Food and Agriculture Organization of the United Nations

Drought risk management guidelines Western Balkan region

Enhancement of Disaster Risk Reduction and Management (DRRM) capacities and mainstreaming Climate Change Adaptation (CCA) practices into the Agricultural Sector in the Western Balkans (TCP/RER/3504)

Drought risk management planning guidelines
Western Balkan region

Enhancement of Disaster Risk Reduction and Management (DRRM) capacities and mainstreaming Climate Change Adaptation (CCA) practices into the Agricultural Sector in the Western Balkans (TCP/RER/3504)

Food and Agriculture Organization of the United Nations
Budapest, 2018

Contents

Acknowledgements v

Acronyms vi

Introduction 1

Definition and different types of drought 2

Drought risk management and relevant international agreements 3

Drought impacts on agriculture in the Western Balkan region 4

Climate change projections and the expected impacts on agriculture 10

Drought risk management 14
- Enabling legal, policy and institutional environment 14
- Early warning system 15
- Drought prevention and mitigation measures 17
- Drought preparedness activities 19
- Drought response actions 20
- Post-drought recovery initiatives linked to long-term development 22

Drought projects in the Western Balkan region 23

References 26

Boxes
Box 1 Voluntary guidelines for fire management 6
Box 2 Monitoring agricultural drought with remote sensing data 17
Box 3 Voluntary guidelines for sustainable soil management 19
Box 4 Livestock Emergency Guidelines and Standards (LEGS) 22

Figures
Figure 1 Crop and livestock production losses per disaster type, 2005-2014 5
Figure 2 Montenegro Map of drought intensity: SPI3 – agricultural drought 2003, SPI 12 – hydrological drought 2007 and 2011 10
Figure 3 Combined economic losses by type of hazards in Serbia, 1990-2014 11
Figure 4 Agriculture Stress Index (ASI) 17
Figure 5 Livestock Emergency Guidelines and Standards (LEGS) 26

Tables
Table 1 Direct and indirect impacts of drought on natural resources, ecosystems & other services 6
Table 2 Examples of the impact of droughts and on agriculture in Bosnia and Herzegovina, 2002-2007 7
Table 3 Typical drought years in Montenegro by decade 9
Table 4 Simplified Drought User Service Scheme 12

Acknowledgements

Under the technical guidance of Dr. Reuben Sessa, Climate Change, DRR and Energy Coordinator of the Regional Office for Europe and Central Asia, this document has been developed and written by Tamara van 't Wout with valuable support provided by Anastasia Tikhonova, Food and Agriculture Organization of the United Nations.

Acronyms

ASI	Agriculture Stress Index
ASIS	Agriculture Stress Index System
CCA	Climate Change Adaptation
DMCSEE	Drought Management Centre of South-East Europe
DRRM	Disaster Risk Reduction and Management
FAO	Food and Agriculture Organization of the United Nations
FYR	Former Yugoslav Republic (of Macedonia)
GFDRR	Global Facility for Disaster Risk and Recovery
GSP	Global Soil Partnership
HFA	Hyogo Framework for Action 2005-2015
IPA	Instrument for Pre-Accession Assistance
NGO	Non-Governmental Organisation
PDNA	Post-Disaster Needs Assessment
SDG	Sustainable Development Goal
SFDRR	Sendai Framework for Disaster Risk Reduction 2015-2030
SSM	Sustainable Soil Management
UNFCC	United Nations Framework Convention on Climate Change
UNCCD	United Nations Convention to Combat Desertification
VHI	Vegetation Health Index

Introduction

Drought is a slow onset phenomenon, in contrast to rapid-onset natural hazards, such as (flash) floods, earthquakes and landslides. As a result, the impact of drought may be felt slowly as it is considered a creeping natural hazard. It is estimated that since 1990 over 11 million people have died and more than 2 billion have been affected by drought (FAO, 2003). Droughts can result in ill health and ultimately death due to the lack or limited access to adequate water supplies and often trigger or worsen malnutrition and famine.

Agriculture is highly impacted by drought due to the climate sensitive nature of the sector. Water is an essential natural resource for the production of food. It helps with the e.g. germination of seeds, the growth of plant roots, conversion from starch to sugar and transpiration, which facilitates the absorption of nutrients from the soil to the green plant tissues. In particular, as precipitation is expected to decrease in certain regions in the world, due to climate change, the sustainable application and management of water will be essential to increase the productivity of agriculture. The latter is highly important due to e.g. the growth of the world population and the increasing demand for food and feed within the context of limited resources such as available land and water and the expected impacts of climate change on the sector.

The Western Balkan region is vulnerable to various natural hazards, including droughts, which generally occur during the summer months. The impact of these hazards on the agriculture sector is considered to be higher than any other natural hazard. However, post-disaster damage and loss figures for the sector are often lacking or not systematically and comprehensively collected, in particular for drought. Adequate, accurate and reliable data is, however, highly important, in order to measure the effectiveness of disaster risk reduction investments in the sector, through e.g. cost-benefit analyses.

This document is prepared as one of the outputs of the FAO project 'Enhancement of Disaster Risk Reduction and Management (DRRM) Capacities and Mainstreaming Climate Change Adaptation (CCA) practices into the Agricultural Sector in the Western Balkans' (TCP/RER/3504). This project aims to increase the resilience of farming communities to natural hazards, in particular floods, landslides and droughts, in Albania, Bosnia and Herzegovina, the Former Yugoslav Republic (FYR) of Macedonia, Montenegro and Serbia.

Objective

The objective of these guidelines is to enhance drought risk management planning in agriculture in the Western Balkans. It aims to provide an overview of the different components of drought risk management, including related to the legal, policy and institutional environment and the other components, such as early warning systems, possible interventions that help to prevent, mitigate, prepare for, respond to and recover from the effects of drought for the agriculture sector.

Target audience

These guidelines are targeting e.g. policy makers, extension officers, development practitioners and NGOs.

Methodology

These guidelines are established through desk research and secondary literature review of relevant articles, publications, documents, data from e.g. EU, FAO, World Bank, CRED-EMDAT, DesInventar databases.

Definition and different types of drought

Drought is generally defined as "an extended period - a season, a year, or several years – of deficient precipitation compared to the statistical multi-year average for a region that results in water shortage for some activity, group or environmental sector" (FAO, 2003). However, other types of definitions are also used, which refer to the lack of rain over various time periods or measure impacts, such as reservoir levels or crop losses and so on. Additional factors, such as high temperatures, high winds and low relative humidity have the potential to contribute to the severity of this natural hazards.

As different types of droughts are distinguished, the following are the categorizations that are the most widely used:

- *Meteorological drought* is referred to when precipitation departs from the long-term normal over a certain period of time. These meteorological measurements are the first indicators of a drought;

- *Agricultural drought* occurs when there is insufficient soil moisture to meet the needs of a particular crop at a certain time. An agricultural drought is usually apparent after a meteorological drought, but before a hydrological drought. The agriculture sector is often one of the first sectors to be affected by this natural hazard. It becomes evident as it adversely impacts agriculture through precipitation shortages, potential evapotranspiration, soil water deficits and reduced groundwater levels among others;

- *Hydrological drought* happens when deficiencies arise in the surface and subsurface water supplies. This type of drought is assessed as stream flow and the level of water in lakes, rivers, reservoirs as well as ground water levels. Due to a reduction in precipitation over a certain period of time, surface and subsurface water levels decrease, however there is delay between diminished rainfall and observation in the water levels. Moreover, hydrological drought can be worsened by human activities, such as changes in land use and land degradation, which can adversely affect the extent and occurrences of this type of drought;

- *Socio-economic drought* materializes when human activities are affected by reduced precipitation and water availability. This type of drought connects the supply and demand of certain economic goods and human activities with elements of meteorological, agricultural and hydrological drought. It can be distinguished from other drought types as its occurrences is related to human activities and its reliance on the processes of supply and demand as the demand for a certain economic good, for instance, water, forage, fish, hydropower is larger than the supply, due to reduced rainfall, which results in social and economic impacts.

Drought can be further characterized based on the time of occurrence of the event, namely into the following three categories: permanent, season and contingent. Permanent drought is a characteristic of the desert climate, where agriculture production can only be undertaken with irrigation during the entire cropping season. Whereas seasonal drought is present in arid and semi-arid climates with clearly defined rainy and dry seasons, while contingent drought may happen in most parts of humid or sub-humid climates and is the result of an abnormal failure of precipitation that is generally brief, irregular and usually affects solely a small area.

Drought risk management and relevant international agreements

The five Western Balkan countries that are the focus of this drought management guidelines are signatories of various relevant international agreements through which they have shown their willingness and commitment to address and reduce drought impacts and increase the resilience of their country's communities as well as the linkages between drought and desertification, poverty reduction and sustainable development among others.

Disaster risk reduction is addressed through international frameworks, including the Hyogo Framework for Action (HFA) 2005-2015 and its successor the Sendai Framework for Disaster Risk Reduction (SFDRR) 2015-2030. The SFDRR's outcome is *"the substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries"* (UNISDR, 2015: 12). The focus on disaster risk reduction is a paradigm shift that focuses on moving away from a reactive emergency response to more proactive DRR approach.

Enhancing the resilience of agriculture-dependent communities to natural hazards and climate change, requires e.g. the establishment of a robust evidence base. This includes a thorough analysis of existing agricultural production trends and the adverse impacts of natural hazards that lead to damages and losses in the crops, livestock, forestry and fisheries sectors. It involves establishing comprehensive agriculture baselines as well as accurate and reliable agriculture post-disaster damage and losses data, which can help to bridge the information gap and inform decision-making for DRR investments and interventions to establish climate-resilient agricultural systems.

Natural hazards can lead to significant losses and can substantially set back national development gains. Women, children, elderly and other vulnerable people are disproportionally affected by these hazards, which can push these countries and communities into poverty loops as well as impede progress towards sustainable development. As it is anticipated that climate change, will increase the frequency and intensity of natural hazards, national disaster risk reduction strategies are essential to be developed and linked to national and international climate change, poverty eradication and sustainable development frameworks.

The United Nations Framework Convention on Climate Change (UNFCCC), for instance, acknowledges the connection between climate change and natural hazards as well as the linkages between disaster risk reduction and climate change adaptation. In addition, the Sustainable Development Goals (SDGs) framework, which consists of 17 goals and is part of the wider 2030 Agenda for Sustainable Development, including relevant for food security, agriculture, disaster risk reduction, goals e.g. 1 'poverty', 2 'zero hunger', 5 'gender equality', 6 'clean water and sanitation', 13 'climate action', 14 'life below water', 15 'life on land' and 17 'partnerships to achieve the goal'.

Drought and desertification are closely related and linked phenomena as drought can be worsened by human activities and climatic variations, which can lead to the degradation of land in arid, semi-arid and dry sub-humid areas and can also have adverse impacts on the living conditions and economic development of the people affected by it. The United Nations Convention on Combatting Desertification (UNCCD), established in 1994, is the legally binding international agreement that links the environment and development to sustainable land management. The Convention has been ratified by 195 states and the European Union, including the five Western Balkan countries of Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia (UNCCD, 2017).

Drought impacts on agriculture in the Western Balkan region

Global overview

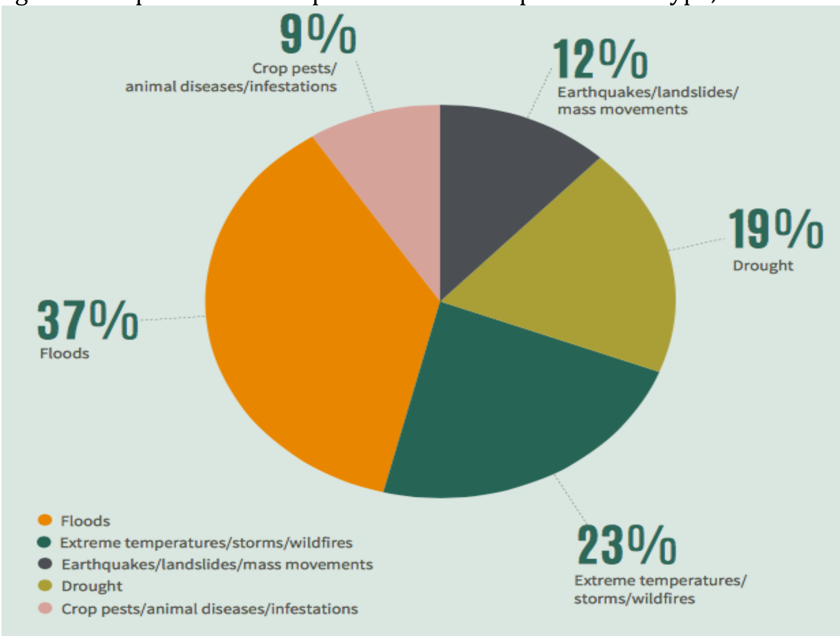
According to a study conducted in 2015 by the Food and Agriculture Organization of the United Nations (FAO), approximately 22 percent of the total damage and losses from natural hazards in developing countries were incurred by the agriculture sector. In addition, the linkage between agriculture and drought is particularly strong as 84 percent of the damage and losses caused by droughts were to the agriculture sector, followed by impacts on other sectors, such as health and nutrition, energy, water and sanitation. Moreover, according to this study, during the period of 2003 to 2013, medium and large-scale drought events affected the livestock sector the most, followed by the crop, fisheries and forestry sector (FAO, 2015).[1]

It is estimated that between 2005 and 2014, around USD 93 billion was globally lost in terms of crop and livestock losses due to natural hazards and disasters in developing countries, of which over USD 17 billion in agricultural losses were caused as a result of drought (FAO, 2017). The impact of natural hazards on agriculture manifest itself through causing damages to critical agricultural facilities, equipment and infrastructure as well as leading to losses in the crops, livestock, forestry and fisheries subsectors and thereby, disrupting agricultural production cycles, trade flows and livelihoods. This also affects food and nutrition security, in particular those of the most vulnerable people, for whom agriculture is often used for subsistence only. As a result, these disasters may undermine and slow overall economic growth, especially in developing countries where the majority of the population relies on the sector and its activities for their employment and income.

[1] This study was undertaken by assessing the Post-Disaster Needs Assessment reports developed by the Global Facility for Disaster Risk and Recovery (GFDRR), as a result, the figures are likely to be underestimated as only the data from these medium to large-scale droughts events were included.

The impacts of drought are estimated to be the largest on the agriculture sector, however, accurate and reliable data is often missing. Other natural hazards, such as floods and extreme temperatures/storms/wildfires, are therefore often mentioned as the hazards that are causing the most crop and livestock losses as shown in figure 1.

Figure 1 Crop and livestock production losses per disaster type, 2005-2014



Source: FAO, 2017

Agriculture is highly impacted by drought due to the climate sensitive nature of the sector. Water is an essential natural resource for the production of food. It helps with the e.g. germination of seeds, the growth of plant roots, conversion from starch to sugar and transpiration, which facilitates the absorption of nutrients from the soil to the green plant tissues. However, due to the limited information available on the impacts of drought on the agriculture sector, the damages and losses are often underreported.

Droughts have various direct and indirect socio-economic and environmental impacts. The sector experiences different economic impacts on its subsectors, due to its dependence on the surface and subsurface water supplies. Table 1 provides a non-exhaustive list of these direct and indirect impacts.

Table 1 Direct and indirect impacts of drought on natural resources, ecosystems and other sectors

Direct impacts	Indirect impacts
▪ Reduced crop, rangeland and forest productivity	▪ Reduced income for farmers and agribusiness
▪ Reduced water levels	▪ Risk of foreclosures on bank loans to farmers and businesses, who may lose their assets
▪ Increased fire hazard	▪ Increased prices for food and timber
▪ Damage to wildlife and fish habitat	▪ Increased unemployment
▪ Increased livestock and wildlife mortality rates	▪ Reduced tax revenues
▪ Increased insect infestations	▪ Increased crime and insecurity
▪ Increased plant diseases and weeds	▪ Migration
▪ Increased wind erosion	

Source: FAO, 2013

For example, a direct impact of drought is enhanced fire risk. In Serbia, wildfires are primarily triggered by droughts, but also due to human causes, which are widespread and regularly occur during the dry summer season and threaten approximately 28 percent of the Serbian territory that is covered by forests. Between 1998 and 2008, 853 forest fires affected an area of 16 357 ha with 258 forest fires counted in 2007 alone, which caused approximately EUR 40 million in damages and burned more than 5 200 ha (Aleksić *et. al.*, 2009).

Box 1 Voluntary guidelines for fire management

There is a strong link between droughts and forest fires, not only regarding forest fire occurrence and area expansion due to drought, but also the interaction between various factors, including forest productivity, topography, weather, management activities, which can affect fire intensity, severity, extent and frequency. Forest fires, which are primarily the result of droughts, but often also due to human activities, are equally frequent and widespread during the summer across the Western Balkan region.

Forest fires can cause extensive damage, which can result in degradation of forest ecosystems and protected areas, affect biological diversity, increase soil erosion, sustainable development and so on. It also reduces forests' ability to mitigate the impact of natural hazards, such as floods and landslides among others.

In order to better manage fire, voluntary, non-binding guidelines for fire management were established, which provide a framework of priority principles that can help with the development of policy, legal, regulatory and other enabling conditions and strategic actions for integrated approaches to fire management. Of the 11 principles outlined in the guidelines, the principles 1 (Sustainable livelihoods), 2 (Human health and security), 4 (Protecting lives and assets), 6 (Interactions between climate change and fire) and 7 (Fire effects on ecosystems) are the most relevant within the context of drought risk reduction and safeguarding people's lives, assets and livelihoods within the context of expected future climatic changes.

For more information on the voluntary guidelines for fire management:
http://www.fao.org/docrep/009/j9255e/j9255e00.htm

There is also a relationship between droughts and pests, diseases and weed growth, as optimal conditions can be created for pests, diseases and weeds to occur and invade new areas. There are some diseases that will happen due to drought related stress on plants, which include e.g root rots, cankers, wood rots and wilt as well as susceptibility to other diseases, such as *Diplodia* tip blight, *Rhizosphaera* needlecast and *Verticillium*. Drought stressed trees and shrubs can also experience the invasion of wood boring insects, like the bronze birch borer, black stem borer (Ambrosia beetle) and other bark beetles (Kujawski, 2011). In addition, the dry soil conditions result in the prolonging of the longevity of weed seed banks and drought can decrease the competitiveness of native plants and enhance the chances for weed invasions, which can negatively affect the production of crops (Australian Government, 2017).

Wind erosion is the process of soil movement from one place to another place by the wind. It can greatly impact agricultural production and the environment by e.g. removing the fertile top layers of soil and organic matter, burying or sandblasting pastures and crops as well as depositing salt and causing blue green algal blooms. Drought can also increase the impact of wind erosion, due to the i) reduced precipitation, which results in decreased growth of vegetation, while vegetation normally fixes the soil in place; and, ii) reduced soil moisture, which also means that the soil particles can more easily be blown away. In addition, when ecosystems are healthy they are better able to withstand and reduce the impacts of natural hazards.

Indirectly drought has various impacts, including on the economy, prices and food and nutrition security. The agriculture sector is among the sectors that will be affected as farmers may lose income as well as food if the drought destroys their crops or kills their livestock. When the supply of certain vegetables is reduced and the demand is still present or increase, prices of these products tend to increase as well. The 1993 drought in the Former Yugoslav Republic of Macedonia, for instance, led to a total crop failure, which was calculated at 7.6 percent of the total national income (WMO, 2012). Moreover, the 2007-2008 drought in Tajikistan that reduced crop yields by over 40 percent (CAREC, 2015), which in combination with the global rise in food prices resulted in 2.2 million people being undernourished (FAO, 2008).

The Western Balkan countries of Albania, Bosnia and Herzegovina, the Former Yugoslav Republic of Macedonia, Montenegro and Serbia, are vulnerable to various natural hazards, including floods, storms, landslides and forest fires and droughts among others. According to the international disaster database from CRED-EMDAT, floods have occurred the most frequently in all five Western Balkan countries and have resulted in substantial economic losses. However, the extent of the drought impacts, especially on the agriculture, should not be underestimated. Information about the occurrence of droughts as well as the exact impacts on the sector are often missing, due to e.g. lack of systematic and comprehensive data collection. In the following sections, an overview is provided of the available drought impact data on the sector per country.

<u>Albania</u>
Droughts have had large scale negative impacts on the agricultural sector in Albania. It has been estimated that more than 3 million people were affected by the 1989-1991 drought, which was one of the most significant disasters that occurred in Albania, which costed the economy USD 24 million (UNDP, 2015). The 'energy crisis' of November 2003 along with electricity interruptions in 2007 were also the results of periods of drought, as the average production of the Fierza hydroelectric power plant decreased by 33 percent due to the impact of this hazard (Laska Merkoci *et al.*, 2012). It is expected that due to climate change, drought will adversely impact agriculture more than floods and landslides.

Bosnia and Herzegovina

Various areas in Bosnia and Herzegovina are prone to drought, especially in the north eastern and south western parts, that usually occurs from June to September. Among major droughts that have affected the agriculture sector are those of 2002, 2003 and 2007 as outlined in table 2 below.

Table 2 Examples of the impact of droughts and on agriculture in Bosnia and Herzegovina, 2002-2007

Event	Year	Impact on agriculture
Drought (worst in 120 years)	Aug 2002	Agricultural production reduction of 60 percent, which resulted in a serious food crisis
Drought & storms	Summer of 2003	Agricultural damages of EUR 200 million
Drought	Summer of 2007	More than 40 percent of the country's crop production destroyed and 250 hectares of land were affected by forest fires, led to high food prices

Source: WMO, 2012; ICPDR, 2015

A drought in 2012 affected the Western Balkan region and in particular Bosnia and Herzegovina, which caused over USD 1 billion in agricultural production losses and reduced yields of grains and vegetables of up to 70 percent (Zurovec et al., 2015). Maize production was the most affected, which is the primary raw material for the production of animal feed, while other losses were experienced regarding the cultivation of e.g. barley, soybeans, alfalfa, clover, beans, meadows and pastures, which resulted in a lack of fodder. This adversely affected the number of livestock, livestock and milk production as well as the supply of meat for the domestic market, which increased food prices and reduced the export of agricultural products.

Another drought that impacted the region occurred in the summer of 2015, when the water balance anomalies were 100 mm below the long-term average. Despite some rainfall in mid-Aug, it was not sufficient to end the dry conditions, which continued until the beginning of October when the precipitation deficit was 180 mm (ICPDR, 2015). It is estimated that the agriculture sector was the hardest hit by the 2015 drought, however, specific damage and losses figures are lacking.[2]

The Former Yugoslav Republic of Macedonia

The FYR of Macedonia is among the most arid countries in Europe. The majority of droughts occur in the rural areas of the southern and eastern regions of the country and adversely impact the agriculture sector. The most vulnerable agricultural zone is the Povardarie region, in particular the areas of the Crna, Bregalnica and Vardar rivers. The exact impact of the droughts on the sector is often not available, for instance, with regard to the droughts of 2003 and 2006-2007 on e.g. crop, grasses and fodder production. Although, the extensiveness of the 1993 drought, which led to a total crop failure was calculated and estimated at 7.6 percent of the total national income (WMO, 2012).

[2] At present, systematic collection of specific agriculture pre-disaster and post-disaster damage and loss data is often lacking. However, understanding the exact impact of natural hazards on agriculture and people's livelihoods is of utmost importance in order to better understand people's vulnerabilities and risks as well as to better inform decision-making and undertake effective risk reduction measures and investments.

Montenegro

According to the Montenegro's Second National Communication on Climate Change (2015), several droughts have been recorded since the 1950s as displayed in table 3.

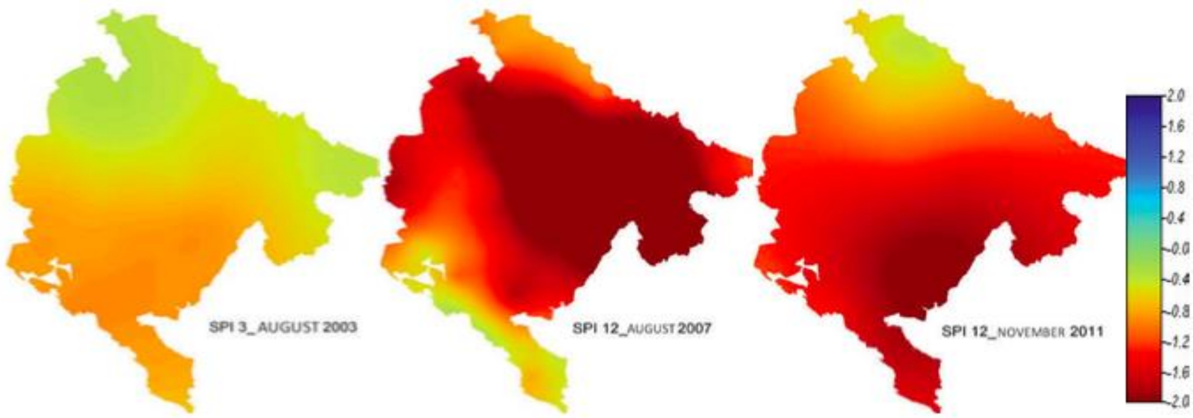
Table 3 Typical drought years in Montenegro by decade

'51 - '60	'61 - '70	'71 - '80	'81 - '90	'91 - '00	'01 - '10
1953	1962, 1967, 1969	1978	1981, 1982, 1985, 1988, 1989	1993, 1994, 1996, 1999	2003, 2007, 2008, 2011

Source: Ministry of Sustainable Development and Tourism, 2015

More recent droughts include the drought of 2003 has been observed as an agricultural drought, which affected the Coastal region, Zeta Bjelopavlići region and the Northern region up to 1,000 m above sea level. In addition, the 2007 drought affected the entire territory, but in particular the kart regions in the north-west and the northern mountainous region and was considered a hydrological drought. Moreover, the drought of 2011 evolved even into a social and economic drought that also affected the whole country and led to an extreme hydrological deficit in Zeta Bjelopavlići region, which includes the largest agricultural area as displayed in figure 2 (Ministry of Sustainable Development and Tourism, 2015). These extreme dry conditions led to forest fires in the following year. The frequent and intense drought adversely impact the e.g. quality of the yield, revenues, the costs to prevent and control the spread of diseases, insects and weeds as well as the irrigation rate.

Figure 2 Montenegro Map of drought intensity: SPI3 – agricultural drought 2003, SPI 12 – hydrological drought 2007 and 2011.[3]

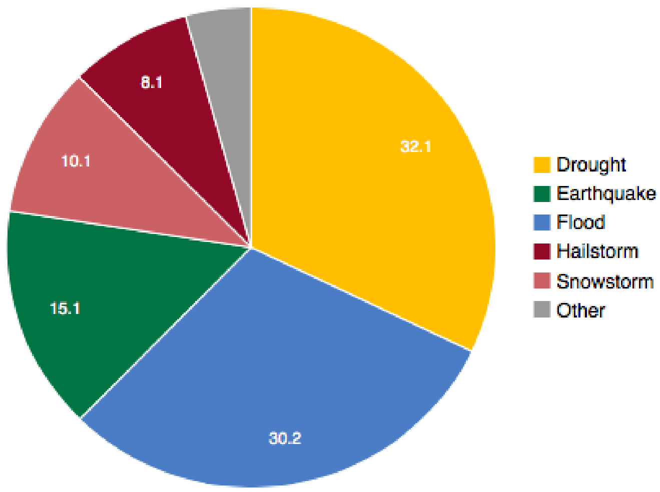


Source: Ministry of Sustainable Development and Tourism, 2015

[3] Expressed through anomalies of the Standard Precipitation Index (SPI), which is a tool that helps to define and monitor drought.

Serbia
Droughts are most prevalent in the eastern part and in the Pannonian Basin in the northern part of Serbia. Three catastrophic droughts occurred in Serbia in the last 20 years. According to temperature and precipitation data during the period of 1991-2010 as well as the average maize yields, the extremely dry years were 1992, 1993, 1998 and particularly 2000, 2003 and 2007 (WMO/UNCCD/FAO & UNW-DPC, 2013.). In addition, a severe drought affected Sremska Mitrovica during April to September 2009, while Central Serbia was also affected by this drought (Duričin and Bodroža, 2013). Moreover, the country was again affected by a drought during the summer of 2012, with estimated agricultural production losses of approximately USD 2 billion, which included e.g. corn (USD 1 billion), sugar (USD 130 million), soybeans (USD 117 million), fruits and vegetables (USD 100 million), sunflowers (USD 55 million) and other agricultural crops (USD 600 million)(USDA Foreign Agricultural Service, 2012). Droughts have caused more economic losses than floods during the period of 1990-2014 in Serbia as shown in figure 3.

Figure 3: Combined economic losses by type of hazards in Serbia, 1990-2014



Source: CRED EM-DAT, 2015

According to the WMO, UNCCD, FAO & UNW-DPC (2013) report, the mean annual economic losses as a result of floods on agriculture are estimated between € 38.75 to € 106.25 million, whereas it is calculated at about € 500 million for the impact of droughts on agriculture. As a result, these figures indicate that the impact of drought on agriculture is much higher than for floods. However, due to the limited available agriculture post-disaster damage and losses data, in particular for droughts, these figures and percentages remain estimations.

Climate change projections and the expected impacts on agriculture

It is expected that global temperatures will increase due to climate change, which may lead to more frequent and longer heat waves, more hot days and nights, fewer days with frost and cold days and nights. In addition, less precipitation is expected, which may lead to more frequent droughts as well as an increase in the number of forest fires. It is anticipated that climate change will increase the frequency and severity of many types of extreme weather events, which include besides droughts and forest fires, also floods and storms. Moreover, seasonal patterns may shift, which will lead to greater variability that may adversely affect the agriculture sector.

Moreover, as precipitation is expected to decrease within the context of climate change, the sustainable application and management of water will be essential to increase the productivity of agriculture. The latter is highly important for ensuring food security, due to e.g. the growth of the world population and the increasing demand for food and feed given the limited natural resources, such as available land and water, and the expected impacts of climate change on the sector.

Similar trends in terms of temperature rises and reductions in precipitation are also anticipated in the Western Balkan region. Climate change, for instance, may have an adverse impact on the fertility of the land as there is an increased risk of erosion as a result of temperature rises and more frequent and intense droughts, in particular an anticipated reduction is expected during the summer. An overview of the climate change projections, in particular related to droughts and expected impacts on the agriculture sector, are described for each of the five Western Balkan countries in the following section.

Albania

In terms of temperature increases, it is expected that Albania's coastal area will, in particular, become warmer due to climate change. This temperature rise is also observed on an annual and seasonal basis as displayed in table 4 below.

Table 4 Projections of temperature changes (°C) for different time horizons

Years	2030	2050	2080	2100
Annual	1.0 (0.7 to 1.2)	1.7 (1.3 to 2.2)	2.8 (2.0 to 3.5)	3.2 (2.4 to 4.1)
Winter	0.8 (0.7 to 0.9)	1.2 (1.1 to 1.4)	2.0 (1.7 to 2.3)	2.4 (1.9 to 2.7)
Spring	1.0 (0.8 to 1.2)	1.5 (1.3 to 1.8)	2.6 (2.2 to 3.0)	3.1 (2.6 to 3.6)
Summer	1.6 (0.5 to 1.8)	2.5 (2.1 to 2.8)	4.3 (3.8 to 4.9)	5.3 (4.6 to 6.0)
Autumn	1.0 (1.0 to 1.1)	1.6 (1.5 to 1.8)	2.8 (2.7 to 3.0)	3.5 (3.2 to 3.7)

Source: Ministry of Environment, 2016

It is anticipated that precipitation patterns will also change due to climate change, which can have a substantial negative impact on agriculture. On the one hand, it is expected that at certain moments, there will be excess rainfall, which may lead to flooding and results in physiological and direct physical stress on plants and animals as well as the occurrence of dry spells and droughts. The latter is expected to be more the case, with general projections of annual precipitation reductions of up to -8.5 percent by 2050 and by up to -18.1 percent by 2100 (Ministry of Environment, 2016).

Due to the seasonal temperature expectations, the start date of the cropping season will likely shift towards earlier dates in February in the entire coastal area and the end date will move towards later dates in December. As a result, the production duration will be extended with 37 to 22 days from north to south, respectively compared to 1990. In addition, the largest temperature rises will likely occur during the spring and summer, which coincides with the period of plant growth and their fructification that can lead to substantial losses. For instance, it is expected that e.g. soybean, maize, spring wheat, barley, beans, tomatoes, cabbage, millet, onion, sorghum, pepper, sunflower and watermelon will be negatively impacted. Moreover, for the majority of the crops, the annual amount of rainfall will be insufficient to meet their needs, therefore supplementary irrigation will be required.

Bosnia and Herzegovina

In Bosnia and Herzegovina, projections have been made regarding the expected temperature rises well as the precipitation reductions, although initially an increase is anticipated, which is then followed by a decrease in precipitation from the 2040s onwards. According to various scenarios, temperature increases vary from +1 °C to +2.4 °C during the period of 2011 to 2040 and from +3.8 °C to +5.6 °C during the 2041 to 2070 period. In terms of precipitation, an increase of +5 percent is expected for most of the country during the 2011-2040 period, while a reduction in rainfall is anticipated of around 10 percent for the 2041-2070 period with further decreases of between 10 to 20 percent for the 2071-2100 period, which are expected to lead to droughts (UNDP in Bosnia and Herzegovina, 2016).

It is expected that on the one hand climate change may have a positive impact on the yield and quality of winter crops, such as fruits, including grapes, due to the longer growing periods as very cold winters and late spring frosts will disappear in Bosnia and Herzegovina. On the other hand, the production of spring crops will be vulnerable to increasing temperatures and water shortages during the summer, which will reduce the growing season for these crops. It is also projected that there will be a decline in the yield and quality of pastures and feed, particularly for spring crops, as well as the expected depletion of pastures due to heavy rains and strong winds. In addition, the outbreak of plant pests and diseases may occur, due to the longer growing period as a result of the increasing temperatures in winter and early spring, which will likely adversely affect agriculture as well.

FYR of Macedonia

As in the other Western Balkan countries, it is expected that the FYR of Macedonia’s climate will become hotter and moderately drier, with significant reductions in summer precipitation and more frequent and severe extreme events, such as droughts and floods. Regional differences are expected, with the largest temperature rise projected in the mountainous north-western region with minimal reductions in precipitation up to 2050, while the south-eastern and central regions are likely to warm at a slightly slower pace, but with greater precipitation reductions, such as a 19 percent decrease projected in summer precipitation by 2100 (Ministry of Environment and Physical Planning, 2008). Given the importance of spring and summer rainfall for crop flowering and growth, this will significantly impact agricultural production, water availability, food security and economic growth of rural livelihoods in the country.

It is expected that the central and south eastern regions will be primarily affected, in particular crop and animal production. Reduction in winter wheat production, for instance, may adversely affect food security as it is an important staple crop for the FYR of Macedonia. A decrease in alfalfa production is also expected, which will reduce livestock production and increase the deficit in animal products (e.g. milk, meat, etc.), that will further negatively impact food security. Thus, animal production will be directly and indirectly affected by climate change, due to the anticipated temperature rise that will lead to increased heat stress, while indirectly through expected forage yield decreases and the emergence of animal pests and diseases.

Montenegro

According to the Second National Communication on Climate Change (2015), it is expected that temperatures may increase, which may lead to more frequent and longer heat waves, more hot days and nights, fewer days with frost and cold days and nights. In addition, less precipitation is expected, which may lead to more frequent droughts as well as an increase in the number of forest fires. These fires can also cause indirect damages that can result in the degradation of the environment, for instance, a reduction in the resistance of forests to pests and diseases and the destruction of authentic landscapes and soil structures.

In terms of dry periods, it is expected that during the 2001-2030 period, the extension of dry periods varies on average from 1 to 5 days. This is anticipated to be the longest (5 days longer) in the karst region, which is located in the north-western part of the country. While it is expected to be even longer during the 2071-2100 period, varying on average from 3 to 8 days compared to the 1961-1990 period. Overall, reduced precipitation is thus anticipated, which will result in a drier climate in the future, in particular during July and August as well as during February and March in case of dry wand warmer winters (Ministry of Sustainable Development and Tourism, 2015).

More frequent and intense droughts will have negative impacts on agriculture and those whose livelihoods are dependent on the sector and its activities, in terms of e.g. the yield quality, reduction in incomes, higher costs to prevent and control plants from diseases, weeds, and insects and increases in irrigation prices. Furthermore, impacts on livestock raising will include e.g. yield reductions in hay and other fodder species, production of milk and a reduction of the livestock numbers.

Serbia

The expected impact of climate change on agriculture in Serbia is similar to the other Western Balkan countries. It is anticipated that agricultural production and primarily plant production will be negatively affected, in particular yields, due to changes in temperature and precipitation. In addition, the frequency and severity of extreme weather events is expected to increase, including droughts, but also floods, storms and other natural hazards, as well as the projected rise in various types of plant and animal pests and diseases, as a result of the higher winter or early spring temperatures. Although, some types of insects, especially those that rely on soil moisture, may also show lower incidence levels and populations due to the expected longer dry periods.

The Vojvodina region, located in the northern part of the country and the most important agricultural area in Serbia, is highly vulnerable to extreme weather conditions in comparison to other regions. Climate change projections for this region estimate that the mean annual air temperatures will rise by 1.3 degrees in 2040 and 2.4 degrees in 2080 compared to 1985-2005 (ClimateChangePost, 2017), which may have negative impacts on crop yields. For instance, it is projected that the yield of winter wheat in Vojvodina could decrease by 5-8 percent and 4-10 percent in 2040 and 2080 respectively, compared to the average yield during the 1981-2005 period (WMO, 2012).

Drought risk management

During the last few decades, there has been a paradigm shift from focusing primarily on emergency response towards taking a more disaster risk reduction perspective. This reactive towards a proactive approach entails that governments aim to focus on 'prevention', 'mitigation' and 'enhancing preparedness for response', thereby reducing the impact of natural hazards, such as earthquakes, floods, storms, forest fires and drought, and building the resilience of people and their livelihoods.

FAO defines resilience as "the ability to prevent disasters and crises as well as to anticipate, absorb, accommodate or recover from them in a timely, efficient and sustainable manner. This includes protecting, restoring and improving livelihoods systems in the face of threats that impact agriculture, nutrition, food security and food safety" (FAO, 2014). Within the context of climate change and the expected increase in number and severity of extreme weather events, including droughts, building drought resilient societies, is of high importance. Particularly for agriculture, as the sector is often one of the hardest hit by this natural hazard.

Therefore, the need to move away from a reactive response mode towards one that is more proactive in nature, requires an enabling policy and institutional environment, such as the inclusion of national drought plans, policies and strategies and a national drought task force. In addition, an effective monitoring and early warning system, DRR measures that focus on prevention, mitigation and preparedness, effective emergency response programmes and interventions aimed at reducing the impacts of drought as well as post-drought recovery initiatives linked to long-term development. In the following section, each of these components of drought risk management is described.

Enabling legal, policy and institutional environment

<u>Drought risk management act or law</u>

Part of ensuring that there is an enabling environment, in which drought risk management can be effectively implemented, is the national legal, policy and institutional framework. Some countries have hazard-specific laws and acts, such as a drought legislation, whereas other governments adopt a multi-hazard approach by developing a disaster risk reduction law, which outlines all relevant hazards, such as natural, biological, technological and so on.

Previously when countries primarily adopted a reactive emergency response approach, a drought emergency relief act or law was part of the country's legal framework for disaster management. However, this type of legal framework only focuses on one response, whereas a drought risk management law would also include specifications related to prevention, mitigation and preparedness for response.

<u>National drought strategy</u>

An important factor in the effectiveness of disaster risk reduction is the development and establishment of policies, strategies, action and contingency plans. In general, it depends on the government whether they prefer to have a separate hazard specific or a multi-hazard strategy, policy, contingency or action plan. A strategy sets the overall goals and objectives at national level and provides general guidance regarding the instruments that need to be adopted in order to fulfil these goals. Furthermore, it provides a framework for drought prevention, mitigation, preparedness and response measures in order to facilitate post-drought recovery linked to longer term planning to reduce vulnerability to drought. It also outlines the governmental policies and services, within which it will operate, and the institutional structure for the planning and implementation of the drought risk management activities.

<u>National drought policy</u>
A national drought policy specifies the objectives, within the adopted strategy, and also outlines the instruments that can be used to achieve the objectives. It usually outlines the roles and responsibilities of all relevant stakeholders, which should also be embedded in related disaster risk reduction legislation to ensure that all outlined interventions can be enforced.

<u>National drought contingency plan</u>
A contingency plan is established in advance and includes the identification of the different types of interventions that are considered applicable and suitable for the different sectors, including agriculture, at different stages of drought, in line with the national drought strategy and policy. It also contains the most vulnerable ecological zones, production systems and population groups and the appropriate interventions to reduce the vulnerabilities and impacts to drought.

<u>National drought action plan</u>
A national drought strategy may be prepared and combined with a national drought action plan. This action plan provides a detailed description of how the contingency plan will be implemented. It will also provide information about the specific requirements of the most vulnerable ecological zones, production systems and specific target groups related to certain drought conditions at a particular time.

<u>National drought task force</u>
The provision for a national drought task force can be included in the national drought policy and strategy and will outline all relevant stakeholders at different levels - national, regional, local, within the country. The contingency and the action plans will contain the specific cross-sectoral interventions to be undertaken by the specific organisations at a particular time. The task force members should regularly meet to discuss the current drought conditions and situation within the country, which can be part of the National Platform for Disaster Risk Reduction and its members, as it is focusing on multi-hazards in any case.

Coordination among all the relevant stakeholders at all levels is also crucial. In general, the designated National Disaster Management Authority coordinates all prevention and mitigation, preparedness, response and recovery activities across all relevant sectors and organisations.

Early warning system

Early warning systems (EWS) can help to identify a drought as early as possible as well as monitoring existing droughts. Adequate rainfall stations throughout the country are therefore highly important, as well as there are challenges like the difficulty to determine the exact thresholds to define a meteorological drought, which would be appropriate in all situations and take certain factors into consideration to justify and initiate government intervention. Moreover, also when government support is provided to farmers and thereby helping them reduce the impact of the drought on their e.g. crops and livestock. The EWS helps to monitor various environmental and socio-economic indicators and will trigger alerts when these indicators are reached to identify various stages of drought status. This is also important for the determination when the government will provide support to farmers to reduce the impact of drought on their livelihoods – e.g. crops and livestock.

In general, an EWS is thus designed to:

- Identify drought and drought-related stress areas and vulnerable population;
- Determine the stage, scale and extent of the drought stress;
- Alert national, regional and local authorities and the local population of the risks to food security and agricultural production and the need to implement contingency measures.

An example of a drought index is the Palmer drought index or so-called Palmer Drought Severity Index (PDSI), which is a measurement of dryness that is based on a supply and demand model of soil moisture. The supply side of the model is quite straightforward to calculate; however, the demand is more complex as it is dependent on various factors, including temperature and the amount of soil moisture as well as more difficult to calibrate aspects, such as evapotranspiration and recharging rates. In order to address these challenges, meteorologist Wayne Palmer who developed the index, established an algorithm, which helps to approximate the drought status by using the most readily available data, precipitation and temperature. The index identifies five levels of drought status, namely:
0 is 'normal'
-1 is 'near normal'
-2 is 'moderate drought'
-3 is 'severe drought'
-4 is 'extreme drought'

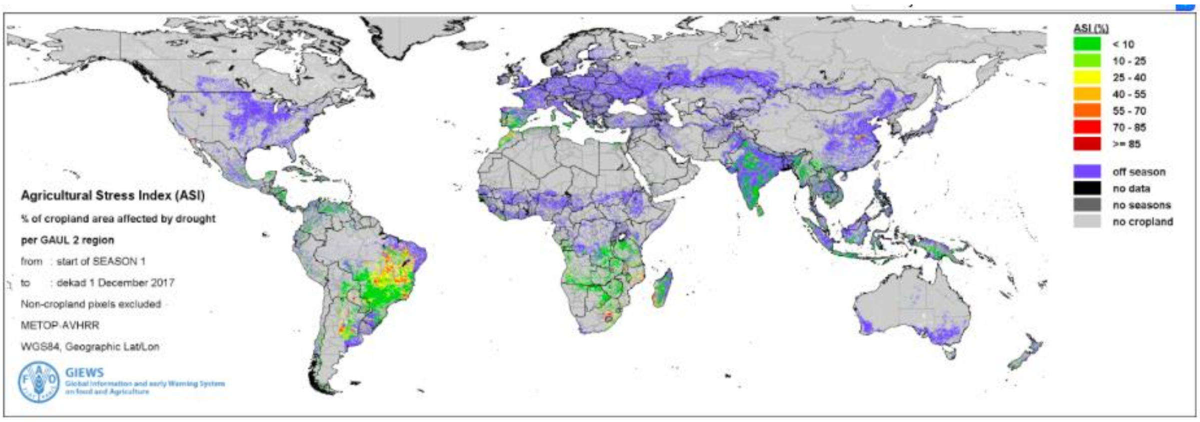
This model is considered most effective for determining long-term drought, with conditions that last over a period of several months, while not for conditions that exist for weeks.

Box 2 Monitoring agricultural drought with remote sensing data

Drought is a slow-onset hazard, which makes it difficult to detect at times. It is a creeping phenomenon, which can have destructive impacts on agriculture production and people's livelihoods. Timely observation, monitoring and the dissemination of alerts can reduce the impact on the sector. Particularly, within the context of climate change and the expected increase in frequency and intensity of natural hazards, including drought, reliable information on the drought status in regions and countries is highly important.

FAO's Global Information and Early Warning System and its Climate, Energy and Tenure Division developed the Agriculture Stress Index System (ASIS), which helps to identify agricultural areas that are likely to experience water stress (drought) on a global, regional and country level. These 'hotspots' are detected through monitoring vegetation health indices (VHI) in crop areas around the world during the cultivation period and which may be adversely impacted by drought. It is based on 10-day satellite data of vegetation and land surface temperature and ASIS conducts the analysis from the start to the end of the cropping season with a focus only on the crop areas. It thereby, assesses the severity (intensity, duration and spatial extent) of the agricultural drought as shown in figure 4.

Figure 4 Agriculture Stress Index (ASI)



Source: http://www.fao.org/giews/earthobservation/asis/index_1.jsp?lang=en

The ASIS allows countries to fine-tune parameters of the system based on detailed land use maps and national crop statistics. In addition, at country level, the ASIS may be used for the development of a remote sensing-based index for crop insurance.

For more information on ASIS: http://www.fao.org/resilience/news-events/detail/en/c/296089/.

Drought prevention and mitigation measures

It is important that farmers are encouraged to implement prevention and mitigation practices and technologies that will reduce the impacts and improve their resilience to drought. The following measures provide a non-exhaustive list and serve as examples of the crops and livestock subsectors in this regard:

- *Drought-resistant and tolerant crop and livestock varieties and species*

Farmers can select crop and livestock varieties and species that are more drought-resistant or tolerant. Indigenous and local seeds and livestock breeds may be better adjusted to the local environmental and climatic conditions of the country and thereby better able to withstand drought and dry spells.

- *Flexible planning – early / late sowing and harvesting*

As the agriculture sector is heavily dependent on the weather and climate, flexible planning may be required to reduce the impacts of natural hazards, like droughts, as the ability of farmers to adapt will be highly important in order to better able to respond to future climatic changes. Flexibility in planning may therefore be desirable to accommodate the expected climate variability and change. An example is the use of early maturing crop varieties or those varieties that have a lower water demand as well as the implementation of early or late planting and/or harvesting.

- *Diversification and integrated farm management*

Through cultivating different types of crops instead of mono-cropping and raising various animals, like pigs and chickens, farmers are able to diversify their products and reduce their risk of total production losses. This may ensure their food and nutrition security as well as may generate additional income and contribute to their livelihoods. An example of a diversified farming system is that of integrated farm management, where trees, agricultural crops and/or livestock are combined. By integrating trees with crops, soil fertility is improved, which enhances agricultural productivity as well as reduces input costs as less fertilizer is needed. In addition, multi-purpose trees can provide fruits and nuts or firewood as well as they can act as natural buffers, which can reduce the impact of storms, floods and droughts as well as help to store carbon dioxide, which contributes to the mitigation of climate change. Moreover, the cultivation of forage species can provide feed for animals and their manure can be used as fertilizer to enhance the fertility of the soil, which in turn may lead to productivity increases.

- *Sustainable and efficient water management*

Reducing the loss of water through irrigation, in particular the use of drip irrigation, can help to enhance production and address irregular rainfall patterns. At present, it is estimated that irrigation is practiced on 20 percent of the agricultural land in developing countries, but studies have calculated that irrigation could increase yields with 130 percent compared to systems that are reliant on rainfall (FAO, 2010). In addition, improved rainwater harvesting and retention practices, such as pools, dams, pits, retaining ridges, can also be applied so that rainwater can be collected during times of the year where rainfall is in excess and can be used when there is a deficit.

- *Sustainable soil management*

Sustainable soil management practices, such as mulching and minimum / zero tillage, can help to reduce the impact of drought. Mulching involves adding an additional layer of material (usually organic) over the soil, like leaves, grass clippings, wood chips, straw, hay, which helps to keep the soil moist and fertile, protects it from the sun, rain and wind and reduces weed growth. It also reduces greenhouse gas emissions, because the extra plant coverage contributes to carbon sequestration as well as the soil requires less nitrogen fertilizer. In addition, mulching conserves and enhances biodiversity, while minimum and zero tillage can help to reduce the disturbance to the soil. It thereby contributes to a reduction in the loss of soil moisture and erosion as well as ensures soil fertility as nutrients are retained. However, this practice may lead to increased weed growth, which in turn compete with crops for e.g. sunlight, water and nutrients.

Box 3 Voluntary guidelines for sustainable soil management

Healthy soils are essential for food production as well as crucial for many ecosystems services. Therefore, it is important that soils are nurtured and protected as they not only help to increase food production, but also store and supply clean water, ensure biodiversity, sequester carbon and increase resilience to natural hazards, such as droughts, and climate change.

At present, many countries around the world are experiencing an increase in degradation, depletion and overexploitation of soils, which are undermining the sustainability of their agricultural production systems. Soil erosion and degradation leading to desertification is also prevalent in the Western Balkan region. It is estimated that land degradation and erosion affected approximately 96.5 (Mitkova & Cvetkovska, 2006) and 95 percent (Spalevic *et al*., 2014) of Macedonia and Montenegro respectively. Restoring degraded soils and improving soil health within the context of sustainable soil management is thereby key.

The voluntary guidelines for sustainable soil management (SSM) were developed through an inclusive process within the framework of the Global Soil Partnership (GSP)[4]. It aims to provide technical and policy recommendations on SSM to a wide range of stakeholders, including government officials, policy makers, extension service officers, agricultural producers, academia, private sector and development practitioners. The guidelines were endorsed by the 155th session of the FAO Council on 5 December 2016.

The following principles are associated with SSM and included in the guidelines:

- Minimize soil erosion;
- Enhance soil organic matter content;
- Foster soil nutrient balance and cycles;
- Prevent, minimize and mitigate soil salinization and alkalinization;
- Prevent and minimize soil acidification;
- Preserve and enhance soil biodiversity;
- Minimize soil sealing;
- Prevent and mitigate soil compaction;
- Improve soil water management.

For more information on the guidelines http://www.fao.org/3/a-bl813e.pdf.

Drought preparedness activities

If a country is better prepared, the response to a disaster may be more rapid, comprehensive and timely, which may in turn reduce the amount of agricultural damage and losses and secures people's food and nutrition security. A few interventions that can be undertaken to enhance a country's preparedness for response, include, for instance:

- *Preservation of food and animal feed*

The preservation of food items for human consumption as well as animal fodder is desirable as a preparedness measure. Animal fodder is preserved through a process that is called 'ensilage',

[4] The Global Soil Partnership (GSP) was developed in December 2012 with the aim to develop a strong interactive partnership and collaboration among all relevant stakeholders. Among its key objectives is the improvement of governance and the promotion of sustainable management of soils.

which can help to reduce the impact of a drought, as this animal feed is stored and can thus be used in times of need. Ensilage is a conservation method where high-moisture fodder is fermented and stored, which can then be fed to e.g. cattle, sheep and other ruminants or can be used as a biofuel feedstock. Silage can be produced from various field crops, although it is usually made from grass crops, including maize, sorghum, or other cereals, using the entire plant and not just the grain.

- *Establishment of food and feed reserves*

It is important that sufficient food and feed is stored, and strategic reserves are build up at national, district and household level during normal times, which can then be utilized during periods of need. For instance, the establishment of essential commodities and fodder reserves in the form of on-farm or off-farm crop residues, standing biomass or designated and reserved grazing areas that can be accessed when needed. In this regard, it is also highly important to maintain adequate water reserves in reservoirs and to prevent excess depletion of water tables.

- *Animal vaccination*

Veterinary support can help to ensure that animals are protected and strengthened against various animal diseases. When the animal's health is maintained or improved, the production of livestock products, such as milk, cheese and meat can be ensured, thereby protecting people's food and nutrition security, their livestock assets and incomes. As veterinary vaccines and medicines are relatively inexpensive compared to the value of livestock when lost as a result of drought. Thus, veterinary care, such as vaccination or early diagnosis and treatment, can help to prevent sudden and large-scale livestock losses due to infectious diseases.

- *National drought (contingency) fund*

In order to finance drought response and recovery programmes, a national drought (contingency) fund can be established, so as to be better prepared when a drought hits. These financial reserves can be build up in the non-drought years to be available when required to support drought relief and recovery interventions. It can be set up in a way that it allows for the disbursement of funds to drought-prone affected districts in a flexible, effective and efficient manner. It can also be used for prevention and mitigation efforts as well as to fund preparedness, response and recovery activities depending on the objectives set by the government. However, it is important to ensure that people's livelihoods are supported and linkages to long-term development are also promoted. There should be a clear structure and procedure for the application and use of the funds, which are usually outlined in the contingency plans and budgets.

Drought response actions

It is important that household food and nutrition security is not compromised by drought, and that incomes and livelihoods are also not substantially affected. The impact of drought can be reduced if prevention and mitigation practices and technologies are implemented, including that the reproductive capacity of livestock in drought prone areas is preserved. In addition, that substantial preparedness measures have been implemented, such as ensuring that there are adequate supplies of water and feed for livestock and people in drought prone areas.

Efficient coordination is crucial in an emergency or crisis, where various interventions are undertaken simultaneously, as it can lead to effective joint programming and to maximize the use of the scarce resources. For example, livestock interventions should be integrated, if possible, with other sectors, like the trucks that deliver aid supplies could be in turn used to move livestock as part of a destocking programme, and the refrigerators to store both human and animal vaccines and medicines or damaged objects for human shelters could be used for animal shelters.

- *For crops*

In terms of drought response actions for crop farmers, who have incurred extensive crop failure due to the drought, the provision of seeds, fertilizer and other inputs can be provided so that the producers are able to replant. However, the suitability of the provided seeds to the local ecological conditions should be ensured. Sometimes, government assistance is provided through credit and loans to pay for the required inputs or services, or redeemable vouchers for vital inputs may be issued.

- *For livestock*

Various measures for livestock can be implemented in times of a drought. For instance, destocking, which is the sale of livestock before they lose too much value to sell for a reasonable price or become too weak to walk to the market. Destocking is desirable during a drought, because if the livestock dies, they would lose an important asset and significant income that could otherwise be used to buy food or animals after the drought. Sometimes, government assistance to livestock holders involves the free provision of free fodder, usually provided to the poorer herders. Veterinary support may also be provided to prevent the mortality and improve the health of animals, which includes the examination and treatment of individual animals or herds. It may also include mass vaccination programmes to prevent and control the spread of animal diseases within the country and across the region as well as to improve animal health by provision of vitamins and minerals to malnourished animals so that they may still be able to produce milk and meat, where their owners may derive their livelihoods from. Veterinary care can in this respect be essential to strengthen or rebuild valuable livestock.

Box 4 Livestock Emergency Guidelines and Standards (LEGS)

The Livestock Emergency Guidelines and Standards (LEGS) consists of a set of standards, key actions and guidance notes that helps to identify the most appropriate interventions to protect and manage livestock during emergencies.

LEGS is in line with the Sphere minimum standards and adopts a livelihoods perspective, that aims to i) provide immediate benefits to crisis-affected communities; ii) protect livestock assets of crisis-affected communities; and, iii) assist the rebuilding of key assets among those affected by a crisis. The guidelines and standards are also based on a rights-based approach, in particular ‘the right to food’ and ‘the right to a standard of living’.

The main technical focus areas include: destocking; veterinary care; supplementary feeding; provision of water, livestock shelter and settlement; and, provision of livestock or restocking. Guidance on the options are outlined in the form of ‘decision-making trees’ and further technical materials, toolkits and information provided.

For more information on LEGS and the downloadable handbook: http://www.livestock-emergency.net/download-legs/

Post-drought recovery initiatives linked to long-term development

As soon as the drought is over, there is possibly a need to support some crop and livestock farmers with the process of recovery back to self-sufficiency. Generally, household and community surveys are undertaken in severe drought affected areas to help identify those that require government assistance and the type and level of needed support. It is also important to identify those farmers that have lost their resources and assets due to the drought and not due to other reasons as well as to provide them with sufficient means to help them restore to previous production levels so that they are able to sustain themselves and their families. The objective of government assistance for post-drought recovery is to enable crop production for farmers and enable livestock herders to re-establish their flocks and herds after a drought. Recovery activities should be planned in a manner that they are included in sustainable, long-term livelihood and development support activities.

In addition, it is important that the needs of the local economy are supported, however, attention should be paid to make sure that the direct provision of agricultural inputs will not undermine the functioning of the local markets. In this regard, preference is given to the provision of credit, loans, subsidies or vouchers redeemable at local markets and traders for specific agricultural inputs.

Furthermore, it is crucial that degradation of the natural resource base is also minimized during droughts as well as in the post-drought recovery period. As healthy soils and other natural resources better able to reduce the impact of natural hazards, including droughts, when they (re)occur.

- *For crops:*

Governments may consider to compensate some farmers that have experienced substantial crop losses and/or implement post-drought recovery measures, which also include the application of those practices and technologies that were mentioned earlier under the prevention and mitigation measures section. The use of those types of crops and management practices should be considered ecologically appropriate and suitable to the area, socio-economically desirable and especially help to reduce the impact of droughts on agriculture. Other measures such as diversification and the preservation and storage of food and seeds will help to reduce the impact of a reoccurring drought in the near future.

- *For livestock:*

For livestock herders, the main requirement during the post-drought phase, is the replacement of those animals that they lost during the drought. Once the stock replacement has been fulfilled, it is important that there is adequate grazing and water resources available so as to sustainably maintain the number of livestock. In some instances, the government may provide credit or loans to purchase replacement stock. However, in some cases where those extremely vulnerable farmers have lost their livestock assets that are crucial for their food and nutrition security as well as their livelihoods, the government may consider sponsored restocking schemes where the breeding stock is purchased and allocated to them.

Rebuilding livestock assets also involves providing livestock and veterinary support including preventative vaccination, treatment and medications, as well as water, feed and shelter to strengthen the health of the animal that have experienced the impacts of the drought. In addition, making sure that they are healthy and fit and thus better prepared for a reoccurring drought that may happen in the near future.

The implementation of some of the drought prevention and mitigation measures that were mentioned earlier, such as diversifying agriculture activities so as to reduce the risk to total crop failure or loss of livestock, preservation and storage of fodder, are among those interventions, which will help to reduce the impact of a reoccurring drought.

Drought projects in the Western Balkan region

Various drought related projects have been implemented in the Western Balkan region during the past few years, by various organisations, which involved different stakeholders. A selection of these projects is described in this section.

Water Resource Strategies and Drought Alleviation in Western Balkan Agriculture (WATERWEB) project

The primary aim of the Water Resource Strategies and Drought Alleviation in Western Balkan Agriculture (WATERWEB) project was the introduction of strategic water management for drought alleviation and sustainable agricultural practices in the Western Balkans region, in particular Serbia (as well as Montenegro[5]) and the FYR of Macedonia. In addition, the establishment and strengthening of research expertise in a range of technologies for water and crop management. It was funded by the European Commission's Sixth Framework Programme (FP6) and implemented for 3 years from 2004-2006 by 4 EU and 3 Western Balkan partners.

Among the institutions that were involved in this project were:
- the Department of Agricultural Sciences, KVL University, Denmark;
- the School of Civil Engineering and Geosciences, and the School of Agriculture, Food and Rural Development, University of Newcastle, UK;
- the School of Biological Sciences, University of Lancaster, UK;
- Instituto Superior de Agronomia, Universidade Técnica de Lisboa, Portugal;
- The School of Agriculture, University of Belgrade, Serbia;
- The School of Agriculture, St. Cyril and Methodius University, Skopje, the FYR of Macedonia;
- The Jaroslav Cerni Institute for the Development of Water Resources, Belgrade, Serbia.

One of the major tasks included the coordination and management of the project activities at the river basin level, to the farm level, to a crop and the water use of a single plant, where the environmental, socio-economic and health impacts of various types of land-water use were considered. Among the key project outcomes were the following:

- A basic network of hydro-meteorological research areas and collection of data procedures was established;

[5] Serbia and Montenegro were one country until 21 May 2006, when it obtained independence through a referendum, which was approved by 55.5 percent of the voters.

- Capacities for the new measurement and data management technologies were build;
- GIS technologies were implemented to install a soil, water, economy information system, and;
- A series of models were developed to correlate plant water uptake, runoff, water quality and establishment of procedures for strategic water management in agriculture.[6]

The Drought Management Centre of South-East Europe (DMCSEE) project

As the South-Eastern Europe region is also prone to drought, among other natural hazards, and with the expected increase in frequency and severity of this hazard due to climate change, 13 countries in this region established the Drought Management Centre of South-East Europe (DMCSEE). This included the countries of Albania, Bosnia and Herzegovina, Bulgaria, Croatia, the Former Yugoslav Republic of Macedonia, Greece, Hungary, Moldova, Romania, Serbia, Slovenia and Turkey.

The main aim of the centre, which is implemented through an EU Instrument for Pre-Accession Assistance (IPA) project titled 'DMCSEE' is to enhance drought preparedness by undertaking vulnerability and risk assessments and by establishing an early warning system to reduce the impacts of droughts.

As part of the DMCSEE project, the crop-water balance model 'Winlsareg' was applied as well as the impact of climate change on irrigation was assessed. For Montenegro, for instance, tests for short-term impacts were conducted in Podgorica and Berane and long-term impacts were evaluated for various corn types. The findings showed the for the 30-year simulation for the Podgorica region, irrigation is required for the different types of corn as well as that shifting the short corn-cultivation season to early spring is possible to avoid the long-term summer dry period. The simulations revealed that the model is a practical tool for the planning of water use for agriculture. Drought monitoring bulletins and drought monitoring products, such as maps were also developed and disseminated on the DMCSEE website.[7]

Drought risk (DriDanube) project in the Danube region

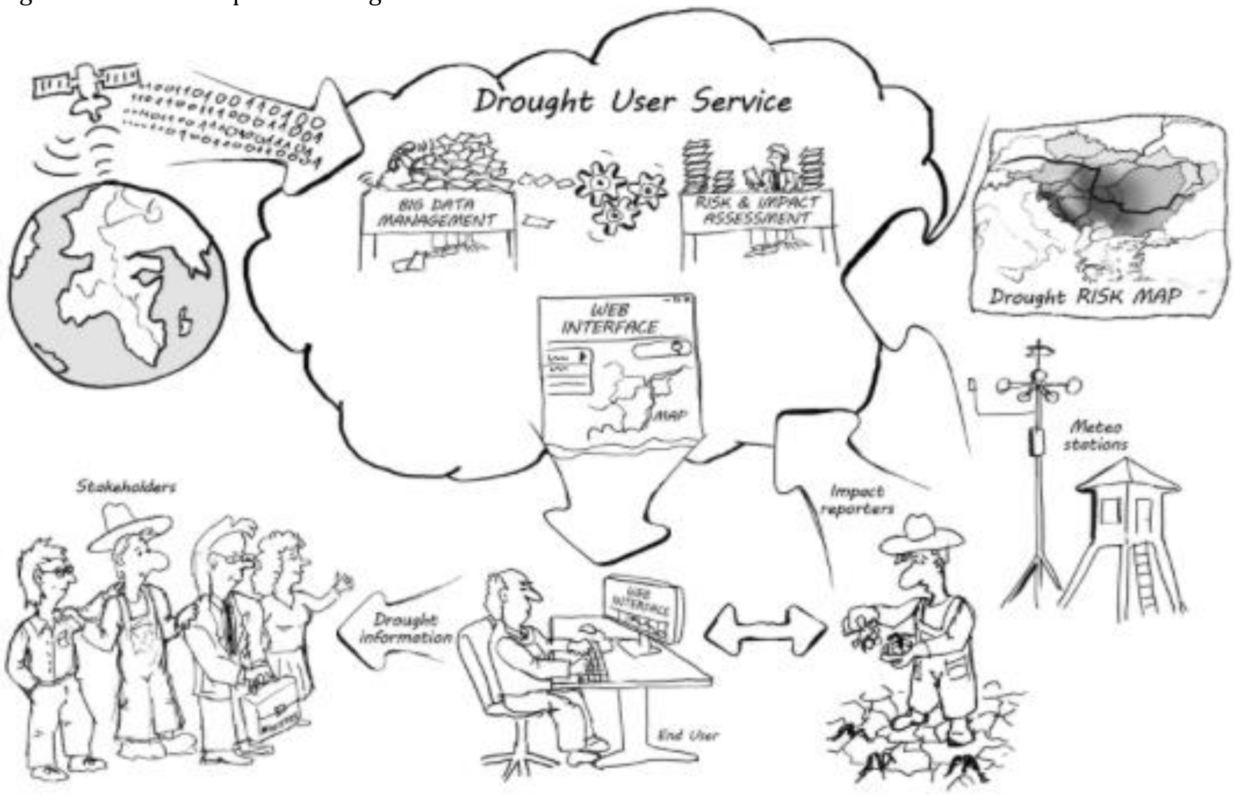
The DriDanube project aims to enhance the capacity of the Danube region to manage drought related risks, with the improvement of drought emergency response and increased cooperation between operational services and decision making authorities in the Danube region at both national and regional level as the main expected result. This project is funded by the EU under the Danube Transnational Programme (DTP) and includes 9 EU countries (Austria, Bulgaria, Croatia, Czech Republic, Germany, Hungary, Romania, Slovakia and Slovenia) and 5 non-EU countries (Bosnia and Herzegovina, the Republic of Moldova, Montenegro, Serbia and Ukraine).

[6] For more information, see http://cordis.europa.eu/result/rcn/53013_en.html
[7] For more information on the DMCSEE, see http://www.dmcsee.org/en/drought_monitor/.

It is led by the Slovenian Environment Agency (ARSO) in collaboration with 14 partners and 8 associated strategic partners and is currently being implemented from January 2017 until June 2019 with a budget of Euros 1.9 million.

One of the main expected project outcomes is the 'Drought User Service (DUS)', which will support more accurate and reliable drought monitoring and timely early warning for the Danube region. Earth Observation data will be used from various operational remote sensing satellites to facilitate the provision of relevant drought information that will be publicly available with a web-browser interface. As a result, access to information to the relevant national organisations as well as end users, including farmers and water managers, will be enhanced, from drought monitoring to forecasting and preparedness for response. A simplified overview of the Drought User Service process is displayed in Figure 5.

Figure 5 Simplified Drought User Service Scheme



Source: http://www.interreg-danube.eu/news-and-events/newsletters/1116

Another expected project outcome is the harmonization of the existing heterogeneous methodologies for risk and impact assessments, as there is currently no systematic collection of drought impacts, in particular for the agriculture sector. Furthermore, there is a lack of and incomparable drought risk assessment methodologies and in addition, drought is still not viewed as a priority issue, despite the fact that national economies are usually highly and adversely impacted by these hazards, especially the agriculture sector.[8]

[8] For more information on the DriDanube project, see http://www.interreg-danube.eu/approved-projects/dridanube.

References

Aleksić, P., Krstić, M. & Janćić, G. 2009. Forest fires – ecological and economic problem in Serbia. *Botanica Serbica*, 33(2): 169-176. (also available at http://botanicaserbica.bio.bg.ac.rs/arhiva/pdf/2009_33_2_499_full.pdf).

Australian Government. 2017. *Factors influencing weeds.* [Cited 20 November 2017]. http://www.environment.gov.au/biodiversity/invasive/weeds/weeds/why/factors.html

CAREC. 2015. *Tajikistan: Country situation assessment. Working paper.* Almaty. 60 pp. (also available at http://prise.odi.org/wp-content/uploads/2015/08/Tajikistan_Country_Situation_Assessment.pdf).

ClimateChangePost. 2017. *Serbia.* Center for Climate Adaptation. [Cited 30 November 2017]. https://www.climatechangepost.com/serbia/climate-change/

Duričin, S. and Bodroža, D. 2013. The impact of drought on yield position of the group of enterprises from agricultural sector. Original scientific paper. *Economics of Agriculture,* 1: 25-37. (also available at http://ageconsearch.umn.edu/bitstream/146735/2/2%20-%20Djuricin,%20Bodroza.pdf).

FAO. 2003. *Drought.* FAO Land & Water. Rome. 4 pp. (also available at http://www.fao.org/docrep/017/aq191e/aq191e.pdf).

FAO. 2008. *FAO's Role in the 2008/2009 Humanitarian Food Security Appeal for Tajikistan.* Rome. 2 pp. (also available at http://www.fao.org/fileadmin/user_upload/emergencies/docs/tajikistan_appeal_2008_2009.pdf).

FAO. 2010. *Climate-Smart Agriculture. Policies, Practices and Financing for Food Security, Adaptation and Mitigation.* Rome. 42 pp. (also available at http://www.fao.org/docrep/013/i1881e/i1881e00.pdf).

FAO. 2014. Disaster risk reduction for food and nutrition security. Key practices for DRR implementers. Rome. 52 pp. (also available at http://www.fao.org/3/a-i3775e.pdf).

FAO. 2015. *The impact of disasters on agriculture and food security.* Rome. 79 pp. (also available at http://www.fao.org/3/a-i5128e.pdf).

FAO. 2017. *The impact of disasters on agriculture. Addressing the information gap.* Rome. 26 pp. (also available at http://www.fao.org/3/a-i7279e.pdf).

Government of Montenegro, Ministry of Interior. 2014. *Planning for protection and rescue flood in Montenegro. Proceedings of the First National Platform for Disaster Risk Reduction.* Podgorica. 112 pp.

ICPDR. 2015. *The 2015 Droughts in the Danube River Basin.* Vienna. 20 pp. (also available at https://www.icpdr.org/flowpaper/viewer/default/files/nodes/documents/icpdr_report_on_2015_droughts_in_the_danube_river_final.pdf).

Kujawski, R. 2011. *Long-term Drought Effects on Trees and Shrubs.* UMassAmherst. The Center for Agriculture, Food and the Environment. [Cited 17 November 2017]. https://ag.umass.edu/landscape/fact-sheets/long-term-drought-effects-on-trees-shrubs

Laska Merkoci, A., Mustaqi, V., Jaupaj, O., Como, E., Bardhi, A. & Dvorani, M. 2012. Droughts and their impact on the Albanian Territory, *Agriculture & Forestry,* 58(1): 7-17.

Littell, J. S., Peterson, D. L., Riley, K. L., Liu, Y. & Luce, C. H. 2016. A review of the relationships between drought and forest fire in the United States. *Global Change Biology* (2016), doi: 10.1111/gcb. 13275. 1-17 pp.
(also available at https://www.fs.fed.us/rm/pubs_journals/2016/rmrs_2016_littell_j001.pdf)

Ministry of Environment. 2016. *Third National Communication of the Republic of Albania under the United Nations Framework Convention on Climate Change.* Tirana. 296 pp.

Ministry of Environment and Physical Planning. 2008. *Second National Communication on Climate Change.* Skopje. 128 pp. (also available at http://www.adaptation-undp.org/sites/default/files/downloads/macedonias_snc.pdf).

Ministry of Sustainable Development and Tourism. 2015. *The Second National Communication on Climate Change.* Podgorica. 296 pp.

Mitkova, T., Cvetkovska, M. 2006. *Presentation on: Overview of soil information and soil protection policies in Republic of Macedonia.* Ministry of the Environment and Physical Planning.

Spalevic, V., Curovic, M., Simunic, I., Behzadfar, M. & V. Tanaskovic. 2014. *Land degradation, land use and soil erosion: the case of Montenegro.* CiHEAM, The Watch Letter: Land issues in the Mediterranean Countries, vol.28, no.1, pp. 58-62.

UNCCD. 2017. *About the Convention.* Bonn [Cited on 5 December 2017]. http://www2.unccd.int/convention/about-convention

UNDP. 2015. *Climate change and disaster risk reduction snapshot. Albania.* Istanbul. 4 pp. (also available at http://reliefweb.int/sites/reliefweb.int/files/resources/UNDP-snapshot-Albania%28web%29.pdf).

UNDP in Bosnia and Herzegovina. 2016. *Third National Communication and Second Biennial Update Report on Greenhouse Gas Emissions of Bosnia and Herzegovina under the United Framework Convention on Climate Change.* July 2016. Sarajevo. 260 pp.
(also available at http://www.ba.undp.org/content/bosnia_and_herzegovina/en/home/presscenter/articles/2017/07/19/usvojen-tre-i-nacionalni-izvje-taj-bih-i-drugi-dvogodi-nji-izvje-taj-o-emisiji-stakleni-kih-plinova-bih/).

UNISDR. 2015. Sendai Framework for Disaster Risk Reduction 2015-2030. Geneva. 38 pp. (also available at http://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf).

USDA Foreign Agricultural Service. 2012. *Drought Driven Declines in Serbian Crops Increased Food Prices. Global Agricultural Information Network.* Belgrade. 3 pp. (also available at https://gain.fas.usda.gov/Recent%20GAIN%20Publications/Drought%20Driven%20Declines%20in%20Serbian%20Crops%20Increased%20Food%20Prices%20_Belgrade_Serbia_8-15-2012.pdf).

WMO. 2012. Strengthening Multi-Hazard Early Warning Systems and Risk Assessment in the Western Balkans and Turkey: Assessment of Capacities, Gaps and Needs. Geneva. 310 pp. (also available at https://www.wmo.int/pages/prog/drr/projects/SEE/documents/SEEPhase%20I%20-%20FinalReport.pdf).

WMO/UNCCD/FAO & UNW-DPC. 2013. *Country Report. Drought conditions and management strategies in Serbia. Initiative on "Capacity Development to support National Drought Management Policy".* Belgrade. 12 pp. (also available at http://www.droughtmanagement.info/literature/UNW-DPC_NDMP_Country_Report_Serbia_2013.pdf).

Zurovec, O., Vedeld, O. P. and Kumar Situala, B.K. 2015. Agricultural Sector of Bosnia and Herzegovina and Climate Change—Challenges and Opportunities. *Agriculture,* 5: 245-266. (also available at https://pdfs.semanticscholar.org/4e8a/c633d46182f02f25633fe83903453065805e.pdf).

I9148EN/1/04.18