptation and mitigation in agriculture will ensure more effective and efficient policies.** For these purposes, it is necessary to establish a regime for systematic investigation into the synergy between adaptation and mitigation measures in agriculture. Some adaptation options for climate change have positive impacts on mitigation. Examples of measures that can contribute to both adaptation and mitigation include: (1) measures that reduce soil erosion and improving soil health; (2) measures for conserving soil moisture; and (3) improving and optimizing crop rotations by choices of species or varieties.

165. **Risk assessment and monitoring frameworks for adaptation should be established**. Adaptation is an on-going process and involves an on-going integration of options, costs, and risks in different parts of the country and over different periods of time. Goals and targets for adaptation must be flexible due to the inherent uncertainty and dynamics of climate change. The assessment of such impacts is very complex and prone to uncertainty. Research and dissemination of updated information is essential for filling any significant gaps as it helps to reduce uncertainty. Continuous research and monitoring of climate change risks and vulnerabilities would contribute to better understanding of climate change impacts and tracing any changes and developments. Furthermore, consistent monitoring on the implementation of adaptation measures, plans and related programs is necessary to ensure that the measures are efficient and effective. To help the monitoring on the progress of implementation, reports from the relevant stakeholders responsible for the implementation may be sought annually. The implementation of the measures needs to be reviewed and additional measures may be deemed necessary.

166. **Adaptation research and knowledge-sharing activities are vital for building capacity and enhancing skills**. Research, knowledge-sharing activities and communication of best practices are needed for promoting CCA. Dissemination activities and advisory services play a significant role in CCA because it can help individuals and farmers to better understand climate risks. Data and information should be comprehensible, easy to understand, and easy to access. Additional activities should include disseminating information of good practices (guidance), documenting case studies, establishing demonstration farms and sites to improve farmers' knowledge and skills in relation to climate adaptation.

Table 15. Matrix of interdependencies

Affecting →	AGRICULTURE SECTOR	
CC effect in… ↑ *(see below)*	**Positively**	**Negatively**
Biodiversity & Ecosystems	• Increase of 'green agriculture' subsidized by EU funds • Development and delivery of eco-system services • Preserved biodiversity and habitats	• Decline of useful insects • Increase of invasive species • Disturbed ecological balance
Energy	• Need for biomass as a fuel • Production of bio gas • Wind and solar farming	• Competition regarding water resources • Water pumping – higher electricity costs • Higher risk of electricity grid failure
Forestry	• Shelterbelts to attenuate climate effects • Erosion control • Use abandoned lands for afforestation	• Reduced availability of agricultural land for food production • Crop damage (wind, water run-off) • Intensity, frequency and magnitude of forest fires will increase

Affecting →	AGRICULTURE SECTOR	
CC effect in… ↑ *(see below)*	**Positively**	**Negatively**
	• Warmer climate would contribute to prolonged growing season for trees	
Human health	• Design food security systems • Increased demand for refreshing types of food products	• Workers health and productivity may decrease
Tourism	• New food types to be marketed • Development of farm tourism • Increase demand of food	• Competition regarding water resources
Transport	• Benefit of road network improvement will also positively impact the agriculture sector • Save cost of faster transport of supplies, crop and livestock products	• Accessibility of farm lands, storage – disturbance of transport lines • Poor irrigation systems can damage transport infrastructure, thus also harm access to agricultural areas • Increase of costs for transport
Urban environment	• Establish food reserves to mitigate food needs in times of disaster • Develop urban agriculture	• Cities and agriculture will compete for water resources • Urban areas become more fire sensitive (risks from agricultural burning practice)
Water	• Develop new crop species requiring less water	• Reduced availability of water and stress on crops and animals • Floods • Competition regarding resources regarding drinking water use

Note: The above Matrix of sectoral interdependencies reflects how climate change effects in one sector affect the Agriculture sector positively or negatively

3.5. Priority Setting Approach

167. **Prioritizing is necessary to better understand which areas need to be addressed urgently and provide a rationale for focusing the adaptation assessment on key issues.** Climate change is an urgent issue that requires immediate attention. Impacts on agriculture (both positive and negative) are of varying significance. Some areas require immediate action while others may require a more flexible approach and/or long-term actions. For example, short-term measures include changes in agronomic practices, such as changes in crop varieties and date of planting and harvesting, changes in the use of fertilizers and pesticides, and practices to conserve moisture in the soil. Most of these actions should be undertaken by farmers. Long-term measures include changes in land use, development of more robust crop types, substitution of crops, modification of microclimate and irrigation, and changes in farming systems for a geographical locality. These include both farmer participation but go beyond that. Moreover,

there are areas which require further evidence and information to determine whether more action is needed. A good example is the emergence of new pests and diseases, and invasive alien species that affect not only plants and animals, but also people.

168. **The prioritizing exercise should be based on defined criteria.** A wide range of possible adaptation actions and measures are available. To prioritize the implementation of the identified adaptation measures, a set of selection criteria should be applied. The following criteria could be taken into account for selecting adaptation measures and assessing their priority: (a) the urgency of the problem; (b) complexity of the solution; (c) feasibility measures (technical, political feasibility); (d) flexibility (can it be easily adjusted or reversed based on changing conditions); (e) cross-sectoral implications (for example water management, tourism, energy); (f) likely impacts (How significant is the measure in absolute terms? Is only a relatively small portion of the population and society affected, or a very large part? If this measure were not implemented, would the damage to society as a whole be large or rather small?); (g) side effects; (h) additional benefits; (i) economic viability (cost/benefit; potential cost for implementation as well as cost-effectiveness).

169. **Optimizing the allocation of resources should be based on the economic assessments of CCA options.** Adaptation to climate change requires investments. If there are limited resources, the following question arises: How much should be invested in which adaptation option(s) and at what time in order to create the highest benefit at reasonable costs and within the available budget? Decision-makers therefore face a basic economic problem: optimizing the allocation of resources. There are several techniques for the economic assessment of climate change (quantitative models). The three most popular methods are. (a) cost-benefit analysis, (b) cost-effectiveness analysis, and (c) multi-criteria analysis. All three approaches can analyze and prioritize adaptation options.

170. Identification of CCA options is an important step in the process of establishing resilience to climate change. However, it is not realistic to expect that all identified adaptation options can be implemented simultaneously. Therefore, adaptation options are normally scored to establish a priority order for their implementation. In the framework of this report we have, following EU guidance,[48] prioritized the adaptation options specifically identified for the agriculture sector.

171. In support of the priority setting a prioritization meeting was organized in Sofia in October 2017, inviting a variety of stakeholders from the sector. The meeting used a basic version of the multi-criteria analysis (MCA) approach. MCA is an approach, as well as a set of techniques, that aims at providing an overall ordering of options, ranging from the most preferred to the least preferred. It represents a way of looking at complex problems that are characterized by a mix of monetary and non-monetary objectives. MCA breaks down options into more manageable pieces by using a set of criteria. The two groups of criteria used for the analysis were those of 'Net Benefits', further broken down into economic, social, and environmental benefits, and 'Implementation Risks', further broken down into financial, social,

[48] http://climate-adapt.eea.europa.eu/knowledge/tools/adaptation-support-tool/step-4/prioritise-and-select

institutional, technical, and technological risks. This approach allows data and judgements to focus on the separate pieces that are then reassembled to present a coherent overall picture.

172. In carrying out the MCA (that is 'scoring the different adaptation options'), the meeting benefited from the presence of stakeholders with professional knowledge and experience in the sector. Nevertheless, this priority setting effort must be considered as indicative and tentative, for three main reasons. First, the effort was carried out at an early stage in the process of developing a strategic view and planning of sector specific CCA options. Second, not all those who were invited to the prioritization meeting used this invitation to attend. And third, a broader understanding of underlying information and notions on the side of the stakeholders would be beneficial to allow them to make more founded scores. Therefore, the current priority list only serves as a 'first feel' about the main direction of the actions to be taken first. At a later stage, further attention should be paid to the priority setting process, both for this sector and across all economic sectors that play a role in the planning of Bulgaria's CCA actions.

173. The main priority adaptation options that were tentatively and indicatively identified for the agriculture sector are listed below:

Horizontal adaptation options

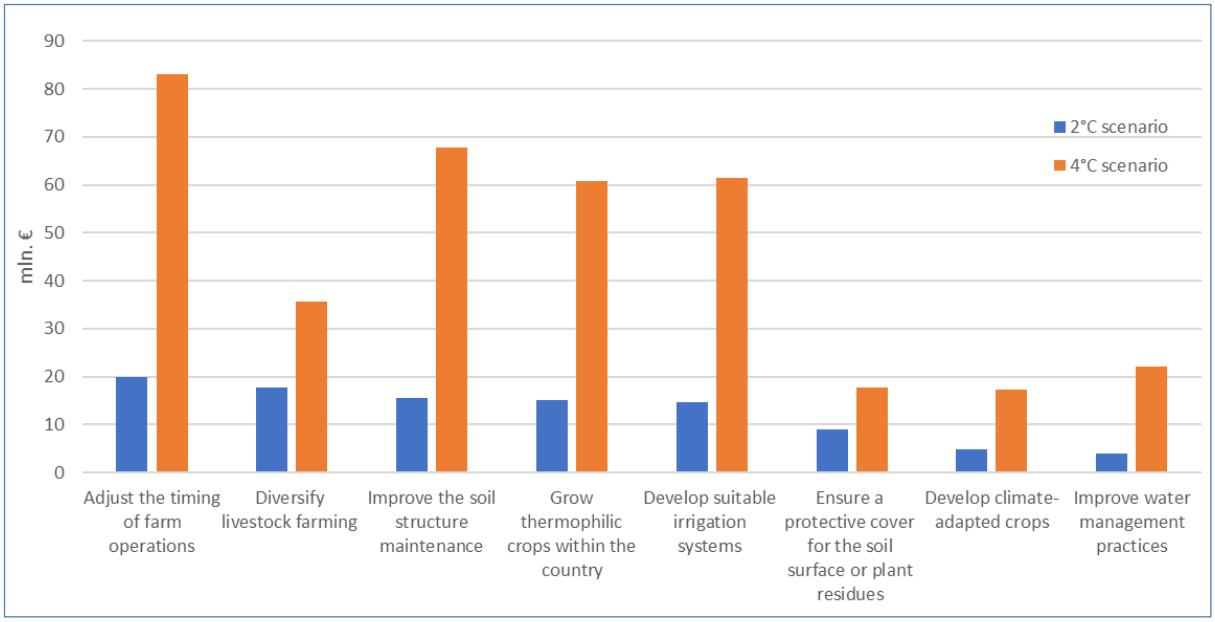
1) Develop climate change training
2) Develop knowledge dissemination actions
3) Develop insurance and risk management programs
4) Develop water management innovations
5) Improve the CCA legal framework

Vertical adaptation options

1) Improve water management practices
2) Adjust the timing of farm operations
3) Improve the soil structure maintenance and increase the soil's organic matter reserves and soil cultivation technologies
4) Eliminate secondary salinization conditions and conditions for anthropogenic soil acidification
5) Maintain and improve existing aquaculture habitats

174. Based on the CBA, the most economically efficient adaptation actions were ranked in terms of their economic efficiency. The adaptation measures for which the benefit exceeds the cost can be ranked as follows: developing a suitable irrigation system, adjusting time farming operations, diversifying livestock farming, improving soil structure, improving water management practices, and others. The figure below shows the estimated contribution of selected adaptation measures in reaching the overall positive effects of climate change adaptation.

Figure 29. Prioritization of the adaptation measures in the Agriculture sector (total PV effect in € million)



175. The high benefits that can be achieved suggest that these adaptation measures are highly necessary in any climate change scenario, even if climatic impacts would be minimal.

3.6. Conclusions

176. Adaptation to climate change can be defined as the range of actions taken in response to changes in climatic conditions. These responses include autonomous adaptation, that is, actions taken by individual actors such as single farmers or agricultural organizations, as well as planned adaptation, that is, climate-specific infrastructure development, regulations and incentives put in place by regional, national and international policies to complement, enhance, and/or facilitate responses by farmers and organizations. The proposed adaptation options have been identified based on the assessment in chapters 1 and 2 and should help address climate risks and increase the resilience of the sector. Chapter 3 also looks at cross-cutting issues and concludes with identifying priority setting approaches for the adaptation options.

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Annex 1. Potential Climate Change Impacts on the Agriculture Sector in Bulgaria

Table 16. Potential Climate Change Impacts on the Agriculture Sector in Bulgaria

Affected Agriculture Sector Aspects	High temp.		Low temp.		Prolonged rainfall		Drought		Water table rise		Sea level rise		Specific effects of CC relevant for agriculture						Extreme Weather Events											
													Water supply shortage		Soil degradation		Pests/ diseases		Electric storms		Fog		Floods		Avalanches		Landslides		Storms	
	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P	D	P
Land losses	L	L	-	-	H	M	H	H	L	L	-	-	M	M	H	H	M	M	-	-	-	-	H	H	-	-	M	L	M	M
Crop yield	M	M	M	L	M	M	H	H	L	L	-	-	M	L	M	M	M	M	-	-	-	-	H	H	-	-	L	L	M	L
Crop productivity	M	M	M	L	M	M	H	M	M	M	-	-	M	L	M	M	M	M	-	-	-	-	H	H	-	-	-	-	M	L
Crop diversification	M	L	M	L	M	M	H	M	L	L	-	-	M	M	L	L	L	L	-	-	-	-	H	H	-	-	-	-	L	L
Livestock productivity	M	M	M	L	L	L	M	M	L	L	-	-	M	L	-	-	H	M	-	-	-	-	H	H	-	-	-	-	-	-
Crop output	M	M	M	M	M	M	M	M	L	L	-	-	M	L	M	M	M	M	-	-	-	-	H	H	-	-	L	L	L	L
Animal output	M	M	L	L	L	L	H	M	L	L	-	-	L	L	-	-	H	M	-	-	-	-	H	M	-	-	-	-	-	-
Loss of income	M	L	L	L	L	L	M	L	L	L	-	-	M	L	M	M	-	-	-	-	-	-	H	H	-	-	L	L	-	-
Unemployment	L	L	-	-	-	-	M	L	-	-	-	-	-	-	L	L	M	L	-	-	-	-	M	L	-	-	-	-	-	-
GVA agriculture	M	L	L	L	M	L	H	M	L	L	-	-	L	L	M	L	M	L	-	-	-	-	H	H	-	-	-	-	-	-
Risk of poverty	L	L	L	L	M	L	M	L	-	-	-	-	L	L	M	L	M	M	-	-	-	-	H	M	-	-	L	L	L	L
Crop quality	L	L	L	L	L	L	H	M	-	-	-	-	M	L	M	L	M	L	-	-	-	-	H	M	-	-	-	-	L	L
Agricultural facilities	-	-	-	-	L	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	H	M	-	-	-	-	M	L

Legend: D = damage; P = probability of occurrence by 2050 at latest; U = unknown; H = high; M = medium; L = low
red = negative impact; green = positive impact; blank = neutral impact

Annex 2. Climate Change Adaptation Options in Detail

Table 17. Adaptation Options Presented in Detail

CLIMATE CHANGE ADAPTATION OPTIONS						
I. Options for agricultural productivity						
1. ADJUST THE TIMING OF FARM OPERATIONS						
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity	
	X		X			
Description / Option's relevance	Adjust the timing of farm operations, such as planting or sowing dates and treatments, in response to agrophenology.					
Economic: +++	Ecologic: ++	Social: +++				
Opportunities that arise	Optimize and increase yields.					
Cross-cutting relevance	YES	Agriculture production, economic and social impact as well.				
Risks addressed	Variability of agricultural productivity.					
2. GROW THERMOPHILIC CROPS WITHIN THE COUNTRY						
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity	
	X		X			
Description / Option's relevance	Grow thermophilic crops within the country, increase thermal resources and explore opportunities to grow more thermophilic crops within the country.					
Economic: +++	Ecologic: ++	Social: +++				
Opportunities that arise	Optimize and increase yields.					
Cross-cutting relevance	YES	Agriculture production, economic and social impact as well.				
Risks addressed	Variability of agricultural productivity.					
3. DEVELOP SUITABLE IRRIGATION SYSTEMS						
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity	
	X		X			
Description / Option's relevance	Develop suitable irrigation systems to maintain crop yields and productivity.					
Economic: +++	Ecologic: ++	Social: +++				
Opportunities that arise	Optimize and maintain crop yields and productivity.					
Cross-cutting relevance	YES	Agriculture production, economic and social impact as well.				
Risks addressed	Variability of agricultural productivity.					

4. DEVELOP CLIMATE-ADAPTED CROPS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description Option's relevance Economic / Ecologic / Social +++ / ++ / +++	Develop climate-adapted crops through agricultural research and experimental production aiming at optimal crop selection and development of varieties best suited and more resistant to new conditions of temperature and humidity.				
Opportunities that arise	Optimal crop selection and development of climate-adapted crops.				
Cross-cutting relevance	YES	Agriculture production, economic and social impact as well.			
Risks addressed	Extreme weather variability / agricultural productivity.				

5. BETTER MANAGEMENT OF EXISTING WOODLAND, HEDGEROWS, WOODY BUFFER STRIPS AND TREES ON AGRICULTURAL LAND					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description Option's relevance Economic / Ecologic / Social ++ / ++ / ++	Better management of existing woodland, hedgerows, woody buffer strips and trees on agricultural land to optimize benefits providing shelter to both livestock and crops.				
Opportunities that arise	Better shelter for livestock and crops.				
Cross-cutting relevance	YES	Agriculture production, livestock shelter, economic and social impact as well.			
Risks addressed	Variability of productivity.				

6. IMPROVE PEST AND DISEASE CONTROL					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description Option's relevance Economic / Ecologic / Social ++ / +++ / ++	Improve pest and disease control through better monitoring, diversified crop rotations, or integrated pest management.				
Opportunities that arise	Development of integrated pest management actions that prevent pest and disease formation.				
Cross-cutting relevance	YES	Agriculture production, livestock, economic and social impact as well.			
Risks addressed	Diminishes the risk of further spread of numerous weeds, diseases and pests in agriculture.				

II. Options for livestock					
7. DEVELOP SYSTEMS AND MECHANISMS FOR STORING WATER ON FARMS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		X
Description	Develop systems and mechanisms for storing water on farms, securing independent water sources and rationalizing water use.				
Option's relevance: Economic +++ / Ecologic ++ / Social ++					
Opportunities that arise	Securing independent water sources and rationalizing water use for improved economic benefits.				
Cross-cutting relevance	YES	Agriculture production, livestock, economic and social impact as well.			
Risks addressed	Water shortages.				

8. ADAPT FARMS AND FACILITIES BY USING ALTERNATIVE ENERGY RESOURCES AND AGRICULTURAL BIOGAS FACILITIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X				
Description	Adapt farms and facilities to the changing environment by supporting the use of alternative energy resources and agricultural biogas facilities situated in farms.				
Option's relevance: Economic ++ / Ecologic ++ / Social ++					
Opportunities that arise	Production of renewable power; avoidance of greenhouse gas emissions; disposal of waste; economical onsite power and reduced transmission losses. Cost effective, proven technology; helps isolate farmer from crop price fluctuations.				
Cross-cutting relevance	YES	Production of renewable power; economic and social positive impacts.			
Risks addressed	Energy power, waste pollution, etc.				

9. IMPROVE VENTILATION AND COOLING SYSTEMS IN ANIMAL HOUSING					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X			
Description	Improve ventilation and cooling systems in animal housing and introduce technologies for effective and efficient isolation and maintenance of temperature regimes. Ventilation of animal housing to remove moisture and odors and replacing them with fresh air is necessary for livestock productivity.				
Option's relevance: Economic ++ / Ecologic ++ / Social +					
Opportunities that arise	Increased livestock productivity.				
Cross-cutting relevance	YES	Increased livestock productivity with positive economic and social returns.			
Risks addressed	Variability of livestock productivity.				

10. DIVERSIFY LIVESTOCK FARMING					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X			
Description / Option's relevance	Diversify livestock farming and introduce more heat-tolerant livestock breeds and adapting diet patterns of animals under heat stress conditions.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Diminishes the risk diseases and heat-stressed breeds.				
Cross-cutting relevance	YES	Livestock, economic and social benefits.			
Risks addressed	Livestock heat-stress and diseases.				

11. SAVE AND IMPROVE EXISTING PASTURES FOR GRAZING					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X			
Description / Option's relevance	Save and improve existing pastures for grazing, improve current practices for grassland management and encourage restoration of degraded land.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Reduced production costs, increased animal output per acre, land use efficiency, environmental friendliness, and improved quality of life for farmers.				
Cross-cutting relevance	YES	Livestock, economic and social benefits.			
Risks addressed	Land degradation				

III. Options for natural resources (soil erosion, desertification; water shortage and irrigation; fisheries and aquaculture)

12. INCREASE THE USE OF PERENNIAL CROPS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Increase the use of perennial crops that are better able to resist climate extremes; the erosive power of rain can be reduced if the soil surface is covered by a crop, stubble or mulch, as these act to dissipate the energy of the raindrop before it hits the soil.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Greater biological and economic diversity and yield additional environmental benefits.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Climate extremes / extreme weather events.				

13. ENSURE A PROTECTIVE COVER FOR THE SOIL SURFACE OR PLANT RESIDUES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Ensure a protective cover for the soil surface or plant residues in the periods of high rainfall (especially in the autumn-winter season) and wind erosion.				
Economic: +++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Minimizes and protects from water stress.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Extreme rainfall and wind erosion.				

14. IMPROVE THE SOIL STRUCTURE MAINTENANCE AND RESTORATION AND INCREASE THE SOIL'S INFILTRATION CAPACITY					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Improve the soil structure maintenance and restoration and increase the soil's infiltration capacity.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Minimizes and protects from water stress.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Agricultural productivity variability, etc.				

15. INCREASE THE SOIL'S ORGANIC MATTER RESERVES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Increase the soil's organic matter reserves. Organic matter in soil serves several functions; first it as a revolving nutrient bank account; and second, as an agent to improve soil structure, maintain tilth, and minimize erosion.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Helps improve agricultural productivity.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Declining soil productivity				

16. USE SOIL CULTIVATION MACHINES AND TECHNOLOGIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Careful soil cultivation (with minimum pressure on the soil surface) can improve the soil capacity to retain water, its aeration, capacity of infiltration, warming up, evaporation etc. But soil cultivation can also harm the soil fertility as it accelerates erosion and the decomposition of humus. It is therefore important to use soil cultivation machines and technologies with minimum pressure on the soil surface.				
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Helps improve agricultural productivity.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Declining soil productivity				

17. USE PLANT RESIDUES FROM AGRARIAN PLANT ROTATION AS RAW MATERIAL FOR VARIOUS INDUSTRIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description / Option's relevance	Use plant residues from agrarian plant rotation for ploughing, briquetting, burning in special furnaces as a raw material for various industries, and so on, instead of burning them directly on the field.				
Economic: + / Ecologic: ++ / Social: ++					
Opportunities that arise	Diminish burning residues directly on the field and turn them into commercially viable raw materials for various industries.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Waste pollution				

18. IMPROVE WATER MANAGEMENT PRACTICES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description	Improve water management practices. Implement management practices to ensure the effective use of water (reducing water losses) improving irrigation practices and efficiency, and recycling or storing water.				
Option's relevance					
Economic: ++	Ecologic: +	Social: +			
Opportunities that arise	Improves water management and irrigation efficiency, reduces economic losses.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Water scarcity / water stress / water loss.				

19. ELIMINATE SECONDARY SALINIZATION CONDITIONS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description	Eliminate secondary salinization conditions, such as irrigation by highly mineralized groundwater sources, naturally or anthropogenically induced deterioration of drainage in intensively irrigated areas; disadvantageous and unsuitable structure of arable land given respective conditions of the soil and hydro-melioration infrastructure.				
Option's relevance					
Economic: +	Ecologic: ++	Social: +			
Opportunities that arise	Improved irrigation infrastructure to address the issue.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Desertification, soil productivity, etc.				

20. ELIMINATE CONDITIONS FOR ANTHROPOGENIC SOIL ACIDIFICATION					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description	Eliminate conditions for anthropogenic soil acidification (surface over-moisturization, unbalanced mineral fertilization). Acidification causes the loss of base cations, increases the aluminum saturation and leads to declining crop yields and possible structural deterioration. Soil acidity is ameliorated by applying lime or other acid-neutralizing materials.				
Option's relevance					
Economic: +	Ecologic: ++	Social: +			
Opportunities that arise	Improve agricultural productivity and reduce soil acidification.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Soil acidification and structural deterioration.				

21. IMPROVE SOIL MANAGEMENT BY INCREASING WATER RETENTION					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description	Improve soil management by increasing water retention to conserve soil moisture.				
Option's relevance					
Economic: +	Ecologic: ++	Social: +			
Opportunities that arise	Storing water in soil decreases the negative impacts of droughts.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Droughts, water stress, etc.				

22. MAINTAIN AND IMPROVE EXISTING AQUACULTURE HABITATS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	
Description Option's relevance	Maintain and improve existing aquaculture habitats, the fish access to spawning, and create new habitats in deep pools, lakes and basins.				
Economic: +	Ecologic: ++	Social: ++			
Opportunities that arise	Enhancing and enabling existing aquaculture habitats.				
Cross-cutting relevance	YES	Aquaculture, economic and social positive benefits.			
Risks addressed	Aquaculture loss, etc.				

IV. Building adaptive capacity

23. DEVELOP CLIMATE CHANGE TRAININGS FOR THE ADMINISTRATIVE STAFF IN GOVERNMENTAL INSTITUTIONS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description Option's relevance	Develop climate change trainings for the administrative staff in governmental institutions (topics may include: identifying and evaluating climate risks; identifying climate change methods for preventing and reducing its negative consequences for the residents of communities, for the aquaculture, and so on).				
Economic: ++	Ecologic: ++	Social: ++			
Opportunities that arise	Enhanced institutional adaptive capacity, etc.				
Cross-cutting relevance	YES	All CCA agriculture-related activities and social impact as well.			
Risks addressed	All risks.				

24. DEVELOP KNOWLEDGE DISSEMINATION ACTIONS AND TRAIN STAKEHOLDERS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description Option's relevance	Develop knowledge dissemination actions (organize seminars, discussions with stakeholders, create councils for monitoring CCA actions) and train stakeholders (training and technological advice taking into account aspects of adapting agricultural production to the increased climate risks and preventing CC).				
Economic: ++	Ecologic: ++	Social: +++			
Opportunities that arise	This option creates great opportunities. Behavioral change is a powerful factor. It can contribute to prevent or at least mitigate climate change.				
Cross-cutting relevance	YES	Social – behavior change, Environmental – protection and mitigation, Financial – less damages due to natural hazards, means less finances for recovery.			
Risks addressed	Risk to infrastructure and to service.				

25. INTRODUCE SUBSIDIES, GRANTS AND OTHER FINANCIAL PROGRAMS FOR DEALING WITH CCA					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description Option's relevance	Introduce subsidies, grants and other financial programs to encourage use of any new/good systems and practices for dealing with CCA.				
Economic: +++	Ecologic: ++	Social: ++			
Opportunities that arise	When financing is ensured, it creates opportunities for improvement of the infrastructure and new jobs as well.				
Cross-cutting relevance	YES	All agriculture-related activities and social impact as well.			
Risks addressed	Risk to infrastructure: better operation and maintenance.				

26. IMPROVE COORDINATION AMONG RESPONSIBLE GOVERNMENTAL AND PUBLIC INSTITUTIONS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description	Improve coordination among responsible governmental and public institutions (MoEW, MAFF and other agencies) and encourage the involvement of municipalities, regional and sectoral administrations (and ensure CCA is integrated into their policies).				
Option's relevance					
Economic: +++ / Ecologic: +++ / Social: +++					
Opportunities that arise	This option will allow an appropriate response, not only in case of extreme weather events, but whenever climate change-related measures are implemented.				
Cross-cutting relevance	YES	Roles, responsibilities and coordination regarding CCA cannot and should not be considered separately from the other activities of the institutions.			
Risks addressed	All risks.				

27. IMPROVE THE SYSTEM OF MANAGING RESERVES OF FOOD AND SEED MATERIAL IN CASE OF CROP FAILURES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description	Improve the system of managing reserves of food and seed material in case of crop failures.				
Option's relevance					
Economic: ++ / Ecologic: + / Social: +++					
Opportunities that arise	Diminish the risk of economic and social hazards in case of crop failures.				
Cross-cutting relevance	YES	Agricultural, economic and social positive benefits.			
Risks addressed	Economic, social, etc.				

28. IMPROVE THE KNOWLEDGE OF THE ADMINISTRATIVE STAFF AND STAKEHOLDERS IN RELATION TO VULNERABILITIES OF INLAND WATER SPECIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	X
Description	For aquaculture, improve the knowledge of the administrative staff and stakeholders in relation to vulnerabilities of inland water species, to prevent bio-physical environment and understand hydro and morphology pressure on rivers and dams related to the decrease of the water levels and drought effects.				
Option's relevance					
Economic: ++ / Ecologic: ++ / Social: ++					
Opportunities that arise	Enhanced institutional adaptive capacity, etc.				
Cross-cutting relevance	YES	Aquaculture, economic and social positive benefits.			
Risks addressed	All risks related to aquaculture.				

29. DEVELOPMENT AND IMPROVEMENT OF A MONITORING AND EVALUATION (M&E) SYSTEM					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description	Development and improvement of a monitoring and evaluation (M&E) system and M&E indicators is critical in ensuring the long-term success of CCA initiatives, plans and actions. Monitoring and reporting on the progress of implementation of the CCA options should be carried out through periodical monitoring reports based on monitoring indicators that would track and assess the relevance and efficiency of CCA actions.				
Option's relevance					
Economic	Ecologic	Social			
++	++	+++			
Opportunities that arise	Storing data in one place in a unified format will reduce the risk of mistakes and wrong interpretations. Better monitoring will allow better understanding of interconnections between climate parameters. This will allow more accurate measures to be selected and no regret solutions to be applied.				
Cross-cutting relevance	YES	Database could be used by different stakeholders for analysis and decision making.			
Risks addressed	All risks.				

V. Improving awareness

30. DEVELOP A NATIONAL DATABASE (ONLINE PORTAL) CONTAINING CCA-SPECIFIC INFORMATION					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description	Develop a national database (online portal) containing CCA-specific information, for raising public awareness and engaging community knowledge-sharing.				
Option's relevance					
Economic	Ecologic	Social			
++	++	++			
Opportunities that arise	Storing data in one place in a unified format will reduce the risk of mistakes and wrong interpretations. Making data publicly available will allow different stakeholders to use it and researchers to prepare more comprehensive studies.				
Cross-cutting relevance	YES	Database could be used by different stakeholders for analysis and decision making.			
Risks addressed	All risks.				

31. ENGAGE IN WIDER DISSEMINATION OF CCA KNOWLEDGE TO REACH LOCAL FARMERS, INCLUDING PUBLICATION OF GUIDELINES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description	Engage in wider dissemination of CCA knowledge to reach local farmers, including publication of guidelines (improving the dissemination of applied research to the farm level should increase the resilience of the agriculture sector to future climate uncertainty, as well as improve agricultural efficiency overall). Information could also be disseminated through newsletters; brochures; risk maps; workshops, and so on. This option requires stimulation of public self-mobilization and action, and mobilization of local knowledge and resources. Awareness campaigns can address groups of people in a region affected by a climate threat. This option requires development and implementation of public education and training programmes.				
Option's relevance					
Economic	Ecologic	Social			
++	++	+++			
Opportunities that arise	This option creates great opportunities. Behavioral change is a powerful factor. It can contribute to prevent or at least mitigate climate change.				
Cross-cutting relevance	YES	Social – behavior change, Environmental – protection and mitigation, Financial – less damages due to natural hazards, means less finances for recovery.			
Risks addressed	Risk to infrastructure and to service.				

32. INTRODUCE CLIMATE CHANGE EDUCATION IN SCHOOLS' AND UNIVERSITIES' CURRICULA					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X
Description Option's relevance Economic: ++ / Ecologic: ++ / Social: +++	Introduce climate change education in school and universities' curricula – this would not only assist in raising public awareness, but also more people would be interested to contribute and participate in CCA.				
Opportunities that arise	This option creates great opportunities. Behavioral change is a powerful factor. It can contribute to prevent or at least mitigate climate change.				
Cross-cutting relevance	YES	Social – behavior change; environmental – protection and mitigation, etc.			
Risks addressed	All risks.				

33. ESTABLISH A FORMAL PLATFORM FOR AQUACULTURE FOR SCIENTISTS AND ALL RELEVANT STAKEHOLDERS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	X
Description Option's relevance Economic: + / Ecologic: +++ / Social: +++	Establish a formal platform for aquaculture where for scientists and all relevant stakeholders (including but not limited to fishermen, seafood industry, seafood preparers and consumers) can discuss issues and policies related to development and conservation of aquatic resources.				
Opportunities that arise	Storing data in one place in a unified format will reduce the risk of mistakes and wrong interpretations. Making data publicly available will allow different stakeholders to use it and researchers to prepare more comprehensive studies.				
Cross-cutting relevance	YES	Database could be used by different stakeholders for analysis and decision making.			
Risks addressed	All risks related to aquaculture.				

34. DEVELOP ENHANCED ECOSYSTEM OBSERVATION SYSTEMS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	X
Description Option's relevance Economic: + / Ecologic: +++ / Social: ++	Develop enhanced ecosystem observation systems, as well as research on ecosystem accounting and valuation, analysis of species; identification and protection of vulnerable fish species, including expanding protected areas.				
Opportunities that arise	Storing data in one place in a unified format will reduce the risk of mistakes and wrong interpretations. Making data publicly available will allow different stakeholders to use it and researchers to prepare more comprehensive studies.				
Cross-cutting relevance	YES	Ecosystem observation systems could be used by different stakeholders for analysis and decision making.			
Risks addressed	All risks related to aquaculture.				

VI. Strengthening research, technology development, and innovation

35. DEVELOP RESEARCH ON NEW CROP VARIETIES

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		

Description	Economic	Ecologic	Social
Option's relevance	++	++	++

Develop research on new crop varieties, including hybrids, to increase the tolerance and suitability of plants to temperature, moisture and other relevant climatic conditions.

Opportunities that arise	Research achievements bring novelty. When implemented, a number of side benefits will arise, including social and environmental. In many cases this has also a preventive or mitigating role in climate change.	
Cross-cutting relevance	YES	Agriculture, economic and social positive benefits.
Risks addressed	All crop-related risks.	

36. DEVELOP FARM-LEVEL RESOURCE MANAGEMENT INNOVATIONS

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		

Description	Economic	Ecologic	Social
Option's relevance	++	++	++

Develop farm-level resource management innovations to address the risk associated with changing temperature, moisture and other relevant climatic condition.

Opportunities that arise	Research achievements bring novelty. When implemented, a number of side benefits will arise, including social and environmental. In many cases this has also a preventive or mitigating role in climate change.	
Cross-cutting relevance	YES	Agriculture, economic and social positive benefits.
Risks addressed	All agriculture-related risks.	

37. CONDUCT RESEARCH DEVELOPMENT

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X

Description	Economic	Ecologic	Social
Option's relevance	++	++	++

Conduct research development and develop additional sectoral studies to identify the nature of climate risks, vulnerabilities and opportunities associated with current climate and projected changes.

Opportunities that arise	Research achievements bring novelty. When implemented, a number of side benefits will arise, including social and environmental. In many cases this has also a preventive or mitigating role in climate change.	
Cross-cutting relevance	YES	Social – behavior change, Environmental – protection and mitigation, Financial – less damages due to natural hazards, means less finances for recovery.
Risks addressed	All risks.	

38. OPTIMIZE THE USE OF ALTERNATIVE FALLOW AND TILLAGE PRACTICES TO ADDRESS CLIMATE CHANGE-RELATED MOISTURE AND NUTRIENT DEFICIENCIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X		X		
Description Option's relevance Economic / Ecologic / Social ++ / ++ / ++	Optimize the use of alternative fallow and tillage practices to address climate change-related moisture and nutrient deficiencies, including crop-rotation.				
Opportunities that arise	Address climate change-related moisture and nutrient deficiencies.				
Cross-cutting relevance	YES	Agriculture production, livestock, economic and social impact as well.			
Risks addressed	Crop production variability, etc.				

39. INCREASE THE USE OF RENEWABLE ENERGY GENERATION					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description Option's relevance Economic / Ecologic / Social +++ / ++ / ++	Increase the use of renewable energy generation: the introduction of bioenergy supply and production systems, improved manure management through capture and conversion to biogas, and the placement of wind and solar-photo voltaic infrastructure can all help to introduce low-carbon energy supply to society and, through decentralized power generation, increase resilience of current generating capacity in rural areas.				
Opportunities that arise	Introduce low-carbon energy supply to society and increase resilience of current generating capacity in rural areas.				
Cross-cutting relevance	YES	Energy generation, agricultural, economic, social benefits, etc.			
Risks addressed	Waste pollution, energy capacity, etc.				

40. DEVELOP WATER MANAGEMENT INNOVATIONS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		
Description Option's relevance Economic / Ecologic / Social ++ / ++ / ++	Develop water management innovations, including irrigation, to address the risk of moisture deficiencies and increasing frequency of droughts. Implement irrigation practices to address the moisture deficiencies associated with climate change and reduce the risk of income loss due to recurring drought (supporting building up irrigation infrastructure, mechanical innovations in farms such as the development of integrated drainage systems, land contouring, reservoirs and recharge areas, and alternative tillage systems).				
Opportunities that arise	Development of water innovations, reducing economic loss risks and the negative drought effects.				
Cross-cutting relevance	YES	Agricultural productivity, economic and social benefits, etc.			
Risks addressed	Moisture deficiencies, droughts, economic loss, etc.				

41. IMPROVE THE TECHNOLOGIES FOR CULTIVATION OF FISH AND AQUACULTURE IN INLAND WATER					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	
Description	Improve the technologies for cultivation of fish and aquaculture in inland water, developing artificial breeding of the fish, use selective breeding, and implement genetic improvements for higher resistance.				
Option's relevance					
Economic: ++ / Ecologic: ++ / Social: +++					
Opportunities that arise	Enhanced cultivation techniques for aquaculture and increased economic and social benefits.				
Cross-cutting relevance	YES	Aquaculture production, economic and social impact.			
Risks addressed	Aquaculture production risks.				

42. DEVELOP RECIRCULATING SYSTEMS FOR FISH BREEDING AND INTEGRATED PRODUCTION TECHNOLOGIES					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	
Description	Develop recirculating systems for fish breeding and integrated production technologies (cultivation of fish or other hydrobionates together with plants). Integrated production technologies are a very ecological way of cultivating fish, as the water from the fishery passes through the plants, which use a significant part of the nutrients, and then goes back to the fish.				
Option's relevance					
Economic: ++ / Ecologic: ++ / Social: +++					
Opportunities that arise	Develop ecological ways of cultivating fish, providing both economic and social benefits.				
Cross-cutting relevance	YES	Aquaculture production, economic and social impact.			
Risks addressed	Aquaculture production risks.				

43. DEVELOP CLIMATE INFORMATION SYSTEMS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X		X
Description	Develop climate information systems: develop early warning systems that provide daily weather predictions and seasonal forecasts. Weather predictions over days or weeks have relevance to the timing of operations such as planting, spraying and harvesting. At the same time, information on longer-term climate change can inform farmers about future variability and the probability of extreme events. Early warning and risk management systems could also include historical climate data archive; an archive on climate impacts on agriculture; using systematic meteorological observations. The prerequisite for the climate information system is developing agro-meteorology stations, which provide daily information for temperature, penetration, wind, soil humidity and other agro-climate indicators related to the cultivation process.				
Option's relevance					
Economic: ++ / Ecologic: + / Social: ++					
Opportunities that arise	Making data publicly available will allow different stakeholders to use it and researchers to prepare more comprehensive studies.				
Cross-cutting relevance	YES	Database could be used by different stakeholders for analysis and decision making.			
Risks addressed	All risks.				

44. CARRY OUT FURTHER STUDIES AND RESEARCH ON HOW CLIMATE CHANGE IMPACTS LIVESTOCK WITH THE SUPPORT OF THE GOVERNMENT AND THE MAFF					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
		X			X
Description	Carry out further studies and research on how climate change impacts livestock with the support of the Government and MAFF (including research and development on alternative livestock nutrition patterns, their general well-being and new diseases resulting from climate change).				
Option's relevance					
Economic: ++	Ecologic: ++	Social: ++			
Opportunities that arise	Research achievements bring novelty. When implemented, a number of side benefits will arise, including social and environmental. In many cases this has also a preventive or mitigating role in climate change.				
Cross-cutting relevance	YES	Livestock production, economic and social impact.			
Risks addressed	Livestock related risks.				

45. CARRY OUT FURTHER RESEARCH TO BETTER UNDERSTAND THE INTERACTION BETWEEN CLIMATE CHANGE AND FISHERIES AND AQUACULTURE					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	X
Description	Carry out further research to better understand the interaction between climate change and fisheries and aquaculture; this will also help policy-makers by providing insights into what adaptive strategies and policies would be most suited. Further aquaculture research is also required on issues such as new diseases and preventive treatments, aquatic animal physiology, the search for new and better adapted species, better feeds and feeding practices that are more ecosystem friendly.				
Option's relevance					
Economic: ++	Ecologic: ++	Social: ++			
Opportunities that arise	Research achievements bring novelty. When implemented, a number of side benefits will arise, including social and environmental. In many cases this has also a preventive or mitigating role in climate change.				
Cross-cutting relevance	YES	Aquaculture production, economic and social impact.			
Risks addressed	Aquaculture related risks.				

46. ENHANCE THE SYSTEMS FOR AQUACULTURE OBSERVATION AND MONITORING					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
			X	X	X
Description	Enhance the systems for aquaculture observation and monitoring to improve the management and science of fish migration and timing of species life cycle.				
Option's relevance					
Economic: ++	Ecologic: ++	Social: ++			
Opportunities that arise	Better monitoring will allow better understanding of interconnections between climate parameters, water resource availability, fish migration and timing of species life cycle. This will allow more accurate measures to be selected and no regret solutions to be applied. Making data publicly available will allow different stakeholders to use it and researchers to prepare more comprehensive studies.				
Cross-cutting relevance	YES				
Risks addressed					

VII. Risk management and legal framework

47. *IMPROVE THE CCA LEGAL FRAMEWORK*

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X	X	X	X	X

Description	Improve the CCA legal framework: updating the legislation to include climate change impact policies and/or adaptation actions.
Option's relevance	
Economic: +++ / Ecologic: +++ / Social: +++	
Opportunities that arise	When the legislation is oriented towards preventive climate change risk management, this saves financial resources for post-event recovery.
Cross-cutting relevance	YES — Some legislative documents are intersectoral
Risks addressed	All risks.

48. *DEVELOP INSURANCE AND RISK MANAGEMENT PROGRAMS*

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
	X				X

Description	Develop insurance and risk management programs (management strategies with respect to climate loss of crop yields and subsidized crop insurance program). Invest in crop shares and futures to reduce the risks of climate-related income loss and income stabilization programs.
Option's relevance	
Economic: +++ / Ecologic: + / Social: ++	
Opportunities that arise	Establishment of insurance and risk management programs will allow better management of the consequences.
Cross-cutting relevance	YES — Human well-being and life
Risks addressed	If a program is available, the damages will be recovered faster.

49. *UPDATE AND AMEND THE LEGISLATION AFFECTING INLAND FISHERIES AND AQUACULTURE TO SET OUT APPROPRIATE FRAMEWORK CONDITIONS FOR CCA*

Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
				X	X

Description	Update and amend the legislation affecting inland fisheries and aquaculture to set out appropriate framework conditions for CCA and how these framework conditions are applied in the best possible way for aquaculture in inland waters.
Option's relevance	
Economic: + / Ecologic: +++ / Social: +	
Opportunities that arise	Improve existing fisheries and aquaculture legislation.
Cross-cutting relevance	YES — Creating of cross-sectoral frameworks and legislation with a positive impact for inland fisheries and aquaculture.
Risks addressed	All aquaculture-related risks.

50. CREATE CROSS-SECTORAL POLICY FRAMEWORKS SUCH AS THOSE FOR CULTIVATION OF FISH IN BASINS AND CAGE FISHERIES FARMS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
				X	X
Description	Create cross-sectoral policy frameworks such as those for cultivation of fish in basins and cage fisheries farms.				
Option's relevance					
Economic: +	Ecologic: +++	Social: +			
Opportunities that arise	Enhanced coordination across sectors.				
Cross-cutting relevance	YES	Creation of cross-sectoral policy frameworks such as those for cultivation of fish in basins and cage fisheries farms.			
Risks addressed	Diminishes the risk of unsustainable use of aquaculture resources.				

51. CREATE ECONOMIC INCENTIVE MECHANISMS					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
				X	X
Description	Create economic incentive mechanisms such as, for example, awards for resource users and fishermen who have put in place improved practices and sustainable use of existing resources.				
Option's relevance					
Economic: +++	Ecologic: +++	Social: +++			
Opportunities that arise	Enhance sustainable fishing practices.				
Cross-cutting relevance	YES	Human well-being, aquaculture.			
Risks addressed	Diminishes the risk of unsustainable use of aquaculture resources.				

52. PROVIDE ADEQUATE FUNDING THROUGH SCHEMES TO MEET THE FISHERMEN'S CAPITAL NEEDS FOR ADAPTATION OPTIONS FOR FISHERIES AND AQUACULTURE					
Relevant to:	Agricultural productivity	Livestock	Natural resources	Fisheries & aquaculture	Institutional adaptive capacity
				X	X
Description	Provide adequate funding through schemes to meet the fishermen's capital needs for adaptation options for fisheries and aquaculture.				
Option's relevance					
Economic: +++	Ecologic: +++	Social: +++			
Opportunities that arise	Enhance sustainable fishing practices.				
Cross-cutting relevance	YES	Human well-being, aquaculture.			
Risks addressed	Diminishes the risk of unsustainable use of aquaculture resources.				

Annex 3. Cost–benefit Analysis in the Agriculture Sector

1. General Description

Agriculture is one of the major economic sectors where climate change has large impacts, affecting crop and livestock growth and consequently productivity. The conceptual framework of this CBA was developed based on the effects that climate change has on the Agriculture sector.

The purpose of this work is to:

- Estimate the parameters of the relationship between performance indicators and climate change indicators for the agriculture sector (temperature +2°C and +4°C, and precipitation changes). It is considered that climatic drivers associated with the impact assessment are average temperature and average precipitation.
- Develop a CBA – appraising the costs and benefits of adaptation actions, thus measuring the efficiency of investments. It quantifies the anticipated costs and benefits of adaptation options with the aim of comparing them and determining whether the benefits outweigh the costs. Benefits are the advantages or positive effects of adaptation measures. Costs are the resources required to deliver adaptation measures. The effects are expressed as a decrease in costs because of measures taken.
- Evaluate and rank the adaptation measures in terms of economic efficiency.

1.1. Description of the methodology

Climate effects are evaluated in an integrated assessment model, which combines a regression (or sensitivity) analysis with CBA, that is, it assesses the value of the costs and benefits of each adaptation action - giving an NPV - and compares the costs (investment expenditure) and benefits (costs avoided). Costs and benefits are expressed in monetary terms and a discount rate is used to determine the NPV[49] of the adaptation measures.

The regression analysis - as a technique to assess adaptation measures under uncertainty - identifies those factors that have the highest influence on main sectoral indicators.[50] The effect can be positive or negative. Positive impact for example results in improved crop yields while a reduction in yield is a negative impact.

Regression analysis was used to determine the effect of climatic variables on the performance of the agriculture indicators. This function is normally used when both the dependent and the explanatory variables are linear. The dependent variables are the main sectoral indicators whereas the independent variables are climate variables (temperature and precipitation). Linear extrapolation of the key indicators was accounted aiming at identifying how the sector would develop under each scenario. Extrapolation quantified each individual indicator.

[49] The NPV of an adaptation option is given by the present value of the estimated benefits net of costs. If NPV is more than zero', this indicates that the investment is efficient and incremental benefits of adaptation exceed the incremental resource costs. If NPV is <0 or B/C is <1, then the adaptation measures add no net benefit to the Agriculture sector. If NPV is >0 or B/C is >1, then it adds positive benefits and. The positive value of NPV confirms that investments for adaptation are efficient.
The benefit-cost ratio (B/C) is the ratio of the present value of benefits to the present value of costs. When the B/C ratio is more than one, the present value of the option's benefits is larger than the present value of its costs.

[50] The regression is linear; the dependent and the explanatory variables are linear.

The estimation of the negative and positive effects of climatic change was developed according to distinct scenarios at +2°C and +4°C temperature rise by 2050. The main scenarios are divided into sub–scenarios: optimistic, realistic, and pessimistic. The sub-scenarios are considered in the context of efficient and effective implementation of the proposed climate change adaptation measures.

The projected effects of adaptation measures are expressed as a logarithmic function, which is a tool to measure the effects of investments that would be gradually made until 2050.

An assessment was carried out of the NPV and the benefits until 2050, holding all other aspects constant. The monetary value of the effects was discounted by 4.5 percent for public funding 4.5 percent, and by 8 percent for private funding.

1.2 Data collection procedures

The primary data used for the CBA was obtained from the Action Plan that is part of the draft proposal for a National Climate Change Adaptation Strategy and Action Plan for Bulgaria, and from official statistical data.

The correlation determined whether there is a relationship between the performance indicators and climate factors. The relationship indicates which indicators are significantly dependent on climate change. Estimation of the correlation coefficient (dependence between each sectoral indicator and climate change factors [temperature and precipitation]) is used to stand out and select the critical variables (variables, which are highly sensitive to climate factors).

1.3 Model specifications - assumptions and limitations

A number of assumptions were made when preparing and carrying out the CBA.

- A baseline scenario was used to quantify the effects (positive and negative) on the key performance indicators in the scenarios of +2°C and +4°C temperature rise. The baseline scenario refers to current development trends of key sectoral indicators, independent of climate change.
- The projected trend value of each sectoral indicator is based on historical data (2005–2016).
- The main performance indicators are: crop output, livestock production, value added in the agriculture sector, saved costs per ha, crop yield per ha, and others.
- Climate projection (temperature and precipitation) was applied to historical variances experienced in Bulgaria (1991–2015. The input data for climate factors consist of yearly temperature (maximum, minimum, and average) and precipitation (maximum, minimum, and average).
- In the CBA model, extreme climate events – floods, drought, water shortage, short snow cover, floods, landslides have not been taken into account.
- The CBA assumption is that ‘soft’ adaptation measures have positive effects, and are therefore calculated as an aggregated value, included in the pool.

2. Results of the Regression Analysis

Differential assessment was carried out by comparing the climate change effects on key performance indicators in all scenarios against the baseline scenario. The results display negative or positive effects on the indicators per scenario.

Correlation was used to measure the degree of relationship between climatic variables and performance indicators.[51] The relationship between performance indicators (cost per hectare, crop output, livestock output, value added, saved cost per hectare) and increased temperature and changes in precipitation is negative, but the correlation is substantial. Overall, it was found that the statistic dependency between climate factors and sectoral indicators is low, because the dynamics of sectoral performance indicators is more associated with other economic and social variables than climate factors.

The regression analysis shows a moderate variation in crop output and livestock output caused by temperature rise and rainfall. There is no significant dependency between climate factors and social indicators. The statistic dependency between variation in temperature and the change in costs per hectare is moderate. Livestock output depends more on temperature than on precipitation. The value added in agriculture has a clear dependence with increased temperatures. Decreased precipitation influences the costs per ha and crop output. The dependency of livestock production from temperature rise is slightly lower than that of crop yield. Changes in precipitation negatively impact on crop output and crop yield.

The assessment of costs and benefits from the introduction of adaptation measures was done against the 'no adaptation' option where these measures are not implemented.

The baseline scenario reveals the total effects caused by direct impact of climate change factors on agriculture.

The cumulative sector effects presented in the table below illustrate the difference between the baseline scenario (that is, without implementing selected adaptation options), and the +2°C and +4°C temperature rise scenarios until 2050.

Table 18. Expected sector effects from climate change without adaptation options until 2050 (baseline scenario)

Performance Indicators	2°C scenario	4°C scenario	Precipitation
Crop yield (kg per hectare)			
Wheat	-17.17	-39.90	-29.75
Barley	-15.83	-41.08	-27.44
Grain maize	-23.90	-40.40	-41.42
Rye	-4.97	-16.62	-8.62
Oats	-14.65	-28.10	-25.39
Rape	-10.44	-31.44	-23.58

[51] A negative sign means there is a negative relationship which means when one variable increases, the other one decreases while, for a positive sign the variables change the same way.

Performance Indicators	2°C scenario	4°C scenario	Precipitation
Vegetable crops yield (kg per hectare)			
Tomatoes	-1.15	-22.40	-2.00
Pepper	-3.60	-7.86	-6.24
Onion	-4.77	-7.07	-6.13
Fruits yield (kg per hectare)			
Apples	-18.59	-39.67	-32.22
Pears	-19.62	-44.88	-34.00
Apricots	-12.74	-40.36	-22.09
Peaches	-18.26	-42.79	-31.65
Total crop output (basic price in €)	-16.18	-47.72	-28.05
Crop and livestock production value (basic prices in €)	-6.47	-24.17	-11.21
Total effect (expected losses in million €)			
Total effect on crop output	-422.54	-1,245.98	-732.42
Total effect on agriculture sector output (crop and livestock)	-243.45	-909.34	-421.99

The calculated cumulative effects indicate that climate factors (temperature and precipitation) negatively affect the agriculture sector in all scenarios. As presented in the table above, without adaptation measures, the losses in terms of crop output will be reduced by 16.18 kg per hectare at +2°C, respectively 47.72 kg per hectare at +4°C by 2050 due to decreased productivity. Precipitation changes, together with an increase in temperature, increase risks to crop cultivation and crop productivity. According to the baseline scenario, wheat crop yield will decrease by 17.17 kg per hectare under the +2°C scenario, and by 39.9 kg per hectare under the +4°C scenario. A decline in yield from changes in temperature and precipitation is also projected for other cereal crops (barley, rye, oats, grain maize).

The crop yield for main vegetables could also fall, for example tomato crops are projected to decrease by 22 kg per hectare under the +4°C scenario. Tomato is a mostly irrigated crop. However, with the existing irrigation system yield losses will be from 2 to 5 kg per hectare. Also, yields of pepper and cucumber were found to decrease as a result of increased temperature and changed precipitation patterns.

As an overall finding, the yield per hectare for major fruit crops will drop until 2050. By then, apple production will decrease by 18.5 kg per hectare under the +2°C scenario and by 39.6 kg per hectare under the +4°C scenario.

The cumulative expected direct losses for the agriculture sector (crop and livestock) are in the range of €243 million to €909 million until 2050, without considering the changes of precipitation and water stress. The overall estimated crop output losses in monetary value will range from €422 million to €1.24 billion until 2050.[52] Except temperature, the change in

[52] The projected cumulative effects (losses) are calculated at basic price 2017.

precipitation will reduce crop productivity, with projected losses for crop of approximately €732 million, respectively €421 million for total agriculture sector output.

3. Results of the Cost-benefit Analysis

The NPV is estimated by using an incremental/differentiated approach.

The CBA for the sector focuses on the assessment of soft adaptation measures. The benefits gained as a result of their implementation are best exemplified through the quantification of saved costs in main performance indicators (crop output; crop yield; livestock production; agriculture industry output; and others). Considering the complex impact of the adaptation options on the agriculture sector, these were not separately quantified in the current CBA. The NPV in the table below illustrates the monetary value of avoided losses as a result of implemented adaptation measures, while the cost effectiveness quantifies the benefits achieved in relation to the required investments/costs.

Table 19. Benefits of adaptation measures in the Agriculture sector until 2050 (in €, million)

Climate scenarios	NPV (€ million)	Cost-effectiveness (Benefit/Cost ratio)
Realistic scenario +2°C	1.66	1.02
Optimistic scenario +2°C	26.34	1.26
Pessimistic scenario +2°C	-23.01	0.77
Realistic scenario +4°C	291.87	3.92
Optimistic scenario +4°C	385.53	4.85
Pessimistic scenario +4°C	198.22	2.98

The projection shows that on average, under the +2°C realistic scenario, the total cash flow in NPV is €1.7 million, and €291.9 million under the realistic scenario at +4°C. Under the optimistic scenario, the projected cash flow in NPV is €26.3 million under the +2°C scenario and €385.5 million under the +4°C scenario. Even under the pessimistic scenario, the future cash flow in NPV is projected at minus €23.0 million at +2°C and €198.2 million at +4°C.

As presented in ***Table 19***, a higher NPV for the agriculture sector under all +4°C temperature rise scenarios (realistic, optimistic, and pessimistic) is calculated. The results indicate that only under the +2°C pessimistic scenario, soft adaptation measures are inefficient (the NPV is negative with a total cash flow until 2050 of minus €23 million). This indicates that the implementation of measures would not lead to achieving positive effects under this scenario.

In all other scenarios, where adaptation measures are applied, the NPV is positive, showing that investment until 2050 is economically efficient.

Within the current analysis, the cost-effectiveness of the adaptation measures is used to quantify the effect of investments under each scenario.[53] Under the +2°C realistic scenario, the benefit/cost ratio is €1.02 (that is, the benefits achieved per Euro spent), and €3.92 under the +4°C realistic scenario. The benefit is higher at +4°C temperature rise. In that case, the benefit

[53] The cost-effectiveness refers to all measures.

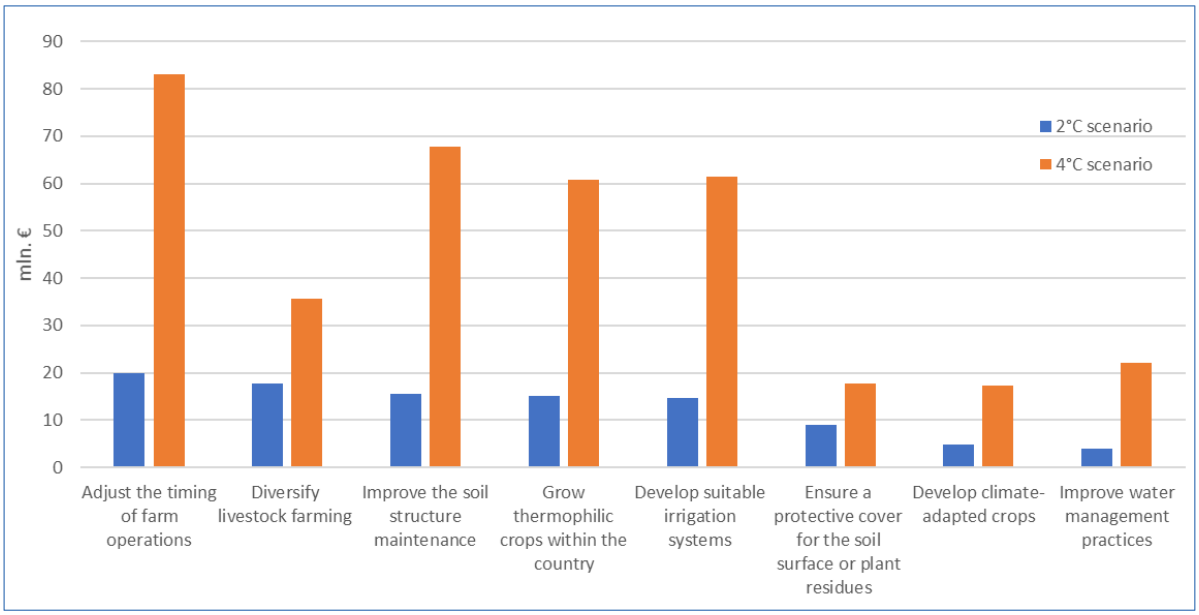
is €4.85 per one Euro of investment under the optimistic scenario and €2.98 per one Euro of investment under the pessimistic scenario.

3.1. Prioritizations of adaptation measures according to CBA

The CBA identifies the most economically efficient adaptation actions and allows for their ranking. The adaptation measures for which the benefit exceeds the cost can be ranked as follows: developing a suitable irrigation system, adjusting time farming operations, diversifying livestock farming, improving soil structure, improving water management practices, and others. The figure below shows the estimated contribution of selected adaptation measures in reaching the overall positive effects of climate change adaptation.

The high benefits that can be achieved suggest that these adaptation measures are highly necessary in any climate change scenario, even if climatic impacts would be minimal. Irrigation, as an adaptation measure, shows a high NPV, but with the high initial costs that come with irrigation, policymakers should consider promoting, or providing, irrigation systems to rural communities.

Figure 30. Prioritization of the adaptation measures in the Agriculture sector (total PV effect in € million)



4. Conclusions

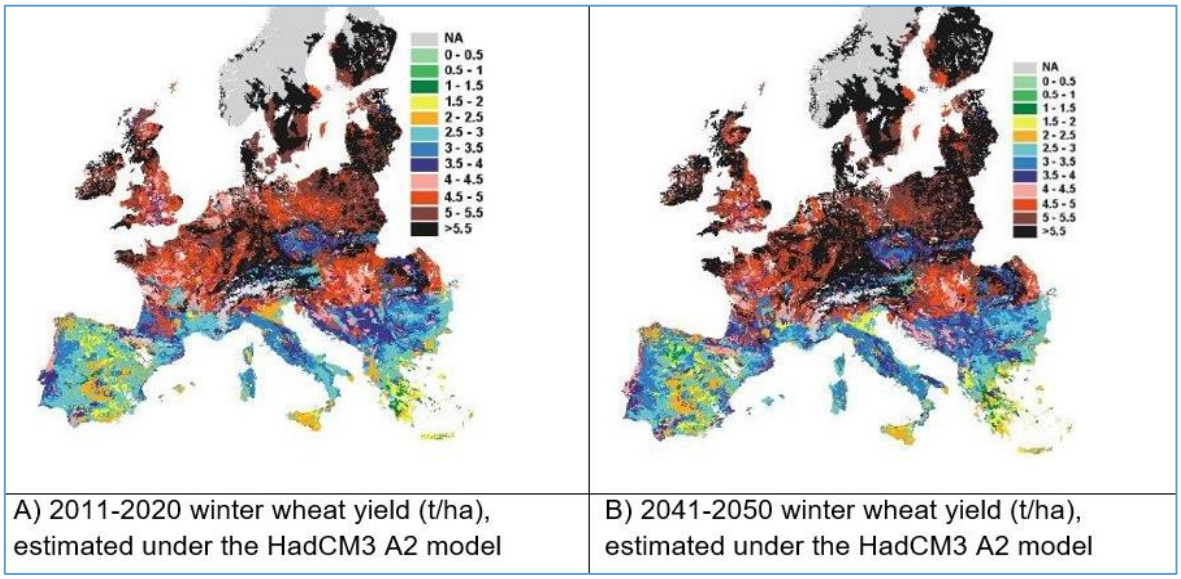
Based on the findings, the effect of temperature rise on crop yields in Bulgaria, can be considered negative. There is no statistically significant dependency between climate factors and sectoral indicators; it is due to the influence of other factors (macroeconomic, demographic, policy decisions) on agricultural business.

NPVs are high, clearly indicating that the benefits are far more significant than the costs incurred. The NPV calculation shows that investments in adaptation measures are economically efficient. The annual cash flow expressed in present value will reach its maximum between 2027 and 2030, meaning that investment in agriculture through implementation of adaptation measures will have a positive impact on the sector.

Annex 4. Forecasted Changes in Wheat, Corn and Sunflower Yields

Figure 31 shows deviations in simulated winter wheat yields for the periods 2011–2020 and 2041–2050 under the ROIMPEL model, using the HadCM3 - A2 emission scenario. The figure highlights that 2011–2020 and 2041–2050 yields in Bulgaria will increase during the first period by an average of about 3 to 3.5 tons per hectare for the greater part of the country, and with no more than 2.5 to 3 tons per hectare during the second period. Major cereal production regions will face dropping yields. Despite expected high air temperatures and reduced precipitation, the projected increase in **wheat yield** varies from 12 to 25 percent due to the fertilization effect of increased levels of CO_2.

Figure 31. Changes in Winter Wheat Yield for 2011–2020 and 2041–2050



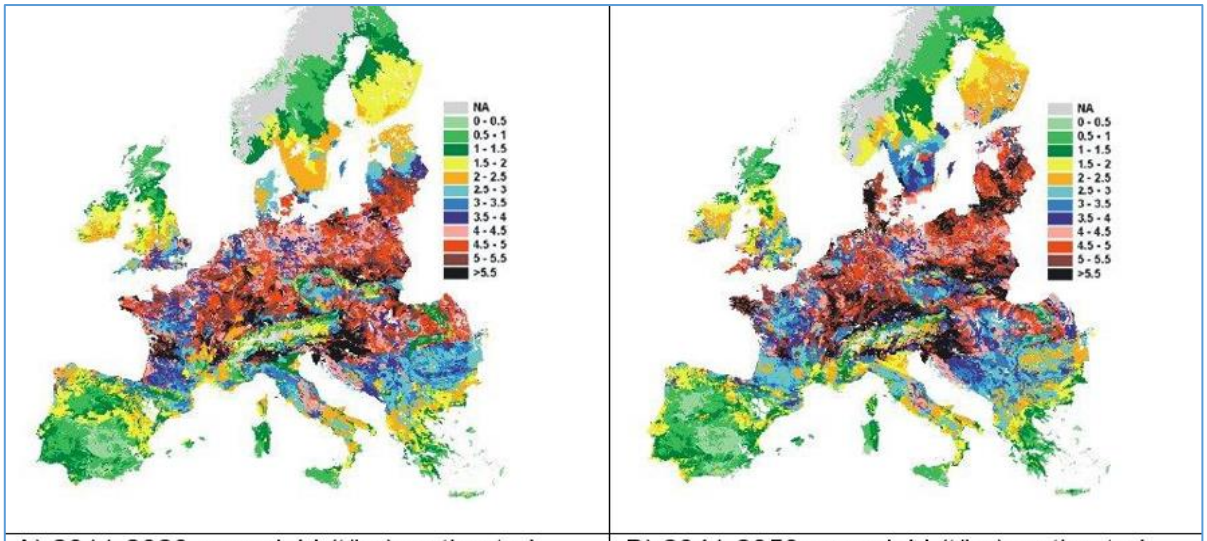
A) 2011-2020 winter wheat yield (t/ha), estimated under the HadCM3 A2 model

B) 2041-2050 winter wheat yield (t/ha), estimated under the HadCM3 A2 model

Source: National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy.

Deviations in simulated **corn yields** for the periods 2011–2020 and 2041–2050 as per the ROIMPEL model and 2000–2100 yields under emission scenario A2 in the HadCM3 model are shown in ***Figure 32***. A decrease in yield volumes is expected by 2050 and will most likely continue toward the end of the century. Reduced yields over the next decades would be attributed to a shorter growing season and reduced rainfall in summer, which is the main development period for the crop.

Figure 32. Deviations in Corn Yields for the Periods 2011–2020 and 2041–2050

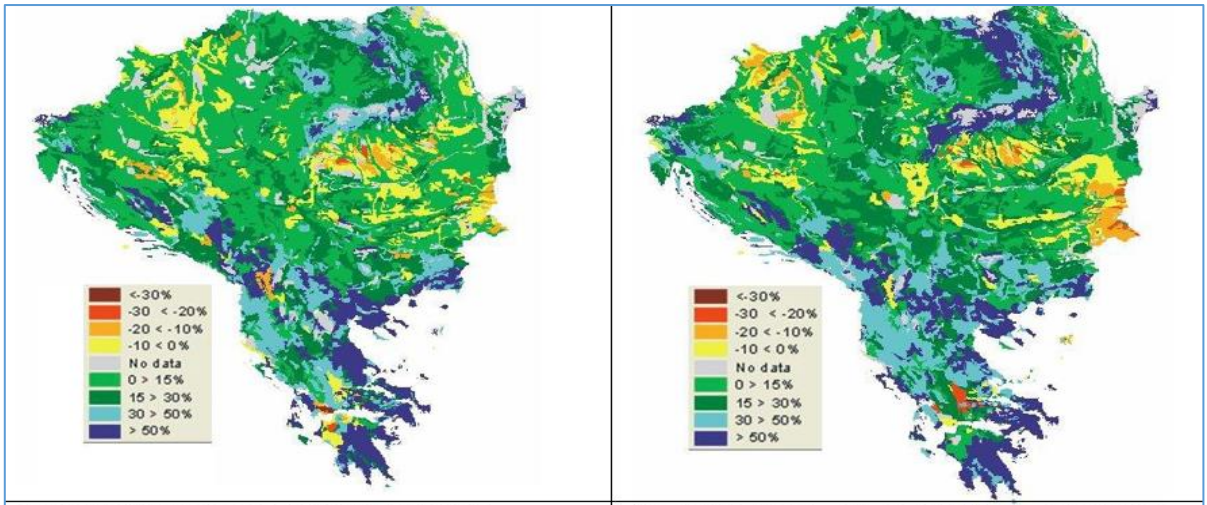


A) 2011-2020 corn yield (t/ha), estimated under the HadCM3 A2 model	B) 2041-2050 corn yield (t/ha), estimated under the HadCM3 A2 model

Source: National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy.

Deviations in simulated **sunflower yields** for the periods 2011–2020 and 2041–2050 (HadCM3 - B2) under the ROIMPEL model are shown in ***Figure 33***. As can be seen, yields in central and western Bulgaria during the first period shall be close to or about 15 percent above the norm, while in the eastern part of the country we see a drop of about 10 percent. By mid-century, yields in eastern Bulgaria shall further decrease by 10–20 percent, while in the rest of the country they shall either remain constant or exceed current figures by about 15 percent. Still, the cultivation of sunflower largely depends on precipitation, especially in summer when the vegetative mass is being formed, and each drought would be detrimental to the formation of the crop.

Figure 33. Deviations in Sunflower Yields for the Periods 2011–2020 and 2041–2050



A) Deviations of calculated sunflower yields for 2011-2020 in relation to the current climate (HadCM3 - B2)	A) Deviations of calculated sunflower yields for 2041-2050 in relation to the current climate (HadCM3 - B2)

Source: National climate change risk and vulnerability assessment for the sectors of the Bulgarian economy.

Annex 5. Other Relevant Best-Practices in the EU

EU member states have developed various policies, tools and actions related to climate change adaptation. Four countries have been chosen to illustrate various good practices and useful tools relevant for sectoral CCA. Sweden's best practice focuses on the Swedish National Knowledge Centre for Climate Change Adaptation, which provides useful tools and information to help society cope with a changing climate. The Centre is an interface for science, policy and practice, bringing together decision makers, businesses, research providers and organizations that make CCA happen. The United Kingdom showcases its consistent involvement in establishing agricultural innovation centers and knowledge-sharing programs. Austria developed practice-oriented tools for humus balancing, viniculture adaptation measures and CCA platforms and websites. Finally, the Netherlands promotes and invests in systematic and state-of-the-art scientific research programs for better understanding the consequences of climate change in agriculture and other sectors.

Box 7. Sweden

In Sweden, there is no central national ministry or agency that has the overall responsibility for CCA. Instead, there are many different specialized local and regional authorities that are responsible for CCA in their respective fields.[54],[55] Since 2009, the county administrative boards are responsible for CCA at a regional level. Many central agencies play an important role through their respective sectorial responsibility. Some 30 agencies are working on prevention, increased competence and knowledge, and improved preparedness for disruptions in vital public services.

As part of its work on CCA, the Swedish National Knowledge Centre for CCA was established in 2012.[56] The center is based at the Swedish Meteorological and Hydrological Institute and provides information and research to all interested stakeholders. The center collects, develops and shares research, information from authorities and good examples to facilitate sound decision making. A short documentary-film on CCA in Sweden is also available, showcasing the challenges and effects of climate change in Sweden and describing ways to mitigate and adapt to meet these challenges.[57] The center also runs the online CCA Portal.[58] The portal was developed through the cooperation between 18 Swedish governmental agencies, municipalities, and county councils. Its main goal is to inform citizens and society at large of the climate change consequences in various sectors, including agriculture and forestry, and to prepare people to respond effectively.[59] The portal collects and shares the latest news on CCA, both internationally and in Sweden. The portal also includes climate change case studies and examples of adaptation actions taken at local, national and international level, providing inspiration and knowledge-sharing experiences.

The Federation of Swedish Farmers (LRF) is an independent interest and business organization supporting farmers at the regional, national, and international level. It encompasses approximately 150,000 individual members and represent around 90,000 enterprises. Almost all cooperatives within the Swedish agriculture sector are also members. LRF's head office is in Stockholm and conducts operations in 17 regional offices throughout Sweden; LRF also has

[54] http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2015/05/SWEDEN.pdf
[55] http://www.klimatanpassning.se/en/about-us/roles-and-responsibilities-1.25109
[56] https://www.smhi.se/en/theme/climate-centre
[57] http://www.klimatanpassning.se/nyhetsarkiv/climate-change-adaptation-in-sweden-watch-the-film-1.31734
[58] http://www.klimatanpassning.se/en
[59] http://www.klimatanpassning.se/en/effects/agriculture-and-forestry/agriculture-1.98669

a Brussels' office for EU representation. LRF runs its business operations through seven subsidiaries, which employ more than 2,000 employees, promoting the development of the green industry and its farmers of agricultural and forest land, growers, and entrepreneurs so that they can fulfil their vision of green growth and profitability. LRF places climate change on top of their priorities' agenda and supports various research studies and initiatives in the field[60]. Its current initiatives include studying the use of energy on farms to make farms more efficient, presenting good examples on smart climate solutions and good practices in agriculture, developing a climate website to inspire farmers to make climate-friendly choices, promoting climate labelling on food, and initiating and financing research on identifying climate-friendly measures.

The Swedish Portal for Climate Change[61] has a dedicated section of adaptation case studies and good examples in various sectors including agriculture.

Insulated and ventilated cowsheds. In 2012, a new loose housing shed was developed to house dairy cows and heifers, with the aim to reduce the risk of heat stress among the cows. The new cowshed uses warm loose housing which means that cows are not penned in and are able to move freely in an insulated building. The roof of the cowshed is also well-insulated which ensures that the construction is both kept cooler in summer and better heated in winter. Other improvements include natural ventilation (coming from the long sides and a roof ridge of the cowshed that can be opened). Circulation fans were also installed to further increase the air flow. Because the new cowsheds have been installed, the owners have noticed that the cows are feeling better and the signs of heat stress have decreased. In addition, the air quality is better and there are far fewer insects in the new cowshed that irritate the cows. The initiative received investment support from the Swedish Board of Agriculture and local investment programs.

Box 8. United Kingdom

The United Kingdom published its first National Adaptation Program (NAP) in 2013. Raising awareness of the need for CCA was among the main topics addressed in the NAP.[62] The NAP and the assessment of climate change risks are due to be renewed every five years.[63] The 2013 NAP includes an analytical economic annex that provides useful information related to the costs and benefits of the various impacts of climate change on the economic activity, as well as recommendations on adaptation paths to be followed.[64] An independent Adaptation Sub-Committee has been set up to provide independent advice on CCA and to assess and monitor implementation of the NAP.[65] The Sub-Committee consists of a Chair and five members who are experts in different fields including climate change, economics and science. It is jointly sponsored by the Department for Environment, Food and Rural Affairs (Defra), the Northern Ireland Executive, the Scottish Government, and the Welsh Government.

One of the main priorities for the United Kingdom is the good management of soils and the government has committed to ensuring that all soils are managed sustainably by 2030. Several publications and booklets for farmers have been developed and widely disseminated, providing useful information and showcasing simple steps to follow for improving the health

[60] https://www.lrf.se/om-lrf/in-english/climate-change/
[61] http://www.klimatanpassning.se/en
[62] Other broad topics include increasing resilience to current climate extremes, taking timely action for long-lead time measures, and addressing major evidence gaps.
[63] https://www.gov.uk/government/publications/2010-to-2015-government-policy-climate-change-adaptation/2010-to-2015-government-policy-climate-change-adaptation
[64] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/209867/pb13942a-nap-annex-economics.pdf
[65] https://www.theccc.org.uk/about/structure-and-governance/asc-members/

and production of the soil.[66] Well-documented case studies offer additional practical information and guidance to farmers on how to sustainably manage a wide range of soils and farms.[67] Additionally, demonstration farms and innovation centers dedicated to farmers and interested stakeholders have been set up across England, Wales, and Scotland within a Demonstration Network.[68]

The government has also expressed support for the development of agricultural science and technologies, including sustainable innovations, and has launched the Agri-Tech Strategy in 2013. This is a long-term strategy; to which it has already committed £160 million.[69],[70] An online Agri-Tech Strategy blog provides updates on the strategy's progress and its ongoing development.[71] Three new centers for Agricultural Innovation have been established since 2015, cumulating a £68 million investment from the U.K. Government: The Centre for Crop Health and Protection, the Centre for Innovation Excellence in Livestock, and the Centre for Agricultural Innovation. These centers aim to revolutionize farming practices in the future.[72] The first Centre for Agricultural Innovation, Agrimetrics, was set up in 2015 and provides expertise and information 'in data science, smart analytics, bioinformatics, translational research and knowledge exchange in crops, livestock and food, and sustainability'[73]. Three additional centers for innovation are expected to be set up in the United Kingdom soon and to form part of what is called a 'family of centers' which will collaborate on different projects.

With regards to the aquaculture and fisheries sector, the U.K. works closely with the Centre for Environment, Fisheries, and Aquaculture Science (Cefas),[74] a scientific research and advisory center for fisheries management, environmental protection and aquaculture science. The center developed the Fishing Info National Science Anglers Catch Log, an online and smartphone application developed for anglers to log georeferenced details of the fish they catch directly from the lakeside, river bank, boat, or shore. This application is intended to be used as a 'reporting platform' for collecting real-time data and mapping the distribution and health of wild fish populations throughout the freshwater and aquatic environments,[75] providing useful indicators for future impacts of climate change events. The Marine Climate Change Impacts Partnership (MCCIP) is a U.K. wide partnership between scientists, the government, its agencies, and NGOs.[76] It provides high-quality marine climate change impacts evidence and advice to policy advisers and decision-makers and thus contributes to building the knowledge base and consolidate evidence of marine climate change impacts. In 2012, the MCCIP launched the Climate Smart Working knowledge-sharing program, a repository of international adaptation measures, best practices, and case studies, to help promote appropriate responses for marine and coastal climate change impacts.[77]

Catchment Sensitive Farming. This is an initiative by the UK Government aimed at enabling farmers and land managers to take bespoke actions in diffusing water pollution from agriculture. It raises awareness by giving free training and advice to farmers in selected areas in England. Topics addressed in the training include manure management, nutrient

[66] See http://www.leafuk.org/eblock/services/resources.ashx/000/595/601/LEAF-Simply_Sustainable_Soils_2016.pdf
[67] http://www.leafuk.org/leaf/farmers/simplysustainablesoils/casestudies.eb
[68] http://www.leafuk.org/leaf/farmers/demofarm.eb
[69]https://www.theccc.org.uk/wp-content/uploads/2015/06/6.736_CCC_ASC_Adaptation-Progress-Report_2015_final_web_070715_rfs.pdf
[70] https://www.gov.uk/government/collections/agricultural-technologies-agri-tech-strategy
[71] https://agritech.blog.gov.uk/about
[72] https://agritech.blog.gov.uk/2016/02/11/centres-for-agricultural-innovation-launching-in-2016/
[73] http://www.agrimetrics.co.uk/about/
[74] https://www.cefas.co.uk/about-us/
[75] https://www.cefas.co.uk/media/53188/cefas-in-a-box-at-v33.pdf
[76] www.mccip.org.uk
[77] http://www.mccip.org.uk/adaptation/

management, soil condition, pesticide management and farm infrastructure. The aim of the advice is to improve the environmental performance of farms. The initiative is run by Natural England in partnership with the Environment Agency and the Defra. A network of catchment sites, called 'Demonstration Test Catchments', has been established.[78] The 2013 U NAP reported that catchment-sensitive farming techniques have been successfully used to reduce soil erosion and improve water efficiency.[79]

Cefas data hub. The Cefas provides data access and 'open science' through its online portal 'Data Hub'. This is aimed at 'allowing the public and U.K. businesses to explore, download and reuse the data for their own research.' Most of the data cover information and records collected since 1980s until present day. Datasets cover various topics including, among others, fish stomach records, food safety, registry of aquatic pathology, water temperature and salinity, and WaveNet (which provides real-time data for risk of flooding).[80]

Box 9. Austria

The 2012 Austrian National Adaptation Strategy provides examples of good practices in various areas where CCA action is envisaged.[81]

Practice-oriented tools for humus balancing. Research conducted by StartClim found that even though Austrian farmers were aware of the value of soil humus and the need for humus balancing to ensure crop rotation and effective management of humus content of the soil, the humus balancing method used did not take sufficient account of regional crop rotation and yield conditions or certain management measures, such as cover crops. As a result, a dedicated project entitled 'Humus Balancing as a practice-tool for farmers supporting CO_2-stroring agriculture', conducted by Bio Forschung Austria,[82] was developed, with the main purpose 'to develop a humus-balancing method that would be easy to use and that would accurately reflect humus development in agricultural areas of the Weinviertel region'. to develop a method that improves the existing humus balancing method, is easy to use as well as accurately takes into account various factors (including regional crop rotations, yield rations, greening, and so on). After comparing various humus balancing methods and taking into account the existing data and the time and financial expenditure, the Kolbe method was chosen.

Viniculture adaptation measures. The region Krems-Trainsental has been used as a case study to develop a best-practice model for viniculture adaptation to climate change, which could be replicated in other wine producing regions.[83],[84] As a result, a set of proposed measures for climate adaptation were developed: cultivation of specialized varieties, expansion of cultivated areas, establishment of a warning service for pests and diseases to facilitate the use of plant protection products 'on demand', monitoring of new diseases and pests and identification of tolerance levels, combination of protection against hail, sun and birds through the use of nets and optimization of green-cover management.

[78] https://www.gov.uk/guidance/catchment-sensitive-farming-reduce-agricultural-water-pollution
[79] https://www.gov.uk/government/publications/adapting-to-climate-change-national-adaptation-programme
[80] https://www.cefas.co.uk/cefas-data-hub/
[81] http://www.mcrit.com/climagranollers/attachments/article/293/AustrianAdaptationStrategy_Context_FINAL_25092013_v02_online.pdf
[82] http://bioforschung.at/
[83] http://www.mcrit.com/climagranollers/attachments/article/293/AustrianAdaptationStrategy_Context_FINAL_25092013_v02_online.pdf
[84] http://alt.seri.at/en/projects/completed-projects/weinklim-viniculture-and-climate-change/

Online platform for natural hazard detection.[85] The primary aim of the platform is to raise awareness of all citizens of various natural hazards and weather events (including flooding, hail, storms, lighting, earthquakes, and so on) in their region.

Severe weather alerts by text or e-mail. Local and temporally precise forecasts and information about imminent weather events (such as storms, heavy rains, snow falls, ice, hail-storms or thunderstorms) are sent through text alert message and/or through e-mail. This system of early warning (up to two hours before the event occurs) contributes to preventing or reducing damage, saving lives and taking timely 'safety precautions'. The weather alerts are determined by the Central Institute for Meteorology and Geodynamics (ZAMG) through a computer program specifically designed for regional weather forecasting– INCA –in Austria. This is a free of charge service supported by ZAMG and other institutions including insurance companies and a local radio station.

CCA platforms and websites. Austria has developed a wide-range of online tools for disseminating information about climate change and adaptation, such as (a) a specific website that reports on the ongoing political process for CCA at a national level,[86] (b) a dedicated platform 'CCA in Austria' that provides information on Austria-specific climate change and adaptation,[87] (c) a handbook for provinces, regions and cities entitled 'Methods and Tools for Adaptation to Climate Change' that can be downloaded for free from the platform and is available in both English and German, and (d) a specific website containing information on climate change within the climate research department of the Central Institute for Meteorology and Geodynamics, the aim being to present information on climate change in a user-friendly, understandable form.[88]

Box 10. The Netherlands

The country's highly recognized climate research programs and long-standing expertise in agriculture place it at the forefront of CCA policy development and debates. The Netherlands is also actively engaged at the international level in promoting cooperation between countries and organizing knowledge-sharing events to identify optimal mitigation and adaptation solutions to offset the negative impacts of climate change.

The Netherlands published its first National Adaptation Strategy in 2007, followed by an updated adaptation strategy in 2016. The document sets out the country's objectives and strategies for adapting to climate change effects[89] in nine economic and social sectors, including agriculture. The Dutch Ministry of Infrastructure and the Environment is the coordinating body for climate change-related programs and policies. However, CCA measures are being developed and implemented by various ministries and local and regional public authorities, in close collaboration with private sector companies, scientific and research institutes, and various organizations. The Dutch Government is expected to present a more detailed Climate Adaptation Implementation Program in 2017, based on the content provided in the National Adaptation Strategy.

The Netherlands promotes and invests in systematic and state-of-the-art scientific research programs for better understanding the consequences of climate change in agriculture and

[85] http://www.hora.gv.at/
[86] https://www.bmlfuw.gv.at/umwelt/klimaschutz/klimapolitik_national/anpassungsstrategie
[87] http://www.klimawandelanpassung.at/ms/klimawandelanpassung/en/
[88] http://www.zamg.ac.at/cms/de/klima/informationsportal-klimawandel
[89] See generally, National Adaptation Strategy (2016) http://ruimtelijkeadaptatie.nl/publish/pages/118852/2016_12_02_nas_netherlands.pdf The NAS looks at nine sectors: water and spatial management; nature; agriculture, horticulture and fisheries; health and welfare; recreation and tourism; infrastructure (road, rail, water and aviation); energy; IT and telecommunications; public safety and security.

other sectors. The *Knowledge for Climate* program[90] plays a significant role in increasing awareness of climate change impacts and the necessity to adapt to them and brings together a wide range of stakeholders determined to take action. The Dutch Government relies on the use of infographics, interactive climate atlases and maps,[91] as well as animated and well-documented videos, to disseminate the available information on climate change in a user-friendly, accessible, and easy-to-use manner to wide audiences. It also frequently produces and publishes research studies, reports and action plans and organizes thematic workshops, knowledge-sharing conferences, and best-practice seminars.[92]

In addition to raising awareness on climate change impacts and encouraging various stakeholders to participate and act, there are various governmental projects and initiatives focused on innovative research in agriculture. For example, the Ministry of Economic Affairs recently commissioned a research on salt-tolerant crops and suitable irrigation techniques; this led to the development of a consortium of Dutch researchers that demonstrated that certain crops can tolerate salt water when the correct irrigation techniques are applied.[93]

A new Global Centre for Excellence on Climate Adaptation, led by the Netherlands, Japan, and the United Nations Environment Programme, and supported by a wide range of countries and international organizations and financial institutions, will be launched by the end of 2017 in the Netherlands.[94] This new center will collect information and knowledge from different adaptation policies, programs and projects developed in various parts of the world to serve and 'address the growing need for support among countries, institutions and businesses for dealing with CCA issues, such as natural disasters and economic disruptions'.[88]

Salt-tolerant crops and saline cultivation. SaltFarm Texel[95] is based in the Netherlands (on the Texel island) and specializes in salttolerant crops and provides the knowledge of saline cultivation under field conditions, including crop salt tolerance, (real-time) monitoring of soil salinity and fertilization strategies. It has created an open-air laboratory and set up a large research facility under field conditions. Within this farm, potatoes cultivated in saline soil were successfully grown. To ensure that the best practice and knowledge of the salt-tolerant seed potato is spread worldwide, a consortium was formed (Salt Farm Holland Potato), which ensures quick action and practical solutions for potato cultivation in different salt-affected areas.

[90] Knowledge for Climate Change Research programme http://www.knowledgeforclimate.nl/ This is a dedicated research programme in the field of climate change and adaptation.
[91] See, e.g., Story mapping and Climate Impact Atlas http://www.climateadaptationservices.com/en/products
[92] See, e.g., http://www.knowledgeforclimate.nl/agenda
[93]https://www.government.nl/latest/news/2017/02/23/dutch-saline-agricultural-knowledge-brings-breakthrough-in-food-security
[94]https://www.government.nl/topics/climate-change/news/2017/02/06/global-centre-of-excellence-on climate-adaptation-seeks-residence-in-the-netherlands
[95] http://www.saltfarmtexel.com/salt-farm-texel

Annex 6. Other Relevant EU CCA Legal Framework and Policies in the Agriculture and Fisheries Sectors

The 7th Environment Action Program[96] sets the common environment policy until 2020 and identifies three priority areas for which actions are needed across the EU: (1) to protect, conserve and enhance EU's natural capital; (2) to turn the EU into a resource-efficient, green, and competitive low-carbon economy; and (3) to safeguard EU's citizens from environment-related pressures and risks to health and well-being. The priority thematic objective is linked to EU's natural capital, which encompasses fertile soils and productive land and seas, as well as clean and fresh water.[97] Among other things, it highlights that one way to achieve better integration and coherence between climate change and other environmental concerns is to avoid counterproductive policies concerning fisheries.

Habitats Directive[98] is aimed at regulating the conservation of natural habitats and of wild fauna and flora and requires EU Member States to take adequate measures to maintain or restore certain habitats and species by providing them favorable conservation status within their natural distribution area.

EU's 2020 Biodiversity Strategy[99] aims to reverse the process of biodiversity loss and the degradation of ecosystem services in the EU by 2020. This EU strategy is built around six mutually supportive and interdependent targets that address the main drivers of biodiversity loss. The third target refers to increasing the contribution of agriculture and forestry to biodiversity, while the fourth target is about ensuring the sustainable use of fisheries resources, aiming to combat overfishing and ensuring a more sustainable ecosystem-based management of fisheries resources.

Horizon 2020, the EU Framework Programme for Research and Innovation, aims to dedicate 35 percent of funds to climate-related research, including adaptation. The program addresses knowledge gaps such as those identified in the EU Adaptation Strategy, including the development and testing of decision-making support tools, monitoring systems for adaptation, resilient infrastructures, and the integration of CCA in sectoral research. The 2016–2017 Work Programme focuses on 'food security, sustainable agriculture and forestry, marine and maritime and inland water research and the bio-economy'.[100]

Marine Strategy Framework Directive was adopted on June 17, 2008 and aims to achieve Good Environmental Status of the EU's marine waters by 2020 and to protect the resource base upon which marine-related economic and social activities depend according to Directive 2008/56/EC.[101]

[96] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN
[97] Natural capital includes vital services such as pollination of plants, natural protection against flooding, and the regulation of climate.
[98] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
[99] http://ec.europa.eu/environment/nature/info/pubs/docs/brochures/2020%20Biod%20brochure%20final%20lowres.pdf
[100] https://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-food_en.pdf
[101] Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive).

Water Framework Directive (WFD).[102] The overall objective of this Directive is to achieve good ecological status of surface waters (rivers, lakes/dam lakes) by 2015. To achieve this objective, the directive introduces a new, integrated approach to assess the status of surface waters, which is based on the concept of water ecosystems.

Legislation Related to European Agricultural Fund for Rural Development

Regulation (EU) No 1303/2013[103] is the main document for programming, implementing and managing the ESIF. The regulation defines 11 thematic objectives, including supporting the shift toward a low-carbon economy in all sectors; promoting CCA, risk prevention and management; preserving and protecting the environment and promoting resource efficiency. These objectives were taken into consideration for the preparation of the RDP 2014–2020. The regulation also includes a requirement to include and promote climate change mitigation and adaptation in Partnership Agreements and programs. Other specific provisions include Article 96(7) (a). Each operational program shall include a description of '(a) the specific actions to take into account environmental protection requirements, resource efficiency, climate change mitigation and adaptation, disaster resilience and risk prevention and management, in the selection of operations'. Article 101 (f) requires an analysis of the environmental impact, taking into account CCA and mitigation needs, and disaster resilience.

Regulation (EU) No 1307/2013[104] contains some provisions that concern climate and environment practices such as crop diversification, maintaining existing permanent grassland, soil and water quality, biodiversity, landscape preservation, and climate change mitigation and adaptation.

Regulation (EU) No 1306/2013[105] requires, among other things, member states to establish a *farm advisory service* aimed at advising 'beneficiaries on land management and farm management' so that they can get a better understanding of their duties and obligations.

Commission Implementing Regulation (EU) No 641/2014[106] sets out the scope and general principles for the payment for farmers observing agricultural practices beneficial for the climate and environment.

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[102] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy.

[103] Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006

[104] Regulation (EU) 1307/2013 of the European Parliament and of the Council of 17 December 2013 establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy and repealing Council Regulation (EC) 637/2008 and Council Regulation (EC) 73/2009 (Direct Payments Regulation). The improvement of the general environmental performance of the holding, in particular with regard to biodiversity, the improvement of soil and water quality, the preservation of landscape and meeting the climate change mitigation and adaptation objectives

[105] Regulation (EU) 1306/2013 of the European Parliament and of the Council of 17 December 2013 on the financing, management and monitoring of the common agricultural policy and repealing Council Regulations (EEC) 352/78, (EC) 165/94, (EC) 2799/98, (EC) 814/2000, (EC) 1290/2005 and (EC) 485/2008 (Horizontal Regulation).

[106] Commission Implementing Regulation (EU) No 641/2014 of 16 June 2014 laying down rules for the application of Regulation (EU) No 1307/2013 of the European Parliament and of the Council establishing rules for direct payments to farmers under support schemes within the framework of the common agricultural policy.

Regulation (EU) No1305/2013[107] explains how the European Agricultural Fund for Rural Development (EAFRD) works and sets out how the EAFRD aims to develop the agricultural sector over 2014-2020. This Regulation lays down general rules concerning the EU financing of rural development and provides that climate change mitigation and adaptation may be included and promoted in the rural development programs, and thematic subprograms.

Commission Delegated Regulation (EU) No 807/2014[108] provides for rules supplementing Regulation (EU) No 1305/2013 in relation to, among other things, young farmers, farm development, agri-environment-climate, animal welfare, and afforestation. It refers to the need for resilience to climate change in relation to afforestation of agricultural land including planting species that are ecologically adapted and/or resilient to climate change.

Commission Implementing Regulation (EU) No 808/2014[109] provides for rules supplementing Regulation (EU) No 1305/2013 in relation to the presentation and amendment of RDPs, the implementation of measures for rural development and the process for monitoring, evaluation, and reporting.

EU legislation related to fisheries

An important regulation concerning financial instruments for the European Maritime and Fisheries is **Regulation (EU) No 1303/2013.**[110] This regulation provides common provision rules applicable to the European Structural and Investment Funds (ESIF), European Regional Development Fund, the European Social Fund, and the Cohesion Fund. This regulation aims to improve the coordination and harmonization of the implementation of all funds. Part Four of Regulation (EU) No 1303/2013 lays down the general rules applicable to the funds and the EMFF on management, control, financial management, accounts, and financial corrections.

Regulation (EU) No 1380/2013 set rules to manage fish and aquaculture resources. The scope of the Common Fishery Policy includes the conservation of marine biological resources and the management of fisheries targeting them. In addition, it includes rules in relation to market measures and financial measures in support of its objectives, freshwater biological resources and aquaculture activities, as well as the processing and marketing of fishery and aquaculture products.

[107] Regulation (EU) No 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and repealing Council Regulation (EC) No 1698/2005.
[108] Commission Delegated Regulation (EU) No 807/2014 of 11 March 2014 supplementing Regulation (EU) of 11 March 2014 supplementing Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD) and introducing transitional provisions.
[109] Commission Implementing Regulation (EU) No 808/2014 of 17 July 2014 laying down rules for the application of Regulation (EU) No 1305/2013 of the European Parliament and of the Council on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).
[110] Regulation (EU) No 1303/2013 of the European Parliament and of the Council of 17 December 2013 laying down common provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund, the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund and laying down general provisions on the European Regional Development Fund, the European Social Fund, the Cohesion Fund and the European Maritime and Fisheries Fund and repealing Council Regulation (EC) No 1083/2006.

Regulation (EU) No 508/2014[111] regulates and defines European Maritime and Fisheries Fund (EMFF) priorities, measures, principle of management, reporting, budget implementation, control and so on. The scope of the EMFF includes support for the CFP for the conservation of marine biological resources, for the management of fisheries and fleets exploiting those resources, for fresh water biological resources and aquaculture, and for the processing and marketing of fishery and aquaculture products.

[111] Regulation (EU) No 508/2014 of the European Parliament and of the Council of 15 May 2014 on the European Maritime and Fisheries Fund and repealing Council Regulations (EC) No 2328/2003, (EC) No 861/2006, (EC) No 1198/2006 and (EC) No 791/2007 and Regulation (EU) No 1255/2011 of the European Parliament and of the Council.

Annex 7. Other Relevant National CCA Legal Framework and Policies in the Agriculture and Fisheries Sector

The National Regional Development Strategy for the period 2012–2022, approved by the Council of Ministers in August 2012, and the Regional Development Plans for the period 2014–2020, approved in August 2013, recognize climate change as a major issue for all regions and define the protection and restoration of the environment as main strategic goals. Specific targets vary for each region: reducing the sources of air pollution, improving the management and prevention of the risk of natural disasters, restoring damaged territories and protection from erosion, protecting and maintaining the biodiversity in protected territories, developing the infrastructure for the protection of the environment and adaptation to climate change, stimulating the use of renewable energy, and investing in water-supply, drainage and treatment of waste water and the waste management system, and so on.

The National Action Program for Sustainable Land Management and Combat against Desertification in Bulgaria (updated for the programming period 2014–2020) defines relevant actions for managing soils, water resources, and other natural resources to improve soil conservation, limit soil erosion, and improve their organic structure. The program contains a series of analyses for soil, water, crop, and animal resources and highlights the main factors contributing to the land degradation. It offers several strategic directions, programs, and measures for the protection and restoration of soil resources as well as measures for strengthening the institutional and technical capacity for sustainable land management and combat desertification.

The National Priority Action Framework for Natura 2000 in Bulgaria[112] is a strategic document developed as per the requirement of Art. 8 of the Habitats Directive. The document aims to improve the management of protected areas and to provide long-term protection of the favorable conservation status of species and habitats. The document also defines priorities for Natura 2000 at the national and regional level, ensuring efficient use of the available financial resources related to Natura 2000 and facilitating the integration of the abovementioned needs into programs financed by EU financial instruments for the period 2014–2020. A National Information and Communication Strategy for the Natura 2000 Network for the period 2014–-2023 was also developed to support the whole process of communication of Natura 2000.

The National Disaster Protection Program sets the objectives, priorities, and tasks for disaster protection in the country for a period of five years. This is the main document in the sphere of prevention, containment, and overcoming of the consequences of disasters and accidents and outlines the guidelines for creating an efficient, funded and technologically provided for national disaster prevention and response system. The strategic objective of the national program and the state policy for disaster protection is the prevention, containment, and overcoming of the consequences, the protection of the life and health of the people, and the preservation of the cultural heritage. The document highlights the risk of floods, hail, and droughts and their negative consequences on agriculture.

[112] National Prioritized Action Framework for Natura 2000 Bulgaria for the EU Multiannual Financing Period 2014–2020 (Final Version, April 2014).

River Basins Management Plans (RBMPs) for 2016–2021 have been prepared in accordance with the EU WFD[113] for each basin management district in the country: Danube Region, Black Sea Region, East Aegean Region and West Aegean Region. The RBMPs are strategic documents that regulate water management in basin management districts and are developed alongside Flood Risk Management Plans (FRMPs) for the same period to ensure coherence between the two strategic documents as elements of integrated river basins management.

Flood Risk Management Plans (FRMPs) are prepared by the basin management districts, pursuant to Directive 2007/60/EC. The FRMPs incorporate measures for protection of the vulnerable regions against the likelihood of flooding and for reducing the consequences of flooding by restoring flood plains and wetlands.

The Program of measures for the restriction and prevention of nitrates contamination from agricultural sources in vulnerable areas is mandatory for all farmers within the Nitrate Vulnerable Zones where the water has been polluted by nitrates from agricultural sources through infiltration or drainage. RDP 2014–2020 will contribute to achieving the objectives of this program.

The Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea provides a set of measures to apply for achieving and maintaining a 'good status' of the marine environment by 2020. However, the issue of climate change and its impact on fish and aquaculture is not sufficiently addressed.

As part of the development phase of the National Strategy for Adaptation to the Impacts of Climate Change, the 'Analysis and Assessment of Risks and Vulnerabilities of the Sectors in the Bulgarian Economy in View of Climate Change' framework document was developed. The document details the relevant climate models and scenarios for Bulgaria and their projections by sector, including agriculture. Furthermore, with the financial and technical support of the World Bank, the 'Financial management of disaster risk and insurance options for adaptation to climate change in Bulgaria' document was developed, with the main goal to analyze the importance of the insurance business in the risk prevention of climate change hazards and to provide recommendations for adaption measures.

Legal acts

The **Climate Change Mitigation Act,** promulgated in 2014, last amended in 2015 outlines the overall policy to be followed to mitigate climate change. The act also aims to ensure that there are long-term plans in place for climate change adaptation. The implementation of these measures is intended to ensure the mitigation of climate change and its impacts and to guarantee the fulfilment of Bulgaria's international obligations within the UNFCCC and Kyoto Protocol, as well as the EU legal framework. The act integrates the already existing climate change mitigation-related articles of the Environmental Protection Act.

There are several ordinances that are part of the Bulgarian legal framework in the agriculture sector. The ordinances provide for measures aimed at protecting the environment, improving the cultivation of the crops and life of the animals. There are also ordinances that correspond to

[113] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

the EU regulations for direct payments and implementation of the measures within the RDP 2014–2020. These ordinances include the following:

- **The Ordinance** of 3.12.2015 of the MAFF: it deals with the terms and conditions for the implementation of direct payment schemes (green direct payments); scheme for young farmers; scheme for small farmers; schemes coupled support; cotton payments, transitional national aid.
- **Ordinance № 5** of 27.02.2009 of the MAFF on the conditions and procedures for submission of applications by schemes and measures for direct payments (amended 26.05.2015);
- **Ordinance № 6** of 24.02.2015 of the MAFF on the application of Measure 13 'Payments to areas with natural or other specific constraints' of the RDP 2014–2020;
- **Ordinance № 9** of 03.21.2015 of the MAFF on the application of sub-measure 4.1 'Investments in agricultural holdings' of the measure 4 "Investments in tangible assets" from the RDP 2014–2020;
- **Ordinance №** 4 of 24.02.2015 of the MAFF on the application of measure 11 'Organic Farming' RDP 2014–2020
- **Ordinance № 5** of 24.02.2015 of the MAFF on the application of measure 12 'Payments Natura 2000 and the Water Framework Directive' of the RDP 2014–2020.
- **Ordinance № 2** of 04.04.2014 on the MAFF on the application of measure 'Restructuring and Conversion of Vineyards' and Restructuring and Conversion Plan from the National Program for Support of the Viticulture Sector (2014–2018).

Table 20. Selected legal acts relevant to agriculture

Scope of the Law	Gaps	Direction for change/ recommendations
Soils act		
This law was enacted in 2007 and its latest amendment is of July 18, 2017. This law regulates the preservation, restoration and improvement of the fertility of the agricultural lands and determines the conditions and order of changing their designation. It is aimed at soil protection, maintenance and restoration of soil functions. The law details the duties of the institutions (MoEW, MH, Ministry of Regional Development and Public Works, MAFF) in relation to administrative measures for conservation, sustainable use of the soil, monitoring and control soil quality.	There are no provisions related to climate change impacts on soils and/or the need for CCA.	Introduce specific provisions for the distribution of information on soil status (on a national level) Include a requirement for the MAFF to systemize data and information; to set up a database; and enhance the role of the ministry in relation to monitoring.

Scope of the Law	Gaps	Direction for change/ recommendations
Preservation of the Agricultural Lands Act		
This law was enacted in 1996 and its latest amendment is of July 18, 2017. It regulates the protection, restoration and improvement of the fertility of the agricultural lands. It sets out specific provisions related to farmers' obligations to protect the land (Article 3). Article 4 outlines the information provided by the MAFF to farmers[114] and requirement to set up information system for soil resources.	There are no provisions related to the climate change impacts on agricultural lands and/or the need for CCA.	Introduce requirements to take adaptation measures preserve the agricultural land
Protection of Plants Act		
The law was enacted in 2014 and its latest amendment is of July 18, 2017. It regulates the protection of plants from pests; it also deals with monitoring, diagnostics, prognosis, control; requirements for fertilizers, soil improvers, biologically active substances and food substrates, and control of the production, placing it on the market. The law regulates the scope of duties of the administrative unit of the Bulgarian Agency for Food Protection.	There are no provisions related to the climate change impacts on plants and/or the need for CCA.	Some supplements for prevention of damages on plants from climate change could be introduced.
Protection of Animals Act		
The law was enacted in 2008 and its latest amendment is of July 18, 2017. This law governs the protection of animals and more specifically the protection of their well-being in accordance with their physiological and behavioral characteristics.	There are no provisions related to the climate change impacts on animals/livestock and/or the need for CCA.	Addition of some provisions related to vulnerabilities of the animals to climate change.
Seed and Planting Material Act		
The law was enacted in 2003 and its latest amendment is of July 18, 2017. This law regulates the variety examination and the maintenance of the official varieties list of the Republic of Bulgaria. More specifically, it governs the maintenance of the varieties, the production and the preparation for the purpose of trade, the preservation, the packaging, the labelling, the trade, the import, the export and the control of the seed and propagating material from agricultural plants. The law sets up the responsibilities of the MAFF in relation to variety maintenance, production, trade, import and export of seed (Article 2). The law also outlines the function of the Executive Agency for Variety Testing, Approbation and Seed	There are no provisions related to the climate change impacts and/or the need for CCA.	Consider including specific regulations or other administrative measures related to climate change impacts or any relevant adaptation actions.

[114] The information is for: technological, environmental, and economic qualities of farmland, as well as the potential risks of deterioration due to erosion, pollution, salinization; the protection of the soil, the mandatory restrictions on the use of agricultural land; pesticides, fertilizers, industrial or household waste, the irrigation water quality, and anti-erosion crop rotation; and soil treatment.

Scope of the Law	Gaps	Direction for change/ recommendations
Inspection (Article 4), which carries out a variety test for the recognition and registration of the varieties of agricultural plants in the official varieties list, keeps a register of the applied for testing and the recognized varieties of agricultural plants, certifies the seeds basis on field inspections and laboratory analyzes, controls the sowing and produced planting material and export and import the varieties and planting materials, control the activity of the approved laboratories with regard to their laboratory analyzes to determine the seed qualities.		
Protection of New Variety of Plants and New Animal Breeds Act		
The law was enacted in 1996 and its latest amendment is of July 18, 2017. This law regulates the creation, protection and use of new varieties of plants and animal breeds, including hybrids (Article 1). The state institution responsible for protection and development of new varieties of plants and animal breeds are the MAFF and its Executive Agency for Variety Testing, Approbation and Seed Inspection, State Animal Breed Commission and Patent Office (Article 2). The law contains provisions for intellectual property for new varieties of plants and stock breeds, conditions for legal protection, conditions for certifying new varieties of plants and animal breeds, the rights of the owners, procedures for submission the certificates for the new varieties as well as the required documents.	There are no provisions related to the climate change impacts and/or the need for CCA.	The law may be updated to include regulations or other administrative measures concerning development of new varieties of plants and animal breeds in a sustainable manner and which are more resilient to climate change.

Fisheries and Aquaculture Act, promulgated in 2001, last amended on August 4, 2017. This act regulates the relations connected with the ownership, organization, management, use and conservation of fish resources in the waters of the Republic of Bulgaria, the trade of fish, and other aquatic organisms. The purposes of this act are to ensure: sustainable development of fish resources, restoration and conservation of the biologic equilibrium and enrichment of the diversity of fish resources in the water ecosystems, development of commercial fishing and angling and aquaculture, implementation of the rules for responsible fishing, and increase of the consumption of fish and fish products in the country. It is the main law in the fishery and aquaculture sector. However, the act does not include specific provisions or measures for the adaptation of aquatic ecosystems to the climate change and breeding fish and aquaculture in a sustainable manner. This could be improved by introducing administrative measures aimed at encouraging sustainable development of fish species and aquaculture, which are adaptable to climate change.

Biological Diversity Act, promulgated in 2002, last amended on September 19, 2017. This act regulates the relations among the state, the municipalities, and the juristic and natural persons in respect to the conservation and sustainable use of biological diversity in the Republic of

Bulgaria. The Bulgarian national legislation related to the ecological policy and biodiversity in the fisheries and aquaculture sectors is relatively strong. However, it is primarily aimed at protecting the species and their habitats, and their biophysical status. The vulnerabilities of the vegetation and animal species in water are not clearly defined. Climate change impacts, on the other hand, are defined but through the prism of sustainability of the ecosystems and measures for their protection. The division of responsibilities for environmental monitoring and protection of the environment between different ministries and intra-ministerial organizations is broadly defined and difficult to understand. This could be improved by adding annexes dealing specifically with preventing damages from climate change on aquatic ecosystems.

Annex 8. Other Relevant National Agencies and Research Institutes

Bulgarian Agency for Food Safety is the national competent authority to ensure compliance with the requirements for stock-breeding holdings in carrying out cultivation activities concerning health and animal welfare, fodder, safety and quality of food, as well as the application of hygiene and sanitary package of measures in processing establishments.

The Executive Agency on Vine and Wine is the state body engaged with operational management and control of the sector. The agency is a management body of the National Program for Support of the Viticulture and Wine Sector of Bulgaria for 2014–2018.

The Agency for Hail Suppression consists of eight regional directorates with nine command and rocket sites. The main function of the agency is to protect agricultural areas from hailstorms and to determine how to decrease the damages on the crops.

The Executive Agency of Variety Testing Field Inspection and Seed Control is an administrative unit of the MAFF and manages the procedures for the testing, recognition, and registration of plant varieties and breeds/hybrids/silkworm in the official varieties list of the Republic of Bulgaria.

Research institutes

Institute of Fisheries and Aquaculture to Agricultural Academy of Bulgaria. This is the leading research body in Bulgaria in relation to the industry. The institute was established more than 60 years ago, and throughout its whole history has performed research, application, and service activities in the field of fish farming in the country. Aquaculture development in Bulgaria is related to the work of scientists from the institute, which underlie the development and deployment of various technologies, introduction of new species, and development of a wide range of applications related to cultivation, raising, prevention and treatment of diseases.

Institute of Oceanology, BAS, Section Biology and Ecology of the Sea. The Institute studies the taxonomic and functional biodiversity of the Black Sea ecosystem and trophic interactions, examines changes in biota due to external factors – the anthropogenic pressure and global climate changes, develops methodological guidelines for monitoring and laboratory analysis of the Black Sea flora and fauna and classification systems for the biological quality elements in the implementation of the WFD 2000/ES/60 in Bulgaria, performs evaluations of the ecological status of waters and stocks intensively exploited fish species along the Bulgarian coast and adjacent water areas, develops science-based criteria for the sustainable development of ecosystems and biological resources with a modern laboratory for molecular taxonomy and ecology of marine organisms that performs genetic analysis for studying the population genetic structure of marine aquatic organisms.

Institute of Fishery Resources (IFR) at the Agricultural Academy of Bulgaria is a state research institute, founded in 1932. Since the early 1950s, the IFR is the only Institute that performs regular tests in the Bulgarian territorial waters.

Department Biology and Aquaculture at the Faculty of Agriculture of the Trakiya University. The Aquaculture division of the department is working in the following directions: development of intensive cultivation technologies for aquatic organisms, analysis of the

financial management of fish farms, environmental assessment of the aquafarms, market information and reduction of price risk in the aqua-production, economic analyses of the fish farms, environmental assessment of the fish farms and organic aquaculture.

Department Animal Science at the Agrarian University – Plovdiv: The department offers bachelor and master's degrees for zoo engineers who are trained in the disciplines Fishery and Technology for the production of quality and safe food in aquaculture. The major Agro-forestry Systems and Mountain Farming students also learn the discipline Fisheries.

Institute of Biodiversity and Ecosystem Research, BAS, conducts significant research in the field of theoretical and applied aspects of ecology, biodiversity, environmental protection and sustainable use of biological resources.

National Reference Laboratory (NRL) for diseases on fishes, marine mollusks and crustaceans to the National Diagnostic Research Veterinary-Medical Institute is a specialized structure within the Bulgarian Agency for Food Safety. It carries out research, laboratory diagnostics, and reference expert activity in the field of health aquaculture.

Annex 9. RDP Choice of Measures by Priority and Focus Areas

Figure 34 shows the priorities and focus areas that are selected in the RDP and the combination of measures used to address them. For each measure, the budget breakdown per focus area is given.

Figure 34. Priorities and focus areas in the Regional Development Plan

Priority	P1 Knowledge transfer & innovation			P2 Competi-tiveness			P3 Food chain & risk manage-ment		P4 Ecosystems management			P5 Resource efficiency & climate					P6 Social inclusion & local development				
Focus Area	1A - Innovation & cooperation	1B - Links with research & innovation	1C - Lifelong learning & vocational training	2A - Farm's performance, restructuring & modernisation	2B – Entry of skilled/younger farmers	2C - Forestry	3A - Agri-food chain integration & quality	3B - Risk prevention & management	4A – Biodiversity's restoration, preservation & enhancement	4B - Water management	4C - Soil erosion & soil management	5A - Water use efficiency	5B - Energy use efficiency	5C - Renewable sources & waste management	5D - Greenhouse gas & ammonia emissions	5E - Carbon conservation & sequestration	6A - Diversification & job creation	6B - Local development	6C – ICT - Information & communication technologies	Total	Planned expenditure (million EUR)
M01 - Knowledge transfer & information actions				20%	8%		1%	1%	23%			16%	10%	2%	15%	2%				100%	25.4
M02 - Advisory services				74%	7%		5%	1%	7%			1%	2 %	1%	1%	1%				100%	19.9
M03 - Quality schemes																					
M04 - Investments in physical assets				20%	3%		23%		19%			12%	14%	5%	5%					100%	840.9
M05 – Damage/restoration /prevention actions																					
M06 – Farm & business development				23%	28%		2%										47%			100%	270.7
M07 – Basic services & village renewal														11%				84%	5%	100%	625.7
M08 - Investments in forest areas						28%			27%							45%				100%	63.5
M09 – Producers groups & organisations							100%													100%	7.8
M10 - Agri-environment-climate									96%						4%					100%	223.3
M11 - Organic farming									100%											100%	151.6
M12 – Natura 2000 & WFD									100%											100%	139.7
M13 - Areas with constraints									100%											100%	275.6
M14 – Animal welfare							100%													100%	56.9
M15 – Forest-environmental-climate									100%											100%	8.8
M16 - Cooperation				24%			29%		30%			3%	3%	3%	3%	3%				100%	32.6
M17 – Risk management																					
M18 – Complementary payments to Croatia																					
M19 - LEADER/CLLD																		100%		100%	131.5

Source: The European Network for Rural Development, 2014–2020 RDP Key Facts and Figures for Bulgaria, Version 1, September 2015.

Annex 10. Indicative General Indicators

A few groups of general indicators are presented in ***Table 21***. The indicators are indicative and do not include specific indicators for soil matter, GHG emission, and other specific bio-physical variables, water availability, humidity, and precipitation climatic variables. Next steps should include defining the indicators in a more specific manner.

Table 21. Indicative general indicators

Indicator	Focus area	Indicators	Source information
OUTPUT INDICATOR	**Information and public awareness**		
		Number of seminars, workshop	MAFF (information platform)
		Number of officials trained on climate change issues (negative/positive impacts, adaptation/mitigation)	MAFF
		Number of research and scientific studies on climate change impacts	MAFF, Agrarian Academy
	Capacity building		
		Number of farmers benefit from training	MAFF
		Number of units in climate change policy	MAFF
		Number of farmers benefit of advisory service	MAFF
		Number of officials trained	MAFF
		Investment in research and scientific studies	MAFF
	Institutional capacity development		
		Number of strategies	MAFF
		Number of updated legal acts, regulations, ordinances, and so on	MAFF
		Proportion of budget allocated to CCA	MAFF
		Number of units engaged with agriculture	MAFF
		Number of new elaborated and certified crops	MAFF
	Adaption options at farm level		
		Number of soil and water conservation work	
		Area of farmland that adopted CCA technologies	
		Number of farmers with insurance for extreme climate events	MAFF, insurance companies
		Changes in land use (per ha)	MAFF
		Increase in soil organic matter (percentage)	MAFF
		Number of irrigation systems in farms	MAFF
		Increased water retention (percentage)	MEW, MAFF

Indicator	Focus area	Indicators	Source information
		Soil carbon level increase percentage)	MAFF
		Increase the number of employees in agriculture	NSI, Eurostat
		Increase of crop yield (percentage)	NSI, Eurostat
		Increase of crop output (percentage)	NSI, Eurostat
	Agricultural household Impact		
IMPACT INDICATOR		Increase of poverty and depopulation in rural areas (percentage)	MAFF, monitoring data
		Cost saving of adaptation measures (percentage)	MAFF, monitoring data
		Increase in income (percentage)	NSI, Eurostat
		Raised drought preventions in farms	
		Increase in crop insurance (percentage)	MAFF
		Agriculture productivity increased (percentage)	MAF, NSI, Eurostat
		Improved irrigation systems	MAFF
		Number of farm holdings affected by floods and prone to risk	MAFF
		Amount the capital spending in flood and drought risks	MAFF