



Subgroup: Agriculture

Case-study: Ústí Region

(CzechGlobe, Czech Republic)

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CzechGlobe

**Project:**

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**Purpose of this document:**

"The Case Studies Living Document (CSLD) will be the document that each case study leader will use to share the information that (i) characterize and give context to its case study, (ii) the goals within BASE, (iii) the methods used and mainly (iv) a synthesis of the results that that case study is providing to BASE project. This will allow the CS leader to understand how its own case is going (having a good overview), but also (v) will allow the sub-group to which the case study belong to know what is happening and what can be done (mainly on synergies and so on) as well as to (vi) WP4 & 5 coordinators to use that information to report (including each WP task leaders). These living document will also (vii) allow WP6 & 7 partner to know the information."

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# 1. General Case Study Description

## A. Location

(Please insert the coordinates of the geographical centre of your case study and additionally the area of the entire area under investigation. For a city, for example, use the city centre and the area of the municipality. Illustrate in the map the area in study)

GPS: N 50°31'4 N / 13°50' E

Area: 5 335 km<sup>2</sup>



## B. Case Study Summary

(Máx 500 words)

Ústí Region lies in Northwest Bohemia and shares a border with Germany. It is one of the most densely populated regions in the Czech Republic, with the tradition in industrial and agricultural production. Concerning the agricultural sector, hop cultivation is traditional agricultural production activity in the region. More than 73 % of the total hop planting area in the Czech Republic is situated in the Usti region.

Based on the climate scenarios in the period 2051-2100, hop yield will decline up to 7-10% and a quality determinant,  $\alpha$ -acid content by 13-32%. The concentration of hop cultivation in a comparatively small part of the Czech Republic makes it more vulnerable than if the crop were grown in more areas with different climates (Možný et al., 2009).

The aim of Ústí Region case study is to investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly hop growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, the aim of Ústí case study is to investigate perceptions of local stakeholders towards climate change (in particular drought) as well as preferences towards suitable adaptation measures and strategies in the agricultural sector.

## C. Context

(Máx 500 words) *If relevant to the understanding of the Case Study, please provide any contextual information of the region, history, etc of the case study*

As agricultural practices are climate-dependent and yields vary over years depending on shorter term weather patterns, the agricultural sector is particularly exposed to climatic change (Moriondo et al., 2010). Changes in temperatures and rainfall patterns directly affect crop yield and subsequent food production and indirectly effect changes in water availability (Nelson et al., 2009).

Žalud et al. (2009a) describes the main climate related risks posing significant hazard for agro-ecosystems in the Czech Republic. These risks include: (a) hydrometeorological extremes (such as storms, short periods of very warm weather in winter, spring frost, flood, drought, heat wave, etc.), (b) occurrence of harmful agents (pathogens, pests, weeds), and (c) change of farming conditions (changes and shifts in production regions).

Drought is perceived one of the main drivers influencing agricultural production. Based on the dominating indices (Heim, 2002), drought can be divided into four categories: (1) meteorological, (2) agricultural, (3) hydrological and (4) socio-economic, which are in time order. Meteorological drought is defined by atmospheric conditions that are resulting in absence or reduction of precipitation. Short-term dryness in the surface layers (root zone) resulting in lack of water availability for crops cause agricultural drought. Hydrological drought is characterized by significant decline of water flows, reduction of streamflow, groundwater, reservoir and lake levels. Socioeconomic drought is associated with the supply and demand of some economic activities, affecting human well-being.

## D. Brief General Information on Climate CHANGE and related issues

*(Máx 2000 words) Please state which is the European climate zone of the case study and insert any information regarding the current available information regarding the case-study, namely expected impacts, scenarios.*

The case study area is located in the temperate climate zone. Ústí region together with South Moravia are one of the driest areas in the Czech Republic with yearly precipitation approximately 450 mm.

The main focus of the case study is related to drought and extreme weather events.

Based on drought analysis performed by Brázdil et al. (2009), the results for the area of the Czech Republic during time period 1881–2006 indicate a clear tendency towards prolongation and greater severity of drought episodes. Moreover, the study confirms the statistically significant tendency to more intensive dry episodes in the region, driven by temperature increase and precipitation decrease. These drought episodes have a substantial impact on national and regional agricultural production, with yields being consistently lower than in normal years.

Drought can be characterized as “sneaky extreme event”, which is gradually accumulated during longer time period (weeks to months) and can cause extensive economic losses. Due to climate change, increasing frequency and intensity of dry periods is expected. The impact of drought can be apart from the length and intensity influenced by the season of the occurrence (e.g. phenological phase) and also by suitable adaptation measures (e.g. change of cropping, irrigation, increased runoff from reservoirs) (Žalud et al., 2009b).

Climate change projections indicate a growing probability of episodes of drought in Central Europe. In 2011–2012, the extreme drought episode was in the eastern part of the Czech Republic. The episode was especially in the southern and central Moravia where rainfall totals for the period from 50 to 70% long-term average, calculated for the period 1961–2000. In the autumn of 2011, the total precipitation accounted for 10–30% of the long-term average for Moravia. According to Palmer drought severity index the drought in 2012 was classified as the worst episode in the past 130 years. Projections for 2050 indicate the occurrence of this type of drought event every 20 years (Zahradníček et al., 2014).



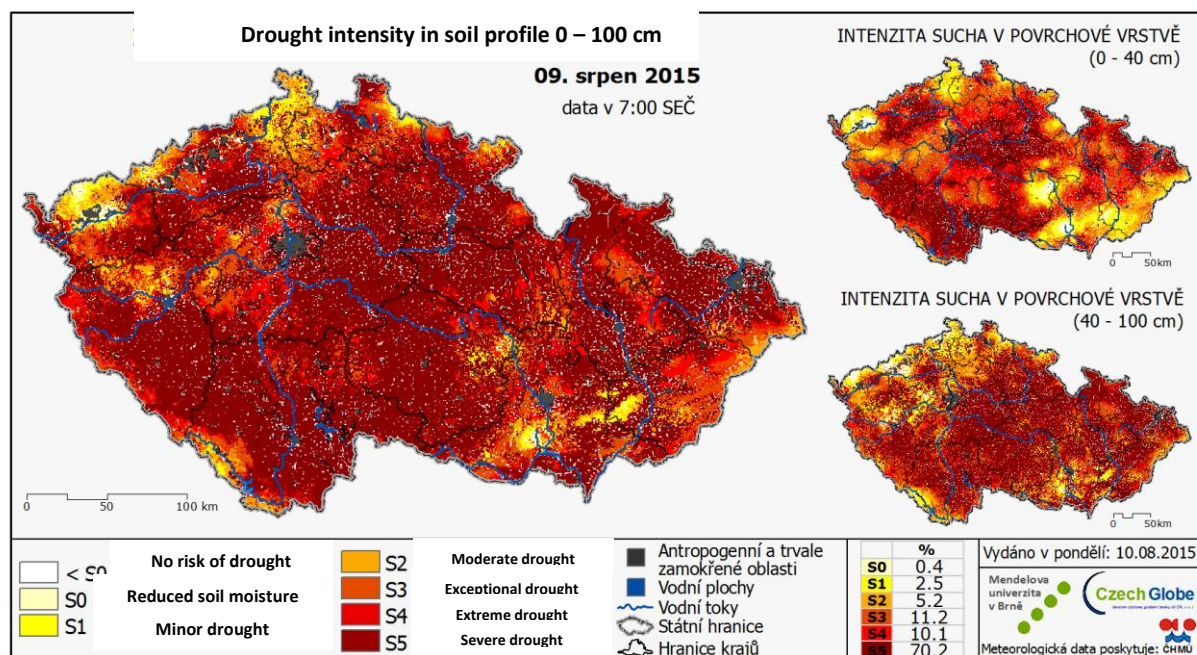


Figure X: Drought intensity (August 2015), project Intersucho (<http://www.intersucho.cz>)

In summer 2015 another drought episode appeared, the drought has been classified as the worst drought episode in the last 12 years. Figure X shows drought intensity in soil profile, which is monitored within Intersucho project.



## E. Existing Information on Case Study's adaptation history

(Máx 2000 words) *Please insert a Short resume of the Case study existing information related to Climate Change Adaptation (major goals, plans, measures and timelines already defined or implemented), important Milestones in its "Adaptation Journey" as well as relevant state-of the art regarding the implementation of Adaptation Strategies and Specific Measure*

As this case study is prospective, it does not have any long adaptation history. At the national level, national adaptation strategy has not been approved yet and discussion regarding climate change adaptation is slowly emerging. Very few programs currently exist to support adaptation on the national, regional level.

In general, the National subsidy program of the Ministry of Environment "Support of restoration of natural landscape features" aims to design and implement adaptation measures to mitigate the impacts of climate change in water, forest and non-forest sectors.

However, farmers already experience climate change impacts related to drought and extreme weather events and adapt rather autonomously.

The case study is focusing on local adaptation actions, perception of local farmers (hop growers) to climate change impacts, such as drought and extreme weather events and preferences towards suitable adaptation measures and strategies in the agricultural sector.

## F. Connection with other research projects:

(Please list and shortly describe previous or ongoing research projects directly related with the Case Study) Please write the name and summary of the project, relevant partner institutions, year of beginning and end of project)

Connection with Intersucho project – duration 2012-2015, development of interdisciplinary research team in the field of drought science and drought monitoring, Funder: Education for competitiveness operational programme, Partner institutions: CzechGlobe (Doc. Miroslav Trnka)

Intersucho project monitors drought in the Czech Republic on the weekly basis:

<http://www.intersucho.cz/en/#mother>

## G. Case ID, Typologies and Dimensions

Having in mind the following BASE Objectives; Categories of Case Studies, please fill in the following table.

### BASE OBJECTIVES

1. Compile and analyze data and information on adaptation measures, their effectiveness. (...)
2. Improve current, develop new and integrate methods and tools to assess climate impacts, vulnerability, risks and adaptation policies (...).

3. Identify conflicts and synergies of adaptation policies at different levels of policy making with other policies (including climate mitigation) within and between sectors. (...)
4. Assess the effectiveness and full costs and benefits of adaptation strategies to be undertaken at local, regional, and national scales using innovative approaches (mainly by integrating bottom-up knowledge/assessment and top-down dynamics/processes) with particular attention on sectors of high social and economic importance.
5. Bridge the gap between specific assessments of adaptation measures and top-down implementation of comprehensive and integrated strategies.
6. Use and develop novel participatory and deliberative tools to enhance the effective use of local contextualized knowledge in adaptation strategies to assess perceptions of adaptation pathways and their co-design by citizens and stakeholders.
7. Disseminate findings by sharing the results of the project with policy-makers, practitioners and other stakeholders. (...)

## CASE STUDIES CATEGORIES

- A. Public administration (municipality, regional, national, european)
- B. Research and education Centres (universities, research centres, projects and groups, schools)
- C. Public companies
- D. Companies (farms, SMEs, big businesses)
- E. Social enterprises (cooperatives, non profit companies, woofing farms, etc)
- F. Consortiums (partnerships, campaigns),
- G. NGOs (environmental NGO, local development NGO, charities, etc)
- H. Transition Initiative
- I. Ecovillage
- J. Informal groups, Movements

Case ID			Typologies and characterization				
Country & Name of CS	BASE Objectives to be answered by the CS	Category of case study	Territorial zones	Scale	Process Direction	Temporal Definition	Timescale <sup>1</sup>
	<input checked="" type="checkbox"/> Objective 1 <input type="checkbox"/> Objective 2 <input checked="" type="checkbox"/> Objective 3 <input type="checkbox"/> Objective 4 <input checked="" type="checkbox"/> Objective 5 <input type="checkbox"/> Objective 6 <input checked="" type="checkbox"/> Objective 7	<input checked="" type="checkbox"/> Companies (Farms)	<input checked="" type="checkbox"/> Rural <input type="checkbox"/> Urban <input type="checkbox"/> Coastal <input type="checkbox"/> River Basin	<input type="checkbox"/> Local <input checked="" type="checkbox"/> Regional <input type="checkbox"/> National <input type="checkbox"/> Transnational <input type="checkbox"/> European /Global	<input checked="" type="checkbox"/> Bottom-Up <input checked="" type="checkbox"/> Top-Down	<input type="checkbox"/> Retrospective <input checked="" type="checkbox"/> Prospective	2013 - 2016

## H. Impacts, Sectors and Implementation

Please tick the relevant boxes for impacts and implementation and insert the number 1 for primary sector and the number 2 for secondary sector.

Impacts	Sectors	Implementation
---------	---------	----------------

<sup>1</sup> Please insert year of start and year of end of case study.

Primary CC Impacts (Climate-Adapt)	Primary CC Impacts (BASE)	Primary and Secondary Sector (Climate Adapt)	Primary and secondary Sector (BASE)	Implemented <sup>2</sup>	Phase of Implementation <sup>2</sup>
<input type="checkbox"/> Extreme Temperatures <input checked="" type="checkbox"/> Water Scarcity <input type="checkbox"/> Flooding <input type="checkbox"/> Sea level Rise <input checked="" type="checkbox"/> Droughts <input type="checkbox"/> Storms <input type="checkbox"/> Ice and Snow	<input type="checkbox"/> Extreme temperatures <input checked="" type="checkbox"/> Water scarcity <input type="checkbox"/> Flooding <input type="checkbox"/> Coastal Erosion <input checked="" type="checkbox"/> Droughts <input type="checkbox"/> Soil Erosion <input type="checkbox"/> Vector Borne Diseases <input checked="" type="checkbox"/> Damages from extreme weather related events (storms, ice and snow)	<input checked="" type="checkbox"/> Agriculture and forest (1) <input checked="" type="checkbox"/> Biodiversity (2) <input type="checkbox"/> Coastal Areas <input type="checkbox"/> Disaster risk reduction <input type="checkbox"/> Financial <input type="checkbox"/> Health <input type="checkbox"/> Infrastructure <input type="checkbox"/> Marine and Fisheries <input checked="" type="checkbox"/> Water Management (2) <input type="checkbox"/> Urban	<input checked="" type="checkbox"/> Agriculture (1) <input checked="" type="checkbox"/> Biodiversity & Ecosystems (2) <input type="checkbox"/> Coastal and Marine systems <input type="checkbox"/> Energy <input type="checkbox"/> Health and Social Policies <input type="checkbox"/> Transport <input type="checkbox"/> Production Systems and Physical Infrastructures <input checked="" type="checkbox"/> Water resources (2) <input type="checkbox"/> Tourism	<input type="checkbox"/> Yes <input type="checkbox"/> Ongoing <input checked="" type="checkbox"/> No	<input checked="" type="checkbox"/> Assessment <input checked="" type="checkbox"/> Planning <input type="checkbox"/> Implementation <input type="checkbox"/> Monitoring <input type="checkbox"/> Evaluation

## I. Importance and Relevance of Adaptation

Please tick the relevant box for the case study.

- ☐ Case developed and implemented as a climate change adaptation measure
- ☐ Case developed and implemented and partially funded as a climate change adaptation measure
- ☒ Case mainly developed and implemented because of other policy objectives, but with significant consideration on climate change adaptation aspects

## 2. Case study research Methodology

### a) Research Goals

(Máx 500 words) Please insert which are the General Goals for the case study as well as how will the case study contribute for BASE projects and BASE key research questions.

Research objective:

To investigate suitable and sustainable adaptation measures and strategies in the agricultural (particularly hop growing) and water management sector to deal with changing climate (mainly water availability), while incorporating perceptions of local stakeholders. Moreover, the aim of Ústí case study is to investigate perceptions of

<sup>2</sup> When the case study consists of a public administration with a top down approach, implementation can be an approved legislation or regulation. When the case study is about practical adaptation measures like a sand dune, for example, implementation should be considered finished when the dune is built in situ.

local stakeholders towards climate change (in particular drought) as well as preferences towards suitable adaptation measures and strategies in the agricultural sector.

Main research questions:

How is the climate change adaptation concept integrated in key sectors?

What are the main challenges resulting from climate change in agriculture (mainly hop growing) and water sectors in region?

What are the current adaptation measures in agricultural and water sectors that deal with changing climate?

How local farmers and other relevant stakeholders perceive the concept of climate change and adaptation?

What are the potential future adaptation measures that should be implemented to deal with climate change?

What are the barriers and opportunities of implementation adaptation policies?

## **b) Stakeholders involved**

**(Máx 2000 words)** *Please insert any information about the stakeholders involved in the adaptation process with which you will relate to, namely their nature, involvement in the process, etc. If possible highlight the decision-making process as well as the leadership process for Climate Adaptation Strategies. Do Mention if there exists any kind of public engagement and participation within the Adaptation process.*

Stakeholders include:

Local hop farmers – key stakeholder with regard to the climate change perception, adaptation actions (cca 100-120 hop growers in the region) – local scale

Farmer union - Hop Growers Union - stakeholder officially representing the hop growing sector – sectoral representative

Companies – regionally based hop business companies – local scale

Water management authorities - stakeholder mainly responsible for potential measures in water sector – regional scale

Hop research institute – research institute focusing on research in the area of cultivation, harvest and post-harvest treatment of hops – research institution

Regional Authority of the Ústí Region – regional management authority – regional scale

## c) Methodology

(Máx 2000 words) Please insert what will be your research approach regarding this case study, how did you define it (did it include participatory sessions or not) and how you will implement it during the BASE Project period.

Methodology includes:

- Questionnaire-based survey (data collection) – that investigates farmers perceptions towards climate change, extreme weather events, current and planned adaptation measures
- Analysis of results of the questionnaire-based survey
- Semi-structured interview with relevant stakeholders
- Analysis of relevant documents and policies in sectors

Expected outcomes:

- Assessment of stakeholders' attitudes towards climate change and adaptation
- Investigating preferences towards suitable adaptation measures and strategies in the agricultural sector, analysis of current adaptation measures (incl. barriers and opportunities) and their assessment
- Identification and analysis of future adaptation measures

### Some preliminary results questionnaire:

50 respondents, hop farmers in Usti Region

- Please indicate the degree to which you agree or disagree with the following statement: global climate change is occurring.

Strongly disagree	disagree	neutral	agree	Strongly agree	Don't know
5	6	10	21	7	1

- Have you observed more frequent extreme or heavy precipitations in your farming area within the years you have been working at the farm?

Yes	No	Don't know
37	11	4

- Who should be responsible for initiating steps to protect your farm from the potential negative impacts of climate change (e.g. drought, floods, storms)?

	Strongly disagree	disagree	neutral	agree	Strongly agree	Don't know
Government	2	2	13	15	17	1
Insurance companies	1	1	19	15	12	1
Myself	0	3	18	15	9	1

- Note: Partners/Case Studies using PRIMATE tool will be using CBA (to prioritize) and/or MCA (with stochastic PROMETHE II) and the Monte Carlo Uncertainty Analysis, so please check these boxes.

<b>METHODS to be used in Case Studies<sup>3</sup></b>	<b>YES // NO</b>
<b>A) Methods for prioritizing adaptation options</b>	
Cost-Benefit Analysis (CBA)	
Cost-Effectiveness Analysis (CEA)	
Multi-criteria Analysis (MCA)	
Analytic Hierarchy Process (AHP)	
<b>B) Quantification of impacts and relationships between factors affecting adaptation</b>	
Causal Diagrams	
Influence Diagrams	
Process-based Modelling	
Welfare variation analysis under restrictions	
<b>C) Uncertainty and sensitivity analysis</b>	
Probabilistic multi model Ensemble	
Monte Carlo simulations ( PRIMATE uses this method)	
Real option analysis	
Climate risk management process	
<b>D) Participatory Methods</b>	
Scenario Workshop	
Participatory Cost Benefit Analysis (PCBA)	
Participatory add-ons to CBA	
Participatory add-ons to Multi Criteria Decision Analysis	
Participatory add-ons to Adaptation Pathways	
<b>Other</b> (add extra lines if necessary):	
Perception of local stakeholders (farmers) towards climate change	Y
Statistical analysis	Y

<sup>3</sup> For descriptions and references of the Methods please refer to Milestone 8. For data requests from specific Work Packages please refer to Deliverable 4.1



Qualitative semi-structured interviews	Y
Document analysis	Y

(Máx 500 words) Please highlight if you have any special need or focus regarding any of these methods and their use on your case study.

## d) Case study Timeline

(Please insert and image/graph of the Timeline of your Research Approach, highlighting important milestones and deliverables.)

Ústí Region	2013				2014				2015			
Phase 1: State of the art, current adaptation measures												
Contacting key stakeholders (e-mail)					x	x						
Analysis of relevant documents and policies in sectors				x	x	x						
Phase 2: Local perception - Questionnaire												
Interview meeting						x	x					
Preparation and set-up of questionnaire based survey					x							
Realization of questionnaire-based survey						x						
Data analysis and survey evaluation						x	x	x				
Phase 3: Results dissemination + BASE reporting												
BASE reporting												
D5.1 Climate change, impact and adaptation scenarios for case studies					x							
D5.2 Impacts, costs and benefits of adaptation measures												
D5.3 Case specific adaptation strategies and measures								x				
D5.4 Methodologies and tools for adaptation planning and implementing adaptation in cases									x			
Article manuscript										x	x	x

## e) Collaboration with other Partners and Case studies

### Collaboration with BASE case studies (see list in EMDESK):

Case: Climate adaptation responses to flooding problems in two Danish predominantly rural municipalities; Person: Anders Branth Pedersen

Case: Drought adaptation in the region of Alentejo in Portugal; Person: André Vizinho

Case: Climate adaptation in the Tagus River Basin of Spain; Person: Ana IglesiasCase:

### **Collaboration within BASE partners/researchers** (EX: for a specific competence):

Name: common questionnaire development; Partner: AU, FFCUL, UPM

## **f) Research Outputs**

### **a. Scientific Publications**

- Interim reports + final case study report for D5.5 (Month 30)

- Scientific papers: #

Provisional Title: Farmer's perceptions towards climate change impacts and adaptation \_\_\_\_\_  
\_\_\_\_\_; Month/Year: \_\_\_\_/2015

*(add more papers in case you need)*

### **b. Other Publications**

- Book – information brochure (prepared by CzechGlobe for Ministry of Agriculture of the Czech Republic)

Title: Czech countryside and agriculture in a changing climate: Adapting Czech Agriculture on climate change impacts \_\_\_\_; Month/Year: 11/2014

### **c. Other**

- Scientific conferences: # \_\_\_\_

- Title: Agriculture and Adaptation: Insights from the Czech Republic Conference: Too Much, Too Little – The Role of Water in Adaptation to Climate Change Month/Year: 10/2013

- Title: Water availability: Climate change adaptation in the agricultural sector in the Czech Republic Conference: Deltas in Times of Climate Change II Month/Year: 09/2014

- Invited seminars, presentations at local events, etc...

### 3. Participation in Climate Change Adaptation

#### a) Process overview

(Please describe the use of Participatory Methodologies within your case study, namely its integration in the overall Research Methodology explained earlier in the CSLD, the rationale behind it and key expected outcomes – Máx 1000 words)

This case study does not focus on participatory methods. However, by the questionnaire we aim to analyse what are farmer's perception to climate change, main barriers to adaptation and preferred adaptation measures.

Interviews were conducted in order to investigate mainly attitudes of farmers towards adaptation action as well as interlinkages between climate change adaptation and common agricultural policy.

In March 2014, a quantitative questionnaire was distributed among hop growers situated mainly in Ústí region. We received answers from 50 respondents out of 119 hop growers in the Czech Republic. From the respondents, 88% were men, 12% women; regarding education, 88% had secondary and higher education and had an average of 24 years of experience farming. The majority, 52%, were farming on an area of hop gardens up to 25 hectares.

Moreover, by selection of questions from a quantitative questionnaire we aim to analyse two aspects of climate change adaptation:

#### *1) Responsibility of stakeholders (farmers, government, insurance companies) for initiating steps to climate change adaptation*

When asking about responsibility of the stakeholders for initiating steps to protect the farm from potential negative impacts of climate change (e.g. drought, floods, and storms), majority of respondents agree and strongly agree with all of the suggested options, confirming the role of farmers themselves, government, as well as insurance companies. Figure 1 shows that 64% of respondents supported the role of the government, 55% also supported role of the agricultural insurance, 53% agree with important role of themselves in initiating steps to protect their farm from the potential negative impacts of climate change.

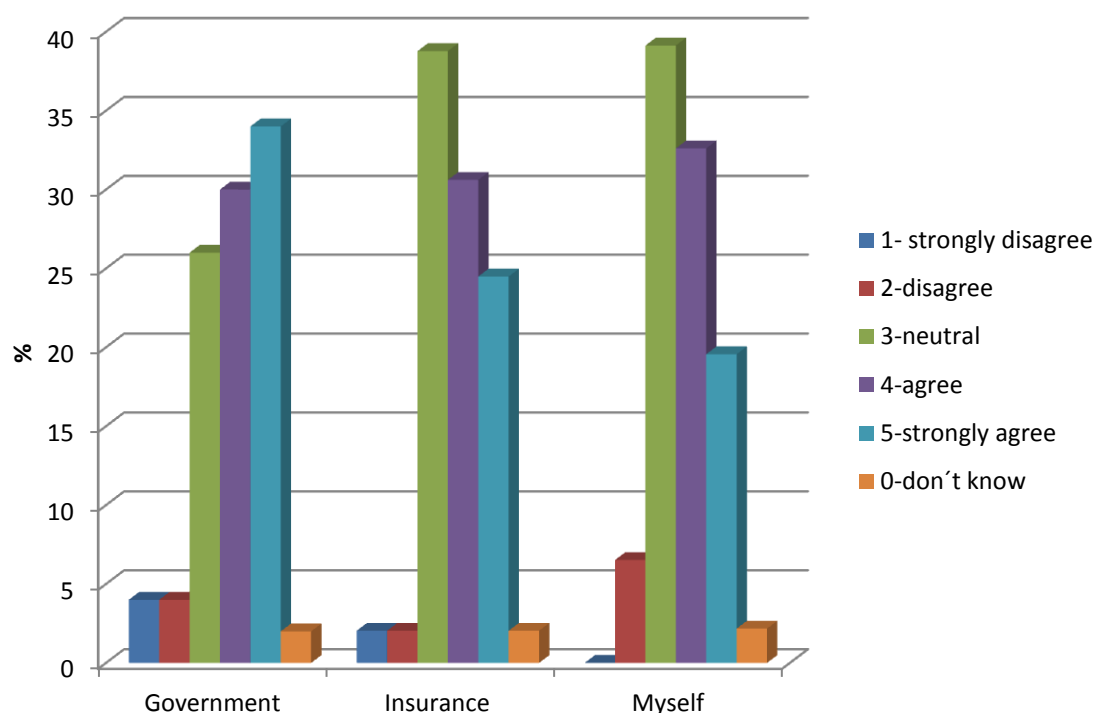


Figure 1: Responsibility for initiating climate change adaptation

## 2) Barriers to climate change adaptation that farmers perceive

The second aspect focuses on barriers to climate change adaptation in agriculture that farmers perceive. From the institutional perspective, among variety of presented barriers, farming policy plays important role. 69% of respondents agree that farming policy regulations may represent an obstacle in climate change adaptation. Furthermore, 71% of respondents perceive economic losses from smaller subsidies as an important barrier (see Figure 2).

Almost a majority of farmers, 49%, agree that lack of information on methods of adaptation might also represent barrier in climate change adaptation. When asking specifically about obtaining information on climate change, on site experience and information from media are perceived as the main source of information.

Apart the farmers, one of the interviewee (representative of the farmer's association – Hop Growers Union of the Czech Republic) mentioned the Ministry of Agriculture as the main source of information on climate change.

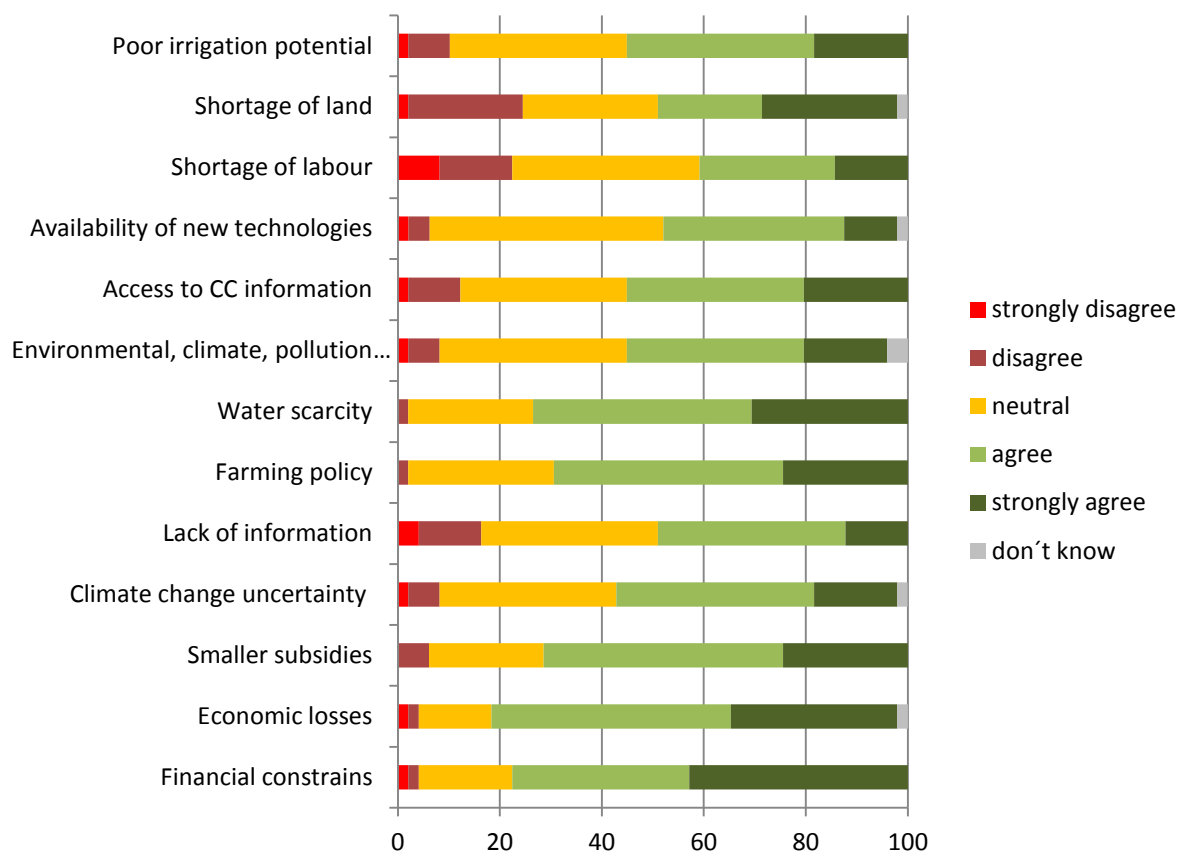


Figure 2: Barriers to climate change adaptation

## b) Participation in the Process Phases

(Please uncover the role of all participants in the process of implementing adaptation measures. The adaptation implementation has been divided into four phases for purposes of ease: 1) Initiative/decision to act, 2) Development of potential adaptation options, 3) Decision-making, and 4) Implementation. The process phases are to be filled out with information corresponding to each participant. I.e. if experts were not consulted in the 'decision-making' phase, then describe why they were not included. It is also important that a wide array of participants is described, including those that were excluded from parts of the process. )

Make a bullet point for each of the five participant categories below (and distinguish between for example different stakeholder or expert groups) and be as descriptive as possible how, why/why not were they involved.

So far, Czech Republic does not have approved National Adaptation Strategy. The preparatory process for the Czech National Adaptation Strategy began in 2009. According to the Policy Statement of the latest Czech government, approval of the Strategy is expected in mid-2016. Since the adaptation process in the Czech Republic is mostly top-down, the actual implementation of specific adaptation measures depends on the implementation of National Adaptation Strategy. Therefore, the adaptation activity on the regional and local level and specific sectors is limited.

In case of agriculture, specifically hop farming, due to the non-existence of particular sectorial adaptation strategy, the adaptation actions are rather fragmented and autonomous. Autonomous adaptation can be defined as the ongoing implementation of existing knowledge and technology by farmers themselves, responding to experienced changes in climate (Leclere et al., 2013). As these practices including mainly measures related to agricultural management practices, water saving measures and insurance (soft measure) are realized by farmers themselves, participation in such an adaptation process is very limited.

## Process phases:

### 1. *Initiative/decision to act*

Stakeholders

Citizens

Experts

Politicians

Officials/legislators

### 2. *Development of potential adaptation options*

Stakeholders

Citizens

Experts

Politicians

Officials/legislators

### 3. *Decision-making*

Stakeholders

Citizens

Experts

Politicians

Officials/legislators

### 4. *Implementation*

Stakeholders

Citizens

Experts



Politicians

Officials/legislators

### c) Participation Experience

(Please report with regards to your case study and the implementation of Participatory Methodologies using a traditional SWOT analysis – Strengths; Weaknesses; Opportunities and Threats)

<b>Strengths</b>  NA	<b>Weaknesses</b>  - In case of autonomous adaptation of farmers, participation is very limited, to non-existent, the adaptation measures were not influenced by that.
<b>Opportunities</b>  - Approval of the National Adaptation Strategy and subsequent mainstreaming of adaptation into sectoral policies will be opportunity for broader participation in the planned adaptation process.	<b>Threats</b>  - Climate change is not the issue that is placed high on political agenda in the Czech Republic. Currently this issue is introduced to political and society arena, which is to some extent rather sceptical to potential impacts.

### d) Learning through Participation

In order to capture how participation could improve the climate change adaptation process, please report with regards to your case study:

a) Your view whether and how participation influenced the strategies and measures decided in your case?

In case of autonomous adaptation of farmers, participation is very limited, to non-existent, the adaptation measures were not influenced by that.

b) How you think the participatory process in your case could be/have been improved?

Approval of the National Adaptation Strategy is needed in order to mainstream adaptation into other sectoral policies, such as agriculture and initiate official participatory process to develop sectoral, regional adaptation policies.

c) Any novel (use of) participatory methods observed in the case studies

No.

## 4. Climate Change Adaptation Measures and Strategies

### a) Adaptation Measures under analysis in your case study

(Please identify your Adaptation Measures considered in this case-study and provide a short description of each)

Adaptation Measure(s):

- 1) Soft measures - Insurance policies
- 2) Agricultural management practices - permanent set aside of arable land, adaptation measures related to changes in planted crop variety, No-tillage technologies, Shift in the timing of agricultural activities (eg, time of planting, sowing, treatment)
- 3) Water saving measures - increase of water retention, change in irrigation practice

Short description for each Adaptation Measure (Máx 50 words):

The list cover adaptation measures mainly related to drought and extreme weather events.

1) Insurance policies – risk transfer tool, can be described as non-structural measure

2) Agricultural management practices:

Adaptation measures related to changes in planted crop variety– option related to land use planning

Permanent set aside of arable land – option related to land use planning

No-tillage technologies – technical measure, management practices

Shift in the timing of agricultural activities (eg, time of planting, sowing, treatment) – changes in management practices

3) Water saving measures - increase of water retention - improvement of water balance in landscape, change in irrigation practice - improved efficiency of irrigation systems

### b) Adaptation Measures selection and data availability prior to BASE

(Please describe how and why where these specific measures selected for further research and analysis under BASE and what is the baseline data already available for each specific adaptation measure. Máx 500 words)

Ústí region case study was selected as one of the driest areas in the Czech Republic, therefore highly relevant area for climate change adaptation, where also majority of wine growing production take place. The adaptation measures reflect potential activities related to drought and extreme weather events in the agricultural sector. The measures were selected as input data for the questionnaire that aim to explore the

attitudes towards these measures, and barriers to implement them. The adaptation measures reflect potential activities related to drought and extreme weather events in the agricultural sector. The measures were selected as input data for the questionnaire that aim to explore the attitudes towards these measures, and barriers to implement them. These measures are further investigated based on interviews and literature analysis.

### c) Full description of Adaptation Measures

(Please provide a full description on each of the Adaptation Measures regarding this 21 leading questions under. If more than one Adaptation Measure please copy paste the structure provided.)

#### Process

- I. Would, or at which part would, institutions and private stakeholders implement the measure autonomously to adapt to climate change (Adaptive capacity)?

This would be identified by the analysis of questionnaire results.

- II. Does the measure initiate further activities for adaptation to climate change? (Y/N)
  - a. If Yes, please name which
- III. Does adaptation aim for flexibility and reflexivity (i.e. the ability to change as CC and other factors develop )? (Y/N) Y
- IV. Is the measure effective under different climate scenarios and different socio-economic scenarios? (Y/N) Y
- V. Is the adaptation measure iterative? (Y/N) Y
- VI. Does the measure contribute to overall sustainable development, alleviate already existing problems and bring benefits for other social, environmental or economic objectives than adaptation (no regret measures)? (Y/N)

a. Please describe briefly how

(fill with your answer)

VII. Can adjustments be made later if conditions change again or if changes are different from those expected today? (Y/N)

### Outcome

#### **Relevance and effectiveness of adaptation measures**

VIII. How important is the climate change threat addressed by the measure? What economic values, ecosystem functions and socio-cultural values are at stake, and to what extent are they affected by climate change impacts? Is there an indication of overriding public interest, e.g. critical infrastructures, public health ?

Drought can be characterized as “sneaky extreme event”, which is gradually accumulated during longer time period (weeks to months) and can cause extensive economic losses. Due to climate change, increasing frequency and intensity of dry periods is expected. The impact of drought can be apart from the length and intensity influenced by the season of the occurrence (e.g. phenological phase) and also by

IX. What portion of the targeted potential damages can be avoided by implementing the measure? (0-100%) difficult to judge

### **Efficiency**

X. How high are the benefits of the measure relative to the costs? Are the costs justified by the benefits (Please refer to results of economic evaluation in chapter 5)

(fill with your answer)

- XI. What are the costs of the administrative implementation of the measure? Are there potential funding under the umbrella of other European policies(eg. CAP/Cohesion policy ?

(fill with your answer)

- XII. Does the measure give an incentive for innovation to different actors (e.g. SMEs) / can it deliver a competitive advantage for the local economy? (Y/N) N
- XIII. Does the measure have effects on employment? (Y/N) N
- XIV. How long is the time-lag between implementation of the adaptation measure and the effect of the measure? \_\_\_\_\_
- XV. What is the timeframe during which the measure will have an effect? \_\_\_\_\_
- XVI. Does the measure create synergies with mitigation (i.e. reduce GHG emissions or enhance GHG sequestration)? (Y/N)
- XVII. Does the measure alleviate or exacerbate other environmental pressures? (Explain briefly)

(fill with your answer)

### **Equity**

- XVIII. What are the impacts on different social or economic groups, are there expected impacts on

(fill with your answer)

particularly vulnerable groups? (distributional impact)

- XIX. Does the measure enhance well-being and quality of life (e.g. in the urban environment)? (Y/N)

## 5. Impacts, Costs and Benefits of Adaptation measures

(This section of the CSLD follows the Economic Assessment Steps put forward by UFZ and thoroughly described in D4.1, chapter 4. Please check D4.1 for any doubts or questions. In case of duplication of information with previous sections of the CSLD feel free to copy paste.) For more detailed guidance (incl. two examples) please see the above mentioned chapter 4 of D4.1. Please do not hesitate to contact [volker.meyer@ufz.de](mailto:volker.meyer@ufz.de), [oliver.gebhardt@ufz.de](mailto:oliver.gebhardt@ufz.de) or Filipe Alves if you have questions about how to fill out this section.

### Step 1 – Preliminary Risk Assessment and identification of adaptation tipping points (max 1500 words)

*(some of these questions might be already answered in section 1 – if so, just copy&paste)*

#### **What is the climate change related problem/risk you would like to reduce by adaptation?**

- Which problems already exist, what is/are the current risk/s?
- Which assets and sectors are at risk under current climate variability?
- Which adaptation or protection measures are already in place? (refer to typology of measures in D6.1, table 2)
- How do these risks presumably change due to climate and socio-economic change?
- What are the main drivers, impacts and affected sectors (refer to BASE impact and sector categories, see also Table 1 of D6.1)
- Which climate and socio-economic scenarios are used?

This case study does not focus on economic assessment of the adaptation measures. The analysed problem is drought and extreme weather events affecting agricultural practices (hop farming), which is analysed mainly through questionnaire, together with semi-structural interviews. As agricultural practices are climate-dependent and yields vary over years depending on shorter term weather patterns, the agricultural sector is particularly exposed to climatic change (Moriondo et al., 2010). Changes in temperatures and rainfall patterns directly affect crop yield and subsequent food production and indirectly effect changes in water availability (Nelson et al., 2009).

Based on drought analysis performed by Brázdil et al. (2009), the results for the area of the Czech Republic during time period 1881–2006 indicate a clear tendency towards prolongation and greater severity of drought episodes. Moreover, the study confirms the statistically significant tendency to more intensive dry episodes in the region, driven by temperature increase and precipitation decrease. These drought episodes have a substantial impact on national and regional agricultural production, with yields being consistently lower than in normal years.

Based on the climate scenarios in the period 2051-2100, hop yield will decline up to 7-10% and a quality determinant,  $\alpha$ -acid content by 13-32%. The concentration of hop cultivation in a comparatively small part of the Czech Republic makes it more vulnerable than if the crop were grown in more areas with different climates (Možný et al., 2009).

#### **Which adaptation tipping points can be identified?**



- Can adaptation tipping points, critical levels for adaptation, be defined for this current strategy? (=when objectives are not met anymore due to changes)  
Refer to otherwise expand on Table 3 of D6.1
- When (roughly) will these critical levels be reached due to climate change or socio-economic change
- Give appropriate period (2015-2030, 2030-2050, after 2050) for each considered combination of climate and socio-economic scenario.

Increase in drought - water demands cannot be met by supply (risk based approach)

Drought, extreme weather events – decline in agricultural production, crops cannot be grown anymore

## Step 2 – Identification of Adaptation Measure and Adaptation Pathways (max 1500 words)

*(some of these questions might be already answered in section 4 – if so, just copy&paste)*

### What are the alternative adaptation measures?

- What are the primary and secondary objectives of adaptation?  
Primary objective of the measures is to increase resilience towards drought and extreme weather events. Secondary objective is to increase adaptive capacity and awareness.
- What are potential measures to meet these objectives? (refer to typology of measures in D6.1, table 2)

Adaptation Measure(s):

- 1) Soft measures - Insurance policies
  - 2) Agricultural management practices - permanent set aside of arable land, adaptation measures related to changes in planted crop variety, No-tillage technologies, Shift in the timing of agricultural activities (eg, time of planting, sowing, treatment)
  - 3) Water saving measures - increase of water retention, change in irrigation practice
- What is your baseline option (the “business-as-usual”-option)?
    - What is the ambition level of this baseline strategy?: Maintaining current risk levels or current protection levels (implying with CC risks may increase)?
    - Is current backlog of investments for adaptation measures included or excluded?
    - Does it include only planned adaptation or also autonomous, non-planned adaptation?

Increasing resilience towards drought and extreme weather events, mainly autonomous adaptation.

- Are there complementary measures? Is it appropriate to bundle these measures?

No information available.

### What are alternative adaptation pathways?

- What is the “sell-by”-date of the measures or bundles of measures? I.e. when will they – under conditions of climate change – not any longer be able to meet the defined objectives?
- What would be alternative measures or bundles of measures at these “tipping points”

This case study does not focus on adaptation pathways.

## Step 3 - Evaluation Criteria and Method (max 2000 words)

### Step 3a Selection of evaluation criteria

**Which evaluation criteria should be used?**

- What are the relevant positive and negative properties of the measures (costs and benefits) to be considered in the evaluation process (economic, ecological and social effects)?
- (see D4.1, chapter 4 for examples)
- What is the appropriate unit to measure each of these criteria? Is the performance of the adaptation options measured in qualitative, monetary or other quantitative terms?

To be developed.

### Step 3b Selection of evaluation method(s)

**What is the appropriate evaluation method?**

- Is it possible to express all relevant cost and benefit criteria in monetary terms?  
(→ cost-benefit analysis)
- Is it possible to express the positive effect (objective) by a single non-monetary indicator?  
(→ cost-effectiveness analysis)
- Are there several relevant criteria which cannot or cannot easily be expressed in monetary terms?  
(→ multi-criteria analysis, PCBA)

## Step 3c Weighting of evaluation criteria (applicable only to multi-criteria analysis)

**What are the preferences of stakeholders regarding the different evaluation criteria?**

- Are there different stakeholder groups with varying preferences regarding the evaluation criteria?
- Which weight do stakeholders and/or decision makers attach to a substantial change in the performance of the adaptation options regarding each evaluation criterion?  
(see D4.1, chapter 4.10.2 for guidance for the Swing-Weight method)

Not applicable.

## Step 4 - Data collection (max 2000 words)

### **What are the costs and what are the benefits of the alternative adaptation options?**

- What potential data sources are available, including damage & impact assessment methods or existing CBA studies on adaptation measures?
- If no relevant data sources are available and modelling cannot be undertaken: Which experts can estimate proxies for assessing the performance of measures regarding the respective criterion?
- How do the adaptation options perform with regard to each of the cost and benefit criteria selected in step 3a?

### **What is the evaluation time frame?**

- What is the lifespan of the measure with the longest lifetime?

### **Which discount rate should be applied?**

- Which discount rate is recommended by national guidelines for climate change adaptation measures (or public investments)?
- Is it a linear discount rate or any other type (i.e. declining, hyperbolic, etc.)
- (In addition, for testing the sensitivity of the results with regard to the discount rate(s) used, also apply a low and high discount rate (1% and 5%).)

### **How to deal with data uncertainty?**

- Can uncertainties related to the performance of the measures regarding certain evaluation criteria be described by a range (min-max), a triangular distribution (min, most likely, max) or any other kind of probability distribution?

## Step 5 – Evaluation and Priorization (max 1500 words)

**What is the ranking order of alternative adaptation options (measures, bundles of measures or pathways)?**

- For cost-benefit analysis:  
What is the net-present value (discounted benefits – discounted costs) of the alternative options?  
What is the benefit-cost ratio?
- For cost effectiveness analysis:  
Which alternative achieves a defined objective at lowest costs?  
What is the cost-effectiveness ratio?
- For multi-criteria analysis:  
Which adaptation option performs best?  
(e.g. for PROMETHEE approach: which option has the highest net flow?)
- What are the uncertainties associated with the performance of the different options?
- Is there and, if so, to what extent uncertainty in the ranking of options?
- Is it possible to determine which option most likely performs best or is it necessary to gather further information to reduce uncertainty (go back to step 4)?

## 6. Implementation Analysis

The aim of this section is to establish whether adaptation measures can be implemented in the real world context of case studies, and what the key obstacles and opportunities are in doing so. To ensure the answers provided in this section are comprehensive and in line with WP2 and WP7, a checklist is provided below with the main factors that all case holders need to consider in their answers If relevant to the implementation of your case study.

### Checklist

When answering the main questions below ensure you consider each factor listed in the checklist below that might have had a role in the implementation of your case study work. Write in the table how important each factor has been to the implementation of your BASE work and adaptation in general at your case study; where 1 = unimportant, 2 = slightly important, 3 = Important, 4 = Very important, and 5 = Critical). The checklist might not be all-inclusive, so feel free to discuss other factors that are not listed.

Key factors:	Rank from 1 – 5
i. <b>Knowledge and information about climate adaptation</b>	4
ii. <b>Actors</b> (e.g. leadership, perceptions, understanding of climate adaptation, participation, decision making, stakes, conflicts/synergies)	2
iii. <b>Framing of climate adaptation</b> (e.g. as sustainability concern, (urban) planning or environmental issue, disaster risk mitigation topic)	3
iv. <b>Local and regional context</b> (e.g. culture, history, geography, environment, economy)	2
v. <b>European, national, regional and local regulatory framework</b> (e.g. be specific about laws, strategies, policies)	4
vi. <b>Institutional context</b> (e.g. integration of adaptation into existing structures/activities/strategies, decision making, conflicts/synergies, governance arrangements, incentives for engagement)	5
vii. <b>Resources</b> (e.g. financial, human)	5
viii. <b>Nature of adaptation measures</b> (e.g. no regret, flexibility, important co-benefits, side-effects)	4
ix. <b>Other</b> (specify _____)	

### Summary Information (based on your answers to the questions below)

a) Specify sectors covered (e.g. coast, city, agriculture):

Agriculture

b) Specify adaptation measures covered (e.g. altering cultivation practices, building defences; explain why they were chosen):

Agricultural management practices, water retention and saving measures and insurance (soft measure)

c) Specify climate change impacts covered (e.g. flooding, heat stress, sea level rise):  
Water scarcity, Droughts, Damages from extreme weather related events

d) Specify main results of activities (e.g. changes, outputs):

Climate change perception, exploring preferences towards suitable adaptation measures and strategies in the agricultural sector.

## Questions

Answer these six questions giving specific evidence and examples where possible. In principle all implementation activities should be included, i.e. adaptation activities supported by BASE partners as well as those by other actors. If it is possible to inform about the implementation of those adaptation measures assessed for task 5.2, it is very important to do so in order to comply with the DoW. The measures covered can be extensive and/or particular to a case study. They can include for example, the development of plans and strategies, vulnerability/risk assessments, economic assessments such as CBA, MCA, the development of participatory processes/public dialogue, through to the implementation of actual measures including physical measures such as engineering developments and land use change, incentives/subsidies for behavioural change, etc. This list is not all-inclusive and is merely a guide. Your own case study may have very different measures. However, **you must be clear what measures you are refereeing to when answering these questions.**

## Questions

1. How have climate change adaptation measures and strategies been advanced in the case study? Describe the process! *Note:* Retrospective case studies will not answer this question, but have to update their answer to question 1 E of this document on the history of adaptation at their case study. (Approximately 500 words)

So far, Czech Republic does not have approved National Adaptation Strategy. The preparatory process for the Czech National Adaptation Strategy began in 2009. According to the Policy Statement of the latest Czech government, approval of the Strategy is expected in mid-2016. Since the adaptation process in the Czech Republic is mostly top-down, the actual implementation of specific adaptation measures depend on the implementation of National Adaptation Strategy. Therefore, adaptation activity on the regional and local level and specific sectors is limited.

In case of agriculture, specifically hop farming, due to the non-existence of particular sectorial adaptation strategy, the adaptation actions are rather fragmented and autonomous. Autonomous adaptation can be defined as the ongoing implementation of existing knowledge and technology by farmers themselves, responding to experienced changes in climate (Leclerc et al., 2013). As these practices including mainly measures related to agricultural management practices, water retention and saving measures and insurance (soft measure) are realized by farmers themselves, participation in such an adaptation process is very limited.

In March 2014, a quantitative questionnaire was distributed among hop growers situated mainly in Ústí region. We received answers from 50 respondents out of 119 hop growers in the Czech Republic.

From the respondents, 88% were men, 12% women; regarding education, 88% had secondary and higher education and had an average of 24 years of experience farming. The majority, 52%, were farming on an area of hop gardens up to 25 hectares.

One of the topics of the questionnaire was asking farmers whether they would be willing to implement particular adaptation measures, in order to protect their land against possible negative impacts of climate change. Measures to increase water retention (such as, infiltration zones, buffer strips, hedges, terracing) were highly preferred, 80% of respondents perceived these measures as important. Majority of respondents also support extension of insurance, shift in timing of agricultural practices, crop diversification (which is not the case of monoculture hop farming, but might in general be suitable agricultural adaptation strategy).

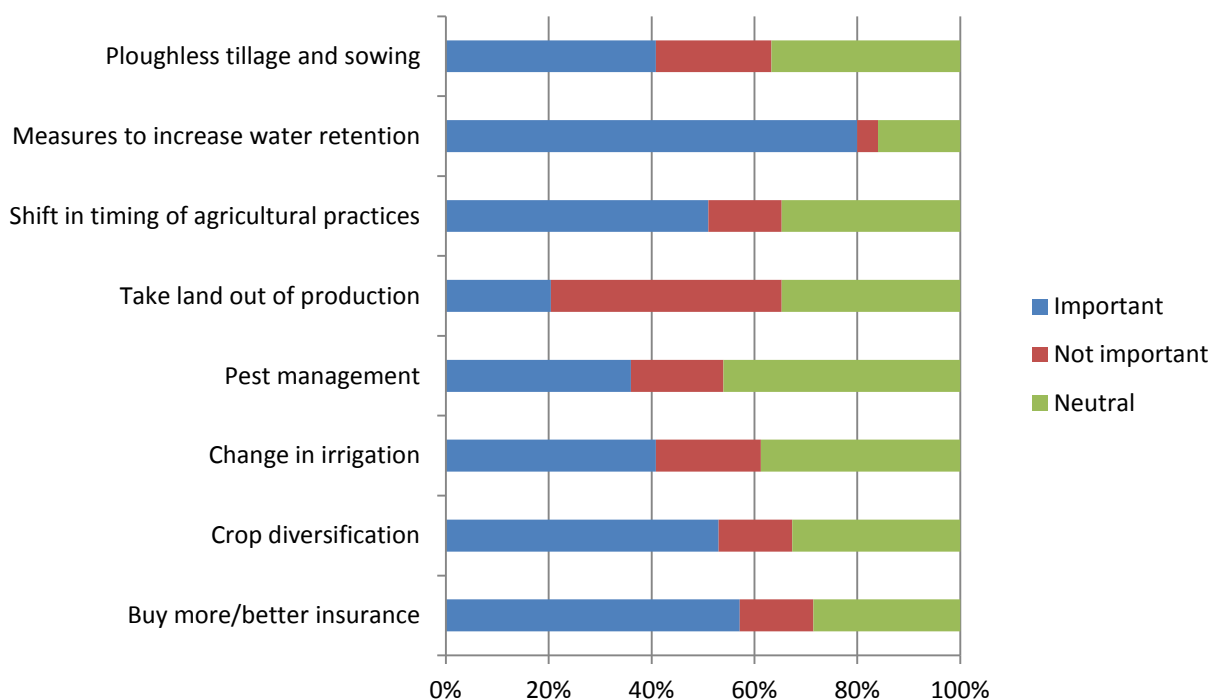


Figure 3: Importance of adaptation measures

2. What and who drives (or enables) the adoption and implementation of adaptation measures and strategies/policies? Please explicitly refer to the factors mentioned in the checklist, highlighting the factor in bold, and be specific about any relevant policies! (Approximately 500 – 1000 words)

In case of agriculture, specifically hop farming and non-existence of particular sectorial adaptation strategy, the adaptation actions are rather fragmented and autonomous. As these practices including mainly measures related to agricultural management practices, water retention and water saving measures, insurance (soft measure).

The implementation of adaptation measures in the Czech Republic depends also on political and institutional setting, which is mainly top-down driven and climate change is not at the top of political agenda. National Adaptation Strategy is in preparation phase.



3. What obstacles were encountered during the adoption or implementation of adaptation measures and strategies/policies? Please explicitly refer to the factors mentioned in the checklist, highlighting the factor in bold, and be specific about any relevant policies! (Approximately 500 – 1000 words)

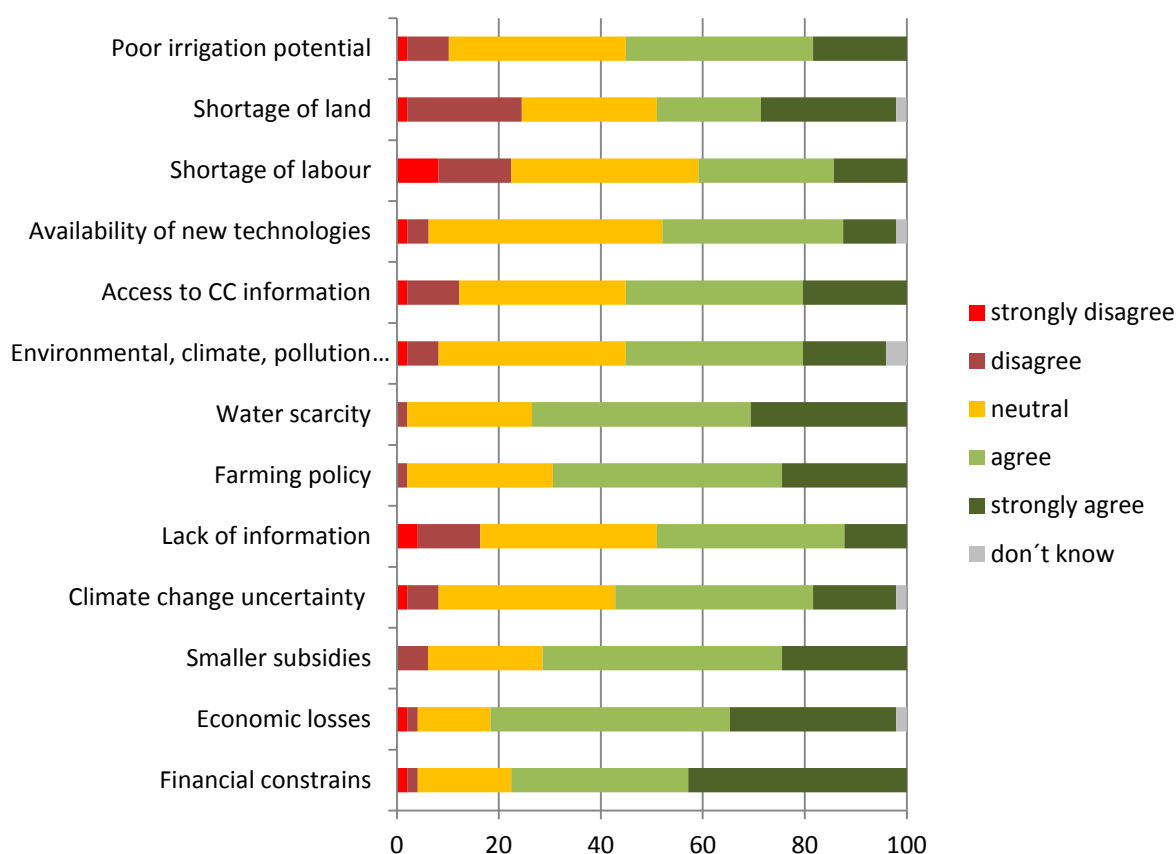
### **Regulatory framework and resources**

One of the topics investigated by the questionnaire was barriers that hop farmers perceive in relation to climate change adaptation. From the institutional perspective, among variety of presented barriers, farming policy plays important role. 69% of respondents agree that farming policy regulations may represent an obstacle in climate change adaptation. Furthermore, 71% of respondents perceive economic losses from smaller subsidies as an important barrier (see Figure 4).

### **Knowledge and information about climate adaptation**

Almost a majority of farmers, 49%, agree that lack of information on methods of adaptation might also represent barrier in climate change adaptation. When asking specifically about obtaining information on climate change, on site experience and information from media are perceived as the main source of information.

Apart the farmers, one of the interviewee (representative of the farmer's association – Hop Growers Union of the Czech Republic) mentioned the Ministry of Agriculture as the main source of information on climate change.



*Figure 4: Barriers to climate change adaptation*

### ***Local and regional context***

Property rights were often mentioned as one of the key obstacles in climate adaptation. For instance, implementation of water retention measures requires sufficient space and area suitable for effective water retention measures can be located in the land of neighbouring property owner. This also might be the case of flood protection measures and establishment of water retention reservoirs.

### ***Framing of climate adaptation***

In general, there is a limited interest in issues connected to climate change (and environmental issues in general) among population and political representatives. National Adaptation Strategy is still in preparation phase, and the policy framework is more or less missing.

4. If any obstacles were overcome, how was this achieved? (Approximately 500 words)

n/a

5. What are the future prospects of the climate change adaptation activities in the case study? (Approximately 200 – 500 words)

Future prospects and opportunities might be seen in the implementation of National adaptation strategy and new common agricultural policy. As previously mentioned, agricultural adaptation is currently rather autonomous, institutional and governance support is needed to support effective adaptation.

6. What is the key message from this case study (and which could work in other cases as well)? Don't forget to consider any specific policy recommendations that arise in your case study! (200 – 500 words)

In general, there is a need for broader political support to assist farmers with the implementation of suitable adaptation measures. As well as awareness raising and knowledge sharing is important at all levels. Agricultural practices are climate-dependent and yields vary over years depending on shorter term weather patterns, farmers are to some extent used to these changes. But with the current and future expected impacts of climate change, the agricultural sector is particularly exposed to climatic change and increasing vulnerability.

## 7. References

- Brázdil, R., Trnka, Dobrovolný, P., Chromá, K., Hlavinka, P., Žalud, Z., 2009. Variability of droughts in the Czech Republic, 1881–2006. *Theor Appl Climatol* 97, 297–315.
- Heim, R.R., 2002. A review of twentieth-century drought indices used in the United States, *Bulletin of the American Meteorological Society*, Vol. 83, Issue: 8, pp. 1149–1165.
- Moriondo, M., Bindi, M., Kundzewicz, Z.W., Szwed, M., Chorynski, A., Matczak, P., Radziejewski, M., McEvoy, D., Wreford, A., 2010. Impact and adaptation opportunities for European agriculture in response to climatic change and variability. *Mitigation and Adaptation Strategies for Global Change* 15 (7), 657–679.
- Možný, M., Tolasz, R., Nekovář, J., Sparks, T., Trnka, M., Žalud, Z. 2009. The impact of climate change on the yield and quality of Saaz hops in the Czech Republic. *Agricultural and Forest Meteorology* 149, 913–919.
- Nelson, G.C., Rosegrant, M.W., Koo, J., Robertson, R., Sulser, T., Zhu, T., Ringler, C., Msangi, S., Palazzo, A., Batka, M., Magalhaes, M., Valmonte-Santos, R., Ewing, M., Lee, D., 2009. *Climate Change: Impact on Agriculture and Cost of Adaptation*. International Food Policy Research Institute. Washington, D.C.
- Žalud, Z., Trnka, M., Dubrovský, M., Hlavinka P., Semerádová, D., Kocmánková, E., 2009a. Climate Change Impacts on Selected Aspects of the Czech Agricultural Production. *Plant Protection Science*, Vol. 45, 2009, Special Issue: S11–S19.
- Žalud, Z. (ed.). 2009b, *Climate change and Czech agriculture – impacts and adaptations*, ISSN 1803-2109, 119 pp.



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