Climate change adaptation in Uusimaa agriculture – risk perceptions, adaptation measures and -policies

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Content

ABSTRACT

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Tiivistelmä – Referat – Abstract

Climate change causes climatic risks (hazard-exposure-vulnerability) that are experienced in agriculture as problems with increased precipitation, droughts, pest invasions and weather variability. Agriculture needs to adapt to these changing conditions to secure its continuation in future. It is the farmers, who in last hand are taking action for adaptation. Farmers are recognized as a stakeholder group in agricultural with plenty of skills to tackle varying weather conditions. In fact, farmers are already implementing adaptation measures, although it is not always driven by or aimed at climate change explicitly.

Adaptation policies aimed at farm-scale are being planned and developed. The Intergovernmental Panel on Climate Change (IPCC) is the leading scientific source of adaptation policy recommendations. Currently it is recommending risk management approach for managing the known and unknown climatic risks that societies and sectors like agriculture are facing. In agriculture, for example, crop loss insurances are part of climate risk management.

Farmers are making adaptation decisions at farm-scale based on their own beliefs and experiences, on information from variable sources, and guided by policies and legislation. The primary driver for taking adaptive action at farm, according to protection motivation theory (PMT), however, is the perception of risk – if the risk is assessed high enough and the adaptation is assessed possible.

In this thesis, PMT and the theory of risk perception are used to explain farm-scale adaptation. Adaptation is examined as climate or weather variation driven adaptation measures implemented by farmers autonomously or guided by policies.

A case study approach and stakeholder interviews were used because of the novelty of the study topic. By examining the case of 'adaptation in Uusimaa agriculture' through the perceptions of interviewed farmers and extension officers, an overview on farm-scale adaptation with its variety of influencing factors, and better understanding of risk perceptions as adaptation drivers is reached.

Findings of the study show that farmers in Uusimaa are taking adaptation measures, but adaptation policies are not yet guiding adaptation at farm level and that farmers are divided by the ways they respond to climatic risks. Further studies on adaptation policies and agricultural adaptation should recognize the varying risk responses, the need for better adaptation policy guidance and farmers' adaptation experiences and skills.

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Ilmastonmuutos aiheuttaa riskejä (vaara-altistuminen-haavoittuvuus), jotka koetaan maataloudessa hankaluuksina lisääntyneen sadannan, kuivuuden, tuholaisinvaasioiden ja sään vaihtelun kanssa. Maatalouden on jatkuakseen sopeuduttava näihin muuttuviin olosuhteisiin. Viljelijät kantavat sopeutumisesta viimekäden vastuun. Viljelijät yhtenä maatalouden sopeutujista, ovat tunnustetusti kyvykkäitä pärjäämään vaihtelevien sääolosuhteiden kanssa. Viljelijät toteuttavatkin jo sopeutumistoimenpiteitä, vaikka ne eivät aina ole välittömästi ilmastonmuutokseen kohdistettuja tai sen ajamia.

Maatilatasolle ohjattua sopeutumispolitiikkaa suunnitellaan ja kehitetään ja tämän johtavana tieteellisenä ohjeistajana on hallitustenvälinen ilmastonmuutospaneeli (IPCC). Tällä hetkellä IPCC suosittelee riskinhallintaa lähestymistapana tunnettuihin ja tuntemattomiin ilmastoriskeihin, joiden edessä yhteiskunta eri sektoreineen on, maatalous mukaan lukien. Maataloudessa esimerkiksi satovahinkovakuutukset ovat osa ilmastoriskien hallintaa.

Viljelijät tekevät sopeutumiseen liittyviä päätöksiä tilatasolla perustuen muun muassa uskomuksiinsa ja kokemuksiinsa, eri lähteistä saatuihin tietoihin, politiikkaohjaukseen ja lainsäädäntöön. Ensisijaisesti sopeutumistoimintaa ohjaa riskikäsitykset, mikäli riksi arvioidaan riittävän korkeaksi ja sopeutuminen siihen arvioidaan mahdolliseksi – tällöin sopeutumisaikomus voi johtaa sopeutumistoimintaan. Päätöksenteko perustuu tällöin suojelumotivaatioon.

Tässä tutkielmassa suojelumotivaatioteoriaa (PMT) ja riskikäsitysteoriaa käytetään selittämään tilatason sopeutumista. Sopeutumista tarkastellaan ilmaston ja sään vaihteluiden ajamina sopeutumistoimenpiteinä joita viljelijät toteuttavat joko itseohjautuvasti tai politiikkaohjauksen seurauksena.

Lähestymistapana käytetään tapaustutkimusta ja asianosaishaastatteluja koska aihe on vähän tutkittu. Tutkimuskohteena on Uudenmaan maatalouden sopeutuminen, josta haastateltujen viljelijöiden ja maatalousneuvojien silmin avautuu kokonaisnäkymä tilatason sopeutumiseen. Tutkimuksen tuloksia tarkastelemalla tilatason sopeutumiseen vaikuttavia tekijöitä ja riskikäsitysten merkitystä sopeutumista ohjaavina tekijöinä voidaan ymmärtää paremmin.

Tulokset osoittavat, että uusmaalaiset viljelijät toteuttavat sopeutumistoimenpiteitä, mutta politiikkaohjauksella ei toistaiseksi ole siinä juuri osaa ja että viljelijöillä on eri tyyppisiä ilmastoriskiin vastaamisen tapoja. Tulevien sopeutumispolitiikan- ja maatalouden sopeutumistutkimusten on syytä huomioida erilaiset riskivasteet, tarve ohjaavalle sopeutumispolitiikalle maataloudessa sekä viljelijöiden kyvykkyys ja kokemukset sopeutumiseen liittyen.

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1 INTRODUCTION

The latest assessment report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) defines adaptation as a "*process of adjustment to actual or expected climate and its effects"* which *"seeks to moderate harm or exploit beneficial opportunities"* in human systems. The adaptation options are responses to the different needs arising from the climate risks [1]and vulnerabilities. IPCC states that more engagement on climate change adaptation on the agricultural sector is needed from the private sector, starting from small farmers and ending up to global corporation giants, such as insurance companies. (Noble et al 2014, 838, 843, 844).

Adaptation policies, in many respects, at all levels of policy planning and implementation globally lean to the IPCC set definitions. Often on the governmental level adaptation is included to risk management policies. In Finland, the ending of the governmental crop loss compensation by the end of 2015 growing season [2] and private crop insurances that emerged simultaneously represent risk management approach adoption. The policy change is also in line with the official adaptation policy alignment in Finland that last hand responsibility of adaptation is on individuals.

The perspective of the study is that of an environmental policy science. It is interesting to study how climate change adaptation works in the current policy environment. Agriculture in Finland is largely government supported sector that consists of individual entrepreneurs who are facing the climatic challenges first-hand with little policy guidance on adaptation or climate risk management. In farm level, risk management is firstly connected to farm economy management. Adaptation to weather and climate changes is an exercise often seen as endogenous for farming. The connection between risk management approach and adaptation is not evident in the farm scale.

In larger context, adaptation of agriculture links to questions of, for example; food supply, regional development and environmental concerns under changing climatic conditions. It is not yet studied much how current adaptation policies and climate risk management approach influence adaptation at farm level and the society more extensively. For more sustainable and equal ways of risk management and adaptation, the risk perceptions of those facing the risks at first hand would need to be considered (Renn, 2008). Protection motivation theory (PMT) (Norman, Boer & Seydel 2005), has been used in adaptation studies with the central idea that adaptation, followed by a series of individual deliberative stages and

[1] . Climate risk constructs of climatic hazard, and exposure and vulnerability to it.
[2] last date to leave the application was 31.10.2015, (retrieved 10.7.2017 from: http://www.mavi.fi/fi/oppaat-ja-lomakkeet/viljelija/Documents/Hakuoppaat/Hakuopas%202015%20liitteineen%20ja%20taulukoineen.pdf)

affected by several external factors, principally originates from perceiving risk. PMT is used in this study to build the analytical framework.

Case study approach and stakeholder interviews were chosen as part of the research strategy to broaden understanding of the little studied field of climate risk perceptions and current adaptation policies influence on adaptation decision-making in farm-scale. For the study case, 'adaptation in Uusimaa agriculture' was chosen because Uusimaa is a region that has already prepared for adaptation: Uusimaa has a regional mitigation and adaptation strategy, and because Uusimaa region plays a significant role in the Finnish crop yield production and the climatic risks thus reach beyond the regional population and economy. Several factors, varying from the erosion sensitive fields to the vicinity of the capital, cause Uusimaa agriculture to be both vulnerable to, and potentially benefitting from climate change.

Aims of the study are to understand better farm-level adaptation and affecting factors. The research questions are:

1) *How do farmers' climate risk perceptions affect farm level adaptation?*
2) *What type of adaptation measures are implemented in the Uusimaa agriculture?*
3) *How are the current adaptation policies affecting Uusimaa farm level adaptation?*

With the qualitative take on climate change adaptation and climate risk perception at farm level, the study broadens the picture of the current perceptions of farmers and their operational environments. The study shows *how climate risk perceptions turn into adaptive action at the farm scale* in Uusimaa. Furthermore, it shows *how adaptation policies and the farm scale adaptation are met* anticipating the development of agricultural adaptation within the current policies.

The thesis starts with a presentation of the background of formal adaptation policies and specifies the agricultural adaptation policies targeted at farm-scale in Finland. The risk management approach in the adaptation context is presented with crop loss insurance as an example. The construction of climate risk perception-, PMT- and adaptation measure studies into analytical framework is presented subsequently. After that, the methodological choices are presented before moving on to the results. The empirical findings [3] are presented and analyzed within the analytical framework. Finally, the findings are discussed in relation to the research questions and literature, and conclusions are summarized.

[3] The empirical part of the study is done as part of a research on thresholds for maladaptation in Nordic agriculture (Juhola et al 2017, Schmidt Neset et al 2017) lead by Tina Simone Schmidt Neset from the University of Linköping, Sweden. Author's participation in the research has been that of an assistant with tasks of collecting and processing of the data, and co-authoring results. In this thesis, the same data is used.

2 BACKGROUND

On the other hand, formal adaptation policies and on the other, independent farm scale adaptation influences the overall adaptation of agricultural sector. In this chapter, first, the overall need and then the challenges *of* adaptation and the society's aims to manage and overcome them are considered. More specifically, the context of agriculture and Finnish adaptation policies are scrutinized. So, why is adaptation in agriculture a topic of interest?

The year 2015 showed us the fastest annual atmospheric CO2 concentration increase [4] and the warmest year [5] recorded. Food production, among other humanly vital livelihoods and functions, are primary when planning and implementing adaptation to climate change (Marttila et al 2005). Studies show that adaptation in agriculture is happening in the Nordic countries (Juhola et al 2017; Peltonen-Sainio & Jauhiainen 2014). Farmers are experts of adapting to varying weather conditions. It is one of the core skills of their profession. But this does not necessarily mean that they would be well-prepared for the changes brought about by climate change.

The adaptive capacity of Nordic agriculture is higher than the European average and the expected changes of climate change are mostly favorable albeit the recognized challenges, such as the increased risk of pest and weed invasions (Kovats et al 2014; Peltonen-Sainio et al 2017). The Nordic crop production is interesting in the viewpoint of adaptation research: on one hand, the crop plants may benefit on increased precipitation and heat, on the other, the weather extremes and new biological challenges make the farming more difficult.

In Finland, more specifically, the expected climatic changes and weather variation will bring about increased total precipitation, milder winters, more extreme weather events (such as hailstorms, spring droughts and downpours), longer growing season and increased risk of pests, weeds and plant diseases to challenge and benefit agriculture (Peltonen-Sainio et al 2017). Often in public discussions on agricultural adaptation, the emphasis has been put on the opportunities brought about by the climate change.

[4] retrieved 20.1.2017 from: http://www.noaa.gov/news/record-annual-increase-of-carbon-dioxide-observed-at-mauna-loa-for-2015
[5] retrieved 20.1.2017 from: http://www.noaa.gov/stories/2016-marks-three-consecutive-years-of-record-warmth-for-globe

2.1 Formal adaptation policies and risk management

Climate change adaptation has lately been raised to the side of mitigation on climate change policies guided globally firstly by IPCC even though mitigation has got more attention in climate policies than adaptation. As the leading scientific knowledge provider for climate policy making globally, IPCC has tremendous impact on climate policy decision-making at all levels (local, regional, national) and sectors (e.g. finance, administration, agriculture).

Currently, the IPCC recommended adaptation policies [6]have shifted from catastrophe prevention/management towards risk management (Noble et al, 2014). This development has been promoted earlier, for example, by Jones and Preston (2011) because of the suitability of risk management as an "*overarching framework*" for adaptation, where alternative approaches can "*sit comfortably within*". The IPCC risk management assessment focuses on the high impact risks (significant changes in physical, ecological and social systems) and the threshold limits on them becoming unavoidable (Oppenheimer et al 2014, 1080).

Risk management according to Renn (2008) is one of the three core functions of risk governance, other two being risk evaluation (including risk assessment) and risk communication. The risk-management approach often includes the recommendations of robust decision making tools (e.g. adaptation assessment frameworks) for better addressing the many uncertainties and the requirement of multidisciplinarity related to adaptation (Kunreuther et al 2013; Howden et al 2007).

The insurance industry inclusion to global climate risk management is presented in the IPCC model. The opportunities of including insurance companies to the larger societal adaptation efforts are often valued high because of the influence and economic resources of the insurance industry that could, for one, respond to the rising damages and costs by climate risks. Simultaneously the vulnerability of insurance industry itself is increasing and it is bound to develop its risk assessment policies. (Garrido et al 2011).

[6] When talking about policies, the meaning of the word varies depending on who are in agreement with the policy. According to Cambridge Dictionary policy is: "a set of ideas or a plan of what to do in particular situations that has been agreed to officially by a group of people, a business organization, a government, or a political party". This could be supplemented by the Merriam –Webster dictionary definition (2b): "a high-level overall plan embracing the general goals and acceptable procedures especially of a governmental body". In this thesis, adaptation policies are discussed as governmental agreements if not mentioned otherwise. Source Retrieved 12.7.2017 from: https://www.merriam-webster.com/dictionary/policy; http://dictionary.cambridge.org/dictionary/english/policy

The Finnish agricultural adaptation policies

The White Paper on Adaptation (European Commission 2009) set the framework for adaptation at the European Union level and it was further developed into a union level adaptation strategy (European Commission 2013). Finland has national guiding plan for adaptation set by coordinative groups initiated by the main governmental adaptation official: The Ministry of Agriculture and Forestry (2014). It is currently preparing and renewing the national adaptation strategy which aims for the societal climate risk management and adaptation capabilities. All national activities around adaptation are bound to the national climate legislation and guided by the EU. The legislation suggests risk management and preparation in advance in cases of climate risks, even when sufficient scientific information is not available for complete risk assessments or specific measures or policies. (Juhola et al 2016b).

National policies for agricultural adaptation are yet loosely guiding, but at the same time the agricultural sector is strongly subsidized and regulated by, for example, environmental legislation. The current environmental subsidies guide agriculture towards better water protection which can have some synergies with adaptation (e.g. buffer zones and diversifying crop rotation). This is, nevertheless, not adaptation policy but adaptation as "a side-product" of environmental policies.

The Ministry of Agriculture and Forestry states that environmental subsidies for agriculture between 2014-2020 are bound to respond to upcoming challenges such as climate change (Ministry of Agriculture and Forestry 2014). This does not, however, include adaptation but only mitigation. It is not only until recently that actual recommendations for adaptation in agriculture were given in a report of the state of adaptation in the administrative sector of the Ministry of Agriculture and Forestry regarding the climatic sustainability (Peltonen-Sainio et al 2017). These are the most recent guiding policies for agricultural adaptation.

In their proposal for action in agriculture Peltonen-Sainio et al (2017) present three main conclusions (translations from Finnish by author):

> 1) "*The climatic sustainability of agriculture should be enhanced by increasing the preparedness for weather variation and extreme events*."
>
> 2) "*Agriculture should also be anticipatory prepared for the annual and seasonal changes in precipitation by developing water management and by enhancing the expansion potential of winter crop cultivation*."
>
> 3) "*The wide spreading of the risk of plant enemies should be restricted*."

The recommended ways to achieve these targets include farming practices, such as: choosing locally adapted crops and resistant varieties, taking care of the soil quality, and diversification of cropping systems and crop circulation; and societal and market led practices, such as: development of insurance products, plant breeding, technological innovation, research, policies and relevant administration (Peltonen-Sainio et al 2017, 62).

In addition to these policy guidelines, another, more indirect policy concerning agricultural adaptation is the crop loss compensation. In 2015 these subsidies for crop losses in the event of extreme weather or climate conditions was ended and, in-line with the national adaptation policy, the first-hand responsibility of adaptation was left to the farmers. The emerged need to secure farmers' economy in case of crop losses arising from weather and climate changes kick-started product development of crop loss insurances in two insurance companies in Finland. This policy turn is in line with EU led discussion on including the insurance sector to climate risk management (Pilli-Sihvola et al 2016, 14).

The products currently provided by the two Finnish insurance companies (Lähi-Tapiola and OP Vahinkovakuutus) are backed-up with some scientific research. The research on different types of crop insurance products is actually exhaustive in the Finnish scale (see e.g. Liesivaara &Myyrä 2017; 2015; 2014; Myyrä & Pietola 2011). Some preliminary estimations of *the costs* of insuring climate risks are also already available for Finland. For example, the four large scale damage caused storms have cost insurance companies 30-100 million euros in Finland and the trend for the cost of indemnities to insurance companies is rising - the largest indemnity paid was from the most recent storm in 2011 (Pilli-Sihvola et al 2016, 13).

It appears, that adaptation policies concerning agriculture exist and are being developed in Finland. In their study on adaptation policy development, Bizikova et al (2014) even recognized Finland as one of the "early adapters" whose experiences in adaptation lead by government agencies could be used to develop adaptation in agriculture elsewhere. It is the general recognition of the need to address adaptation with large scale policy interventions that was seen as exemplary (Bizikova et al 2014). Good planning, indeed, has taken place in the Finnish agricultural adaptation context. It is now a question of successful implementation of the planned policies, though, whether Finland will be an exemplary case of agricultural adaptation in the future.

Currently, adaptation decision making in agriculture, regardless of certain before mentioned policy guidelines, is at the last hand up to the farmer and the farm scale climate risk management. According to the Finnish expert panel on climate change (Juhola et al 2016b) it is of primary concern in the agricultural adaptation research to understand better the farmer decision making and attitudes towards risk, especially at the occurrence of the current crop loss compensation policy change.

2.2 A broader perspective for climate risk management in agriculture

Yohe (2009) argues that the risk management recommended by IPCC is difficult to apply to the climate arena because of its economic underpinnings and the high uncertainty related to the risk assessments on climate change. Although often based on the realistic risk definitions (such as IPCC's), the risk management approach itself does not exclude cultural theorist viewpoints: emphasizing the management target to be rather the varying *risk perceptions* (Treby, Clark &Priest 2006, 353). Adaptation policies in agriculture, too, can vary from mainly technical problem solving to cultural theorist viewpoint, noting, for example, social identity as a factor affecting farmer adaptation decision making (Feola et al 2015). Could a broader perspective on risk and risk management also broaden the possibilities of risk responses?

Antón et al (2014) show that analyzing the complexities of agricultural risk management is possible, albeit, difficult especially in terms of choosing optimal policies. Antón et al (2014, 1727) sum up that it is crucial to *inform* farmers better on climate impacts, since there is not enough sound evidence for other type of guiding policies (on climate impacts on yield and production, farmer's risk perceptions and their adaptation responses, and the different risk-profiles for farms).

According to Slovic (2000, 220-231) the information and knowledge about the risk and the assumed severity of the risk affect the individual risk perceptions and attitudes and consequently the attitudes towards risk management policies.). Slovic's risk perception theory leans on the psychometric paradigm that risk is 'inherently subjective' (Gebrehivot & van der Veen 2014). In Renn's (1998; 2008, 171-200) perspective, regardless of the theoretical approaches to risk (naming social constructivist or realist viewpoints), multidisciplinary and participatory approaches and stakeholder involvement are recommended, especially on the risk management option evaluation phase. It is indeed widely stressed that aiming for better understanding of the public perceptions of and attitudes towards risk, is necessary for better adaptation policies (Treby, Clark and Priest 2006; Mills et al 2016; Juhola et al 2016b).

In the Nordic countries, the adaptation policy development has been lacking the stakeholder viewpoint along with effective policy-science interaction (Klein & Juhola 2014). The requirement on careful stakeholder analysis "*for sustainable, effective, planned adaptation that is flexible, but also systematic enough to fulfill practical and scientific requirements for the study and advancement of ongoing adaptation processes and implementation*" is duly stressed by André et al (2012). Also, Smit and Skinner (2002) point out that, for a realistic assessment of adaptation options, the roles of different stakeholders should be systematically considered.

In their study on differing *perceptions on climate change adaptation* in Europe, Otto-Banaszak et al (2011) distinguished different stakeholder groups on agricultural adaptation - advocacy groups, administration, politicians, researchers, media and the public - and found that common understanding can be aggravated for the varying aims and logics (i.e. mental models) leading their action. Especially problematic, regarding risk management, are the differing viewpoints of a) administration sticking to more traditional engineering approach and structural measures and emphasizing their own interests, b) scientist with a more holistic societal or sectorial approach escaping practice, and c) policy makers and practitioners with their often cost-benefit analytical wealth viewpoint. Public was assessed to not have enough knowledge on adaptation to act for it. (Otto-Banaszak et al 2011). Understanding the differences behind the mental models could help to achieve common understanding on needs and ways for adaptation in the larger societal context.

Finally, it appears that broadening the risk definitions to cover individual risk perceptions, and risk management to include science and stakeholders could help to find commonly accepted policies for adaptation in agriculture.

Crop insurance as farm scale risk management

Crop insurance does not work as an adaptation strategy by itself, but it can be used as a risk management tool (Antón et al 2014), or more precisely: a climate risk finance management tool (Porrini & Shwarze 2014). It could be used at the side of on-farm risk exposure reduction measures [such as crop diversification (Falco et al 2014) and production system diversification (Howden et al 2007)] for reducing vulnerability by transferring it out of the farm (Garrido et al 2011, 424).

Questions about *the liability regarding the final costs* of climate risks are in the center of the discussion regarding all relevant actors: 1) the farmers bearing the cost of either the insurance premium or the climate risk, 2) insurance companies bearing the costs of damages resulting from the unpredictable weather and climate changes, and 3) the state and tax-payers bearing the cost of compensations to farmers and/or insurance companies in case of limits of compensation exceeded (see e.g. Garrido et al 2011; Liesivaara & Myyrä 2017). This is relevant even in the US, where the insurance industry has established itself as part of the climate risk management policies by providing crop insurance products subsidized by the state (Smith, Glauber & Dismukes 2016).

On the other hand, there are *opportunities* related to inclusion of insurance industry to the broader agricultural adaptation efforts, as well. Harjanne et al (2016, 64) point out how, by restricting to insure

most vulnerable regions, the insurance companies in Sweden and Denmark, for example, have used their influence on society and guided climate risk management towards better practices (by complicating cultivation on the most vulnerable areas). Despite the obvious regional equity concerns of this market-led policy, and social equity questions in general raised by the exclusive nature of crop insurance, the role of insurance companies especially as providers and distributors of climate impact knowledge should be recognized in adaptation discussion (Harjanne et al 2016; Lunt et al 2016; Johansdottir et al 2014).

The challenge most often related to crop insurance in the US literature is the moral hazard (farmers relying on the insurance rather than on good farming practices for guaranteeing their income). However, it is so far well controlled in the European yield insurance system where losses are to be assessed by the cause and extent of the risk, in contrary to the US policy where yield losses are compensated in comparison to expected yield (Garrido et al 2011).

The less discussed challenges related to crop insurance developments should, as well, be accounted for in the policy deliberations: ecologically adverse land-use and planning impacts (Müller & Kreuer 2016); unattractive equity effects (favoring rich farmers) and generally, failures in common property management (ecosystem protection, pollution control) typical for market-led initiatives (Mendelsohn 2006).

In summary, climate change is evolving and challenging societies not only to mitigate but with increasing concern also to adapt to it. Adaptation needs are recognized in many sectors and levels of organization, also in agriculture and at farm level. This has led to adoption or development of varying adaptation policies and practices. In turn, varying perceptions of risk and adaptation cause difficulties for climate risk management when it is too narrowly defined and does not include multidiscipline scientific approach and stakeholder participation.

In Finland, adaptation policies guiding agriculture in the face of multiple challenges brought about by climate change are in process and partly leaning towards private risk management approach where major part of adaptation decision-making would be left to the farmers and partly to private insurance companies. Worries of leaving governmental adaptation policy and science based decision-making to a smaller role have been raised. Multilateral and stakeholder inclusive policy planning and better understanding of adaptation decision-making and risk perceptions on the farm level is needed.

3 THEORY AND ANALYTICAL FRAMEWORK

Studies on climate risk perceptions in the agricultural context draw a picture of the complexity of factors affecting the decision making in the farm in front of climate change. It is often pointed out how simplified the risk assessments based on sheer economic or technical evaluations of the adapting system and the measures are. The need for research on the farmer decision making in front of, or at the moment of climatic risk is widely recognized (Keshavarz & Karami 2014; Treby, Clark and Priest 2006; Juhola et al 2016b).

The construction of the analytical framework of this study is based on the theoretical background of climate risk perceptions and non-climatic factors affecting the adaptation motivations and consequently the adaptation measures implementation. In this chapter, these theories behind and on the adaptation decision-making process at farm are examined and finally synthesized into the analytical framework.

3.1 Climate risk perception

Study of risk perception has its origins in psychology. The application of risk perception analysis to policy studies, such as this one, has its roots in critical studies of risk assessment and management. The critique is directed mainly to the overemphasizing of expert knowledge and technical appraisal on risk (the external risk definition), in relation to the public experience and affective approach on risk (the internal risk definition) (Slovic 2000; Dessai et al 2004). For good policy responses, both, the external expert led risk assessments and the internal collective or individual perception and experience based risk definitions, should be accounted for (Dessai 2004).

The leading external risk definition is the one used by IPCC where risk is built of three factors: *hazard* of the potential losses, *exposure* to these hazards (coupled with the exposed entity and its location) and *vulnerability* of the affected entity (including its adaptive capacity) (Noble et al 2014).

Depending on the viewpoint, there are numerous contributing factors to risk perceptions. They are mainly divided to psychological and socio-cultural factors such as: 1) experience of hazard or climate change related events, 2) expectations of adaptation management and vulnerability, and 3) knowledge and awareness of adaptation (Treby, Clark & Priest 2006; Jørgensen & Termansen 2016). The factors gathered by IPCC include similar factors, but highlight also values and leave out further recognition of perceived

personal capabilities of risk response. The IPCC risk perception variables are roughly categorized to 1) interpretations of the threat, 2) exposure and personal experiences (highlighting their proximity), 3) priorities of individuals, and 4) environmental values and value systems in general. (Oppenheimer et al 2014, 1069).

Also the *public climate policy preferences* are influenced by risk perceptions underlain or surrounded by influential factors that are both: psychological (e.g. affective images, values) and socio-cultural (e.g. cultural values, ethics, knowledge) (Leiserowitz 2006; Adger et al 2009). According to Renn (2011) it is, more broadly, the psychological, social, institutional, and cultural processes connected to hazards that either amplify or attenuate the individual and social perceptions of risk and, further, affect risk behavior. In summary, the risk perceptions and arising risk behavior of individuals and their collectives are shaped by more than rational cognition. The variables of climate risk perception based on the above literature and examined in this study are visualized in *Figure 1*.

3.2 From risk perceptions to adaptation through protection motivation theory (PMT)

Originally, PMT was introduced by Rogers (1975; 1983) as a psychological theory of fear-appeals affecting human behavior through attitude changes. Its main components were later defined by Boer and Seydel (1996) and reconstructed by Norman, Boer and Seydel (2005) as 1) perceived severity and vulnerability, that can lead to 2) threat appraisal, including the perceived response efficacy and self-efficacy, followed by 3) assessment of response costs and coping appraisal, leading to 4) protection motivation and eventually to behavioral changes.

As such, there are few examples of research showing risk perceptions directly leading to *adaptive action.* However, implications of climate risk perceptions *affecting* the adaptation/adaptive behavior, adaptation attitudes, adaptive capacity, decision-making, support for adaptation, adaptive responses and adaptation/mitigation action are found from several studies (see e.g. Abid et al 2016; Arbuckle, Morton & Hobbs 2015; Flaten et al 2005; Gebrehiwot &van der Veen 2015; Keshavarz & Karami 2014; Mase, Gramig and Prokopy 2017; Takahashi et al 2016; Tucker, Eakin & Castellanos 2010).

Some studies have emphasized the significance of *past experiences* or *awareness* of extreme weather events and the negative impacts of climate change, such as crop losses (Menapace, Colson & Raffaelli 2015) as important explaining factors of climate risk perceptions driving the agricultural adaptation behavior (Li et al 2017; Wilke & Morton 2017; Comoé et al 2014). Others stress the significance of *contextual nature* of risk perception formulation and adaptation decision making (Takahashi et al 2016; Singh, Dorward & Osbahr

2016). Some emphasize more specifically, for example, the *regional nature* of risk perception (Abid et al 2016; Tucker et al 2010). Furthermore, some studies have specified features within the climate risk perceptions of farmers to *different dimensions of life*: physical health, income, physical assets, production, social relationships, anxiety about personal loss and happiness (Dang et al 2014b).

In their exhaustive study of factors affecting farmers' adaptation behavior in the Mekong delta (Vietnam) Dang et al (2014 a, b, c &d) show how climate risk perceptions lead to *intention to adapt.* In their model, Dang et al (2014a) have translated the core PMT -components into adaptation context as follows: 1) climate risk perception (perceived severity and probability), 2) adaptation assessment, and 3) adaptation intention (protection motivation), leaving further behavioral changes out of their analysis since the data does not allow it.

Dang et al (2014a) were using a structural equation model to analyze their results quantitatively and found that PMT framework suites well for studying the adaptation behavior of farmers as a response to climate change. In this study, their PMT –based model is used as basis for the analytical framework, but it is modified according to literature on risk perception (in the chapter 3.1), adaptation measures (in chapter 3.3) and on protection motivation presented in this chapter.

Adaptation assessment in the PMT model is part of the farmers' adaptation decision-making process after a threshold level of risk perception is crossed. It was appraised by farmers' perceptions on effectiveness, their personal ability to perform and cost of different adaptation measure categories [7]based on literature and expert evaluations. (Dang et al 2014a).

Also, the influence of incentives and disincentives, climate beliefs, habit and subjective norm to the farmers' adaptation assessments were appraised in the Dang et al (2014) study. These factors affecting the adaptation assessment process are visualized in the analytical framework with a plus-sign (*see Figure 1*). The definition of habit, originally from Verplanken and Aarts (1999), used by Dang et al (2014a, 15) is ''*learned sequences of acts that have become automatic responses to specific cues, and are functional in obtaining certain goals or end-states''*. Subjective norm according to Ajzen (1991) and used by Dang et al (2014a, 15) refers to "*how individuals perceive the pressures of the beliefs of other people that he or she should or should not perform the behavior*".

Intention to adaptation was assessed in Dang et al (2014) study by asking the farmers to what extent they were intending to implement the five pre-determined measures used in assessment. In their framework, the intention is another one of the optional consequences of adaptation assessment, the other being

[7] *adjusting planting techniques, crop diversification, water use management, diversifying income sources, and reinforcing safety for humans and assets*

maladaptation. Dang et al (2014a) examine *maladaptation* as disregarding adaptation by wishful thinking or denial. This concept derives from the PMT framework where maladaptive coping is the negative option for adaptation intention. In the climate adaptation context, however, maladaptation is also recognized as unintended negative outcome of adaptation efforts (Noble et al 2014, 857-858). The latest IPCC report lifts maladaptation to the adaptation discussion and states the need for further study of the concept:

> "*In a general sense maladaptation refers to actions, or inaction that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future*" (Noble et al 2014, 857)

The IPCC definition of maladaptation continues with notions on the contextual nature of adaptation causing the potential maladaptation for other groups or sectors than those adapting in different time-scales. Also, in the IPCC definition, the systemic nature of adapting entities with their varying interactions and feedbacks should principally be noted to avoid maladaptive "*strategies and responses*" (Noble et al 2014, 858). It has even been stated that anticipating the risk of maladaptation should be the prior concern for adaptation decision makers and stakeholders (Magnan et al 2016). For better acknowledging the risk of maladaptation in adaptation, the IPCC definition of maladaptation is recognized in the analytical framework and in the empirical examination of this thesis.

Other than climatic, in other words, the non-climatic factors: cultural, social, economic, political, and institutional have been shown to affect adaptation behavior (Smit & Skinner 2002) as well. Smit and Skinner (2002) use economic conditions, institutional arrangements and social norms to exemplify these factors. In their study, Dang et al (2014a) found the similar types of *system characteristic* factors to influence the adaptation assessment that are part of the systemic context where adaptation efforts are taking place. They include the markets affecting the economic stability and prosperity at the farm and policies that might guide adaptation. In the analytical framework the 'system characteristics' are presented separate and labeled with plus-sign reflecting their additional effect on the cognitive and affective factors of the adaptation decision-making process (*see Figure 1*). The broader definition of Smit and Skinner (2002) is used in guiding the analysis.

In summary, protection motivation can arise from experiences with climate risks and related affective factors. As a result, adaptive action can take place which can cause maladaptation if not planned and implemented well. In the empirical part of the study these variables, found from the visualization of the analytical framework in *Figure 1,* are analyzed. Next, the analytical framework is built further from the Dang et al (2014a) model based on the behavioral change -outcome of the original PMT framework by Norman, Boer and Seydel (2005).

3.3 Adaptation measures in agriculture

Smit and Skinner (2002) present a variety of analytical and theoretical approaches to adaptation in agriculture to be about impact assessment, natural hazards, agrarian political economy, vulnerability research, agricultural systems research, or as in this case, of farm decision-making research and risk management. The study of adaptation measures can also vary by being, for example technical or cost-benefit oriented, or as in this case, focus on the driving factors of adaptation measure implementation.

Depending on farm characteristics (e.g. size, production orientation, land use and intensity of farming) (Reidsma et al 2010) and external factors (non-climatic and climatic) both, the impacts of and adaptation options to climatic risks vary. The varying adaptation options, for reducing risk and vulnerability to, utilizing the opportunities brought by and aiming to cope with climate change (Noble et al 2014) can be classified as different types of adaptation measures.

The classification can be based on how, when and why they are implemented or planned to be implemented. Smit and Skinner (2002) have made fundamental work on a typology of adaptation options in agriculture that can shortly be presented as: 1) technological developments, 2) government programs and insurances, 3) farm production practices, and 4) farm financial management. It is noteworthy, that the categories are interdependent and that in case of crop insurance (type 4 adaptation), for example, Smit and Skinner (2002) present the degree of implementation (how much crop insurances are bought) to be up to governmental subsidizing (type 2 adaptation) the measure.

In this study, the focus is on the farm-scale adaptation, thus autonomous adaptation measures (Smit, Klein & Wandel 2000) by farmers and the planned adaptation policies targeted to be implemented on the farm are studied. In terms of characteristics of adaptation (Smit & Skinner 2002, 104; Smit & Wandel 2006; Rickards & Howden 2012, 242-3) the scrutinized adaptation measures are intended, varying by their timing and duration, scaled to farm level, responsibility of the farmer, and of varying forms and impacts /impact expectations.

The adaptation measure typology used in this study is based on the results of Juhola et al (2017), where the literacy and empirical data based adaptation measures found to be use in the Nordic agricultural adaptation were categorized according to their responsiveness to different climate risks (increased precipitation, increased heat and drought, increased pests and weeds, longer growing season) and their aim (risk reduction, adaptation capacity, coping capacity, capitalizing on climate change).

Risk reductive measures are aimed at reducing a certain climatic hazard. For example, the increased heath waves caused drought and consequent losses could be aimed to reduce by irrigation. *Coping capacity building measures* are less planned and targeted to tackle climatic challenges on the spot within a growing-season time-perspective at maximum. *Adaptive capacity building measures*, on the other hand, are taken with a longer-term vision and they are planned. In case of drought risk, for example, investing in better irrigation systems and building dam could be considered as adaptive capacity building measures. *Capitalizing on climate change –type of measures* aim to take advantage of, for example, the increased heat summation during a growing-season by choosing economically profitable plants that require warmer growing conditions than more typically grown crops. (Juhola et al 2017).

Adaptation measures are implemented at farm level as responses to climate risks, aimed at either reducing the risks or increasing the capacity to handle them, including using opportunities brought about by climate change. This 'adaptive action' taking at the farm results from the adaptation decision making process presented in the *Figure 1*.

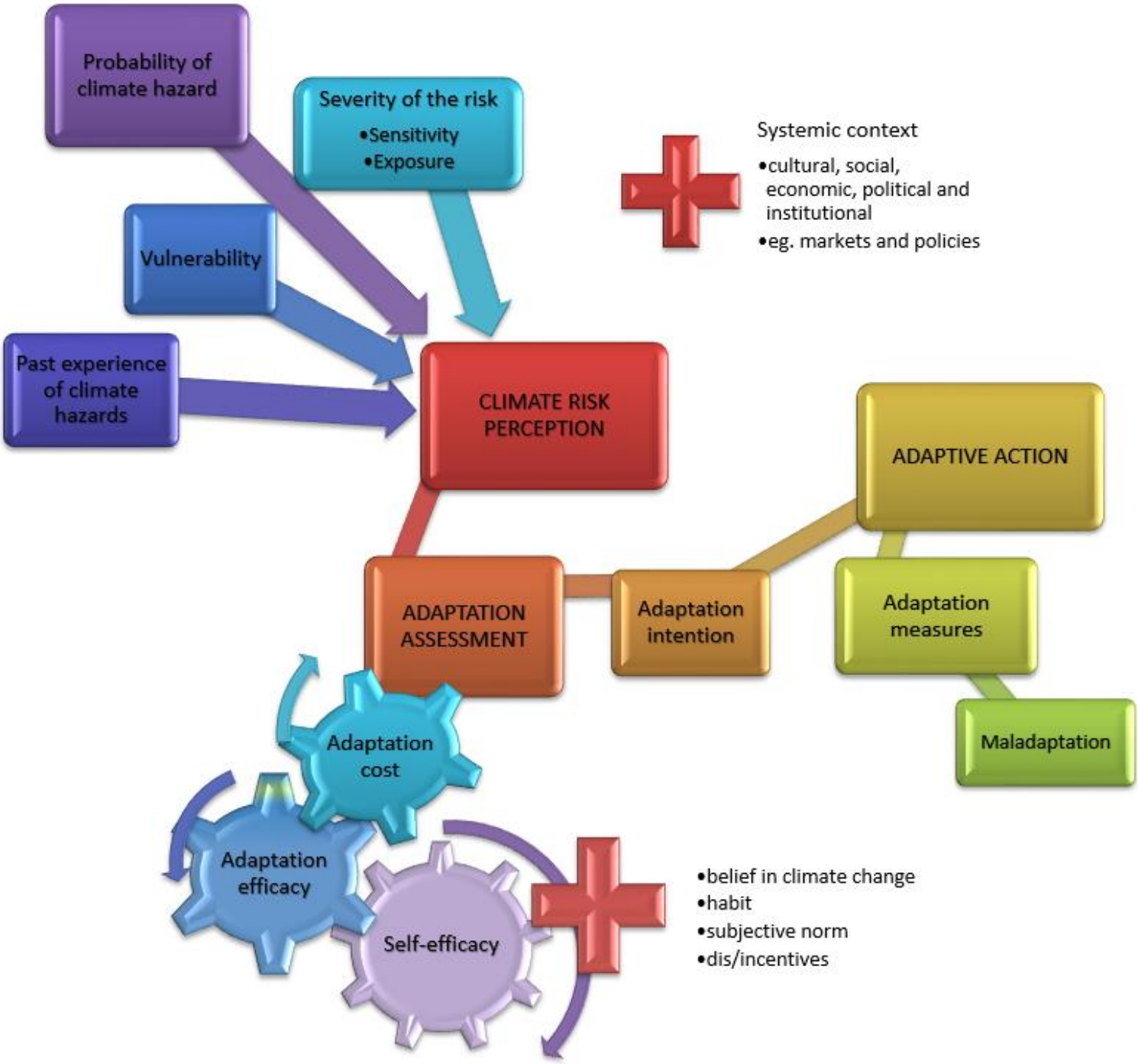

Figure 1. The analytical framework: factors affecting climate risk perception, the process from risk perception to adaptation action, factors affecting climate risk assessment and systemic context affecting the whole process of adaptation decision-making (based on the framework by Dang et al 2014a; modified by using: Smit & Skinner 2002; Norman, Boer and Seydel 2005; Comoé et al 2014; Noble et al 2014; Juhola et al 2017; Li et al 2017; Wilke & Morton 2017).

4 STUDY CASE, METHODS AND DATA

The research strategy in this study is a case study and the composition is more specifically a single-case study with 'adaptation in Uusimaa agriculture' being the study case. The value and meaning of a case study strategy is to look thoroughly into the complex process of adaptation decision-making in the contemporary agricultural context. The division between the phenomenon of adaptation and the context of agriculture is not evident, which, for one, validates the case study approach (Yin 2014, 16).

The methodological approach of this case study is adaptive: the research questions and analytical framework have been revised after the data-collection and first rounds of the analysis (Yin 2014, 65) (implicated with the green arrow from 'analytical framework' to 'data collection' in *Figure 2*).

In this chapter, the process from data collection to analysis is presented; starting from the case description, followed by a presentation of the data collection phase of the study (interviews), leading through data processing (transcriptions, data reduction and coding), to the qualitative analysis of the data, including operationalization of the analytical framework. *Figure 2* visualizes the interaction of data flow and analytical framework.

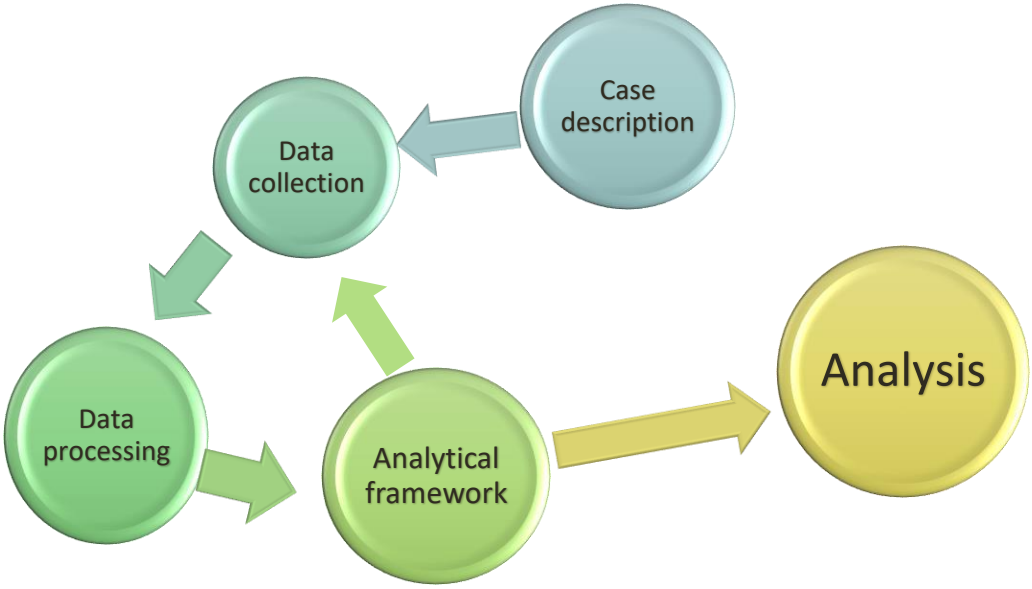

Figure 2. Data flow chart

4.1 Study case: adaptation in Uusimaa agriculture

Uusimaa is one of the 19 regions[8] of Finland situated in the south coast by the Gulf of Finland. It includes the capital region and is thus highly urban and relatively densely populated. It is the largest and fastest growing region by population in Finland (Tilastokeskus 2009; 2016). Given that it's highly urban, it is mostly covered by forests and agricultural lands. The agriculture in the region is particularly vulnerable to climate change and exposure to climate risks is significant in national scale, since Uusimaa is the thirds largest provider of bread grains. (ELY 2012; SVT: Luonnonvarakeskus, Maatalous- ja puutarhayritysten rakenne).

Average farm size is already big in Finnish scale, yet it is growing. Small scale farming is economically more challenging and the proximity of the urban centers lures to work outside farm. The proximity of urban centers has also an effect on the trends of; part-time farming increasing, animal husbandry declining, and farmers becoming fewer in Uusimaa. (ELY 2012; SVT: Luonnonvarakeskus, Maatalous- ja puutarhayritysten rakenne[9]). *Table 1* gives a quick look on the basic info of the region and on the regional climatic vulnerability and agricultural factors.

Uusimaa region		**Climatic vulnerability & agriculture factors**	
Inhabitants	1 644 107	**Erosion risk degree**	high
Habitats/ km²	180	**Coastline (with Baltic Sea)**	1 200 km
Population estimation by 2040	1 900 000	**Dominating soil types**	clayey & clayey silt soils
		Farmer population	2 828
Total land area (km²)	9 097	**Average farm size**	50 Ha
Agricultural land of the total land area (km²)	1 860	**The main crops (excluding fodder)**	spring wheat, barley and oats
Sea water area (km²)	6 490	**Climate change scenarios relevant for agriculture**	temperatures and precipitation rise, snow cover and frost decrease, winters become darker, changes become greater in the winter than in the summer
Municipalities	26		
Villages	260		
Climate (Köppen - classification)	warm humid continental		

Table 1. Uusimaa: regional, vulnerability and agricultural facts

[8] https://en.wikipedia.org/wiki/Regions_of_Finland
[9] Retrieved 12.7.2017 from: http://stat.luke.fi/maatalous-ja-puutarhayritysten-rakenne

(Sources: Tilastokeskus 2009, 2016; Maanmittauslaitos 2016; Ministry of Agriculture and Forestry 2004; ELY 2012; SVT: Luonnonvarakeskus, Maatalous- ja puutarhayritysten rakenne; Peltonen-Sainio 2017, 39; Uusimaa regional council 2014)

In regional administrative and governmental level, there are several adaptation and mitigation activities being implemented or in process. Uusimaa regional council has been engaged in climate change mitigation and adaptation early and it has its own mitigation and adaptation strategy (Keskitalo 2010). Also, it is part of the 'Climate-KIC -public-private partnership' and coordinating global adaptation expert exchanges[10] regionally. In a development strategy for the rural Uusimaa until 2020, climate change has been regarded a risk (ELY 2012). The municipal coalition of Central Uusimaa (KUUMA) has its own climate change adaptation [11]instructions but it does not account for agriculture in any detail.

4.2 Data collection

The data is primarily collected as part of the Nordic maladaptation thresholds research and the interview guides (see Appendix I) are based on the first round of interviews in the spring 2015 in Linköping, Sweden. Those sessions were designed and executed by MA Natacha Klein and Professor Tina-Simone Schmidt Neset (see Juhola et al 2017). Here the whole process of data collection is presented with an emphasis on Finland.

Stakeholder interviews

To broaden the sectoral examination of this study, farmers and extension official as stakeholders with first-hand knowledge on, and ringside seats for observing the complexity of the study subject were chosen as informants. Interview was chosen as data collection method since adaptation in Uusimaa agriculture is not much studied and need for flexibility regarding the discussed topics and the depth of discussions in the interview situations was appraised valuable (Hirsijärvi & Hurme 2008, 34-38).

[10] Retrieved 20.7.2017 from https://www.uudenmaanliitto.fi/aluekehitys/liiton_hankkeita/paattyneita_hankkeita/climate-kic_pineers_into_practice

[11] Retrieved 20.7.2017 from: http://www.kuumailmasto.fi/kuumailmasto/attachments/text_editor/26877.pdf?checksum=b413ba475b3f45e2359cff4ee3dcfd27&name=Sopeutumisohje.

A thorough background work on the agricultural sectors of first Östergötland by the Swedish research group and then of Uusimaa by the Finnish research group (Käyhkö & Juhola), was executed for the interview guide development and for the selection of the test interviewees. Following a test interview with a local farmers union representative with an exhaustive background on the study context, the Finnish interviews were set up and run in May-August 2015.

Since Uusimaa agriculture is crop production oriented and the crop yields are directly more vulnerable to climate change than animal production, the scope of the research was outlined to crop production (Peltonen-Sainio 2017, 11). The selection criterion for all interviewees was crop production orientation. For farmer participants, the criterion was to have a large farm (average on the region) cultivating at least one of the main crops of the area. Other crops that farmers were cultivating included rye and green pea, turnip rape, buckwheat, malt wheat, malt barley, cumin, animal fodder, hay, pasture, fava bean, apple and strawberry. Other sources of income included forestry and husbandry of cattle, pig and organic poultry, which are typical for the region. The farm size of the farmers interviewed ranged from 80 ha to 360 ha. Their farms situated evenly across the Uusimaa.

The interviewed farmers and extension officers [12]from the region, including county officials, agricultural advisors and farmer's union representatives were "snowball sampled" (i.e. the interviewees were selected based on recommendations from the previous interviewees). Snowballing was selected as a sampling method because information on suitable interviewees is not available from other sources – especially the officials acknowledged with adaptation are basically "a hidden group" that is, nevertheless, possible to find by snowball sampling (Atkinson & Flint 2001). The coverage of the sample was evaluated sufficient as the interviewees started to repeat recommendations for other interviewees and the topics and the answers to interview questions; in other words, the saturation point was reached (Hirsijärvi & Hurme 2008, 58-60).

Farmers and extension officers were valued as key informant groups for this study, and as relevant stakeholders in agricultural adaptation. Other stakeholders would be, for example, interest groups (farmers unions, producer associations, etc.), retailers, local communities, municipalities, etc. Interviewing other stakeholders was considered as a topic for future research. In this study, the interviews were chose to be kept individually for the depth and flexibility requirement of the little studied topic (see earlier). (Hirsijärvi & Hurme 2008, 61-63).

The open-ended semi-structured interviews were executed at the interviewees' home or work-place at the most suitable time for each of them. The interview protocol allowed free-flowing speech and short discussions between the interviewer and the interviewee. The interview guide was not followed timidly

[12] An agricultural extension officer works with farmers and other agricultural actors for better decision making and productivity on the farm scale.

regarding the sequence and not all aid-questions were presented (below the main themes and lead questions in interview guide: Appendix I), but it was cared for that all themes came to be dealt with. This flexible protocol (Hirsijärvi & Hurme 2008, 102-105) was chosen because of the novelty of the study topic, allowing new themes to arise during the interviews and for creating a comfortable atmosphere, where participants could feel free to speak, and not that they are being interrogated.

Interviews were recorded and afterwards transcribed in a convention describing only talk and simple annotations of laughter, pauses and emphasis. This convention was appraised sufficient because the level of analysis stays on *what* the interviewees say (content analysis) and not *how* they say it (discourse analysis) (Hirsijärvi & Hurme 2008, 139-141). The 13 interviews lasted from 45 to 60 minutes each.

In addition, for the sole purpose of broadening the scope of this thesis, two interviews were done in 29.11.2016 with one representative from each of the only two insurance companies in Finland that provide crop insurances at the moment. The first one was a face to face interview, lasting approximately 1, 5 hours and the second was done on phone and lasted approximately 30 minutes. These interviews were also recorded, but transcribed only selectively on parts that were relevant for the study (Hirsijärvi & Hurme 2008, 140). The collected data is used to broaden the stakeholder perceptions on the crop insurance influence on farm scale decision making.

The interview-guides are included as Appendix I and II. All data (raw and processed) is conserved in several electronic locations (hardware and cloud services) and are retrievable through the author.

4.3 Data analysis

The analysis of the data followed a general methodology of qualitative content analysis and started with the reduction of data by extracting the most important and interesting quotations according to the research questions. Qualitative content analysis is often used for analyzing interview data for the interviewees perceptions. The quotations were coded according to the predetermined themes (of the analytical framework). Then the data was visited again, for other often occurring themes, opinions and keywords; contradictions, patterns and thematic connections. These findings were again coded for easing the handling of the data and as part of the preliminary categorizing. Eventually, after categorizing and re-categorizing the codes in hierarchies and networks and revisiting the data for new quotations or themes accordingly, an analysis could be made. The coding and categorizing process itself was analytical and it complemented the analytical framework. (Halperin & Heath 2012; Tuomi & Sarajärvi 2003).

The qualitative data processing tool Atlas.ti was used for the technical share of coding, categorizing and arranging the data. The analytical functions of it were not used in this thesis for the analysis was firstly theory-led and the because of the potentially narrow approach of the computerized analytic logic (Seale 2000, 163, 168).

Analytical framework

The analytical framework is based on the risk perception- and protection motivation theory-led classification to six main themes underlying farm-scale adaptation: climate risk perception, adaptation assessment, adaptation intention, adaptation measures, maladaptation and systemic context (introduced in chapter 3). The operationalization of these themes into the interview guide (Appendix I) are presented here. In addition to explicit expressions, implicit expressions were looked for from the transcripts. They were based on predetermined themes or recognized from keywords presented in Appendix IV.

Climate risk perceptions theme was operationalized into questions regarding perceptions of climatic challenges (weather variations and extreme weather events), vulnerability (personal, regional agriculture, crop yields and crops), severity and probability. *Adaptation measures* theme was assessed by direct questions on implementation of adaptation measures. This was usually done after the risk perception questions to confirm that adaptation was understood as a concept and not confused, for example, to mitigation. The concept of adaptation was explained with examples from literature, when necessary.

For assessing the *adaptation assessment* of the interviewees, the explicit questions on observations and expectations on the effectiveness and costs of measures and the perceptions of farmers' capabilities to manage/handle the measures were presented. Both the expected and implemented measures were under examination, thus leading to more strongly built data. The implications for belief in climate change were mostly straight forward, for example: "climate change makes progress slowly but with certainty". The expressions of habit, instead, were more implicitly embedded to the farmers' speech: "it is difficult to make changes and more explicit in the officials' speech: "when farmer gain experience on certain measures, they realize it is ok to make changes". Subjective norm was recognized from expressions where the interviewees were referring to others than themselves as critics or influential person of their actions, for example: "neighbors thought I'm crazy".

Adaptation intention theme focuses on the prospects regarding new adaptation measures or such that farmers were already familiar with. It was assessed by asking the interviewees directly about their intentions. For the assessment of *systemic context factors* and the factors affecting adaptation assessment

in Dang et al (2014a) framework (habit, subjective norm, belief in climate change and dis/incentives) the answers to the explicit question on other factors (than climatic) affecting farmers' adaptation behavior and the according implicit notations where looked for in the transcripts. For the assessment of *incentives and disincentives* implicit notations on what factors, excluding all the other above mentioned factors, could encourage or discourage the farmers' adaptation were detected from the transcripts.

Maladaptation theme was operationalized with the explicit question: "Have you countered maladaptation?" following an explanation of the concept, if necessary. As with all factors, the implicit notations were also coded and analyzed. For example, if a farmer was explaining how diversifying crop rotation had caused unintended extra work, or expected extra costs, this was coded as maladaptation. All implemented and intended measures were analyzed for possible maladaptive outcomes.

In the following chapter (5) the results of categorization within the analytical framework are presented and analyzed based on analytical technique of explanation building. Explanation building was used for "explaining how", in this case: how are climate risk perceptions and adaptation policies affecting farm-scale adaptation. The analytical framework was built by comparing the findings of the research to the theories of risk perception, protection motivation and adaptation measures and by repeating this until a logical model was found and the causal links between the steps in adaptation decision-making process could be presented. (Yin 2014, 147-150).

4.4 Limitations, ethics & reliability

Poorly planned and implemented case studies can be too subjective, fail to find correct operational measures, and/or fail in providing sufficient information for repetition of the results. To overcome these typical methodological pitfalls, tactics for a) construct validity, b) internal validity and c) reliability of case study were used. The main features of these tactics accordingly were a) using multiple sources of evidence (literature and interviews), b) using explanation building model to aid the analysis, and c) using and recording a case study protocol and database and including relevant parts to the study publication (see Appendices). (Yin 2014, 45-49).

The snowball sampling may raise concern of the sample being biased and of isolated informants not being reached (Atkinson & Flint 2001). In this study, one of the first interviewed officials recommended three of the following interviewees. Later, two of them were also recommended by others and it seems unlikely that bias on the sample by single informant occurred. On the hand, the viewpoint of isolated farmers could

have been neglected. In this study, however, it was rather the commonly shared viewpoints and experiences that were under examination, although, individual experiences with climate extreme caused hazards could broaden the picture of adaptation needs more generally.

Interviews as sampling method has its limitations that were also recognized when planning this study: good interviewer skills are gained by experience, interviewing is time-consuming and several potential sources of error are included to interviews (Hirsijärvi & Hurme 2008). The reflexivity (interviewees responding according to expectations of the interviewer), inaccuracies and bias due to poor interview skills were aimed to take notion of (Yin 2014, 105-107). To avoid the liability caused by inexperience of the author as an interviewer, the preparation to the interviews included several weeks of background work on the study topic and on research interview methodology. The research group was consulted with all doubts and occurring problems (for example, when interview guide seemed to need revising after the test interview). The triangulation of data (different stakeholders were interviewed) enhanced, for its share, the reliability of the data (Tuomi & Sarajävi 2003, 140-146).

As limitations of research interview and qualitative research in general, the interpretations of the data by researcher may cause reliability issues. The strength of this study, as part of a broader research with several researchers, is that the data has gone through investigator triangulation (Tuomi & Sarajävi 2003, 140-146). Coding and categorization in most parts and conclusion in total are nevertheless of authors own. Since all interviews were conducted in Finnish, the translations may have changed the original meaning of some presented quotes. The translations are all also by the author (native Finnish speaker) which, for one, limits the reliability question of translations to mainly concern the reader and not the analysis itself.

The protocol in interviews followed the good scientific practice and ethics. The common problems with first-time interviewers were studied beforehand and mostly avoided: silent time for interviewees to gather thoughts was given (although it felt sometimes difficult), talking too much or putting words into the interviewees mouth was wearied of. Generally, the atmosphere in interview situations was good and at ease, at least by the end of the interviews. Sometimes, after the last themes were discussed and the recorders were switched off, the interviewees started speaking more freely. Handwritten notes were then made on the relevant parts as well as possible. Some participants were left worried with the interview because it raised thoughts of climate risks and adaptation needs they had not thought before. When these worries were expressed, it was attempted to discuss more on them and to provide helpful information after the interviews. Nevertheless, all interviewees were left with feeling that they could participate in the follow-ups of the research which implies that they were not left feeling negative about the interviews. Copies of the research publications were promised to send to all interviewees. (Hirsijärvi & Hurme 2008, 124-127; Tuomi & Sarajärvi 2003, 131-146).

5 RESULTS

Painting a picture of the mindsets of Uusimaa agriculturalists [13]in front of climatic challenges, this chapter shows how climate risk perceptions, affecting factors and systemic context influence the adaptation assessment process leading to adaptation intention and further to adaptive action. Outcomes of maladaptation and adaptation measure implementation and plans are presented last.

5.1 Climate risk perceptions – severity and probability

Climate risk perceptions are constructed from experiences with climate hazards and perceptions of vulnerability, severity and probability of the hazard, where severity is treated as a sum of exposure and sensitivity to the hazard. To outline the context that is studied in this thesis, the interviewees' experiences of exposure to climatic challenges and weather extremes are presented first. Perceptions of the probability of the climatic challenges were seldom expressed as such but notations on some events becoming more prevalent were made.

When talking about climate change as a challenge for their livelihood farmers were mostly expressing their concerns of the unexpected variability of weather conditions. Other more specific climatic challenges were excess or lack of precipitation, rising temperatures; increased risk of pests, plant deceases and weeds, and the longer growing season. Longer growing season was, however, more often seen as an opportunity than a challenge.

The concerns regarding *excess or lack of precipitation* occurred most often of the specific climatic challenges. Interviewees found the intensification, prolongation and bad timing of the excess or inadequate precipitation as the main problem with an emphasis on the excess precipitation. Nevertheless, it was noted that drought causes bigger yield losses than excess precipitation.

Increased heat was connected to problems brought up by climate change in Finland also despite the correct notion of it being a more severe challenge in southern agricultural areas. Observed and expected harmful outcomes to agriculture of overall rising temperatures were heat waves, milder winters and droughts.

[13] In the results chapter the interviewees are referred to as 'farmers', 'extension officers', 'officials' or 'advisors' depending on the role that the statement was given. When referring to all interviewees, reference is 'agriculturalist' or 'interviewees'.

Especially the mild winters bringing along a) new pests and b) precipitation as water instead of snow, were of concern.

Accompanied with the changing weather conditions, chiefly increased heat and precipitation, it was well acknowledged that the *exposure to pests, plant diseases, harmful fungi and weeds* would increase. Some of the interviewees had already experiences this. The harms affect both the crops and the soil and can lead to increased pesticide usage which was in other opinions seen as unwanted development and in others, as normal agricultural practice.

The experiences with especially harmful or difficult climatic hazards or *extreme events* on the top of the interviewees' minds dated back to the decade of 1960, although mostly the memorable experiences were from the past 17 years with an emphasis on the previous five years. The events caused mainly crop losses, increased costs (drying, seed corn), distortions in the markets and increased workload. The crop losses from these events cause financial losses that are more than often solely carried by the farmer since most farmers do not have crop insurance.

Problems with excess precipitation were the most often arising climatic challenge in the interviewees' memories. Exceptional events included summer night frosts (in 1977), river flooding on the fields, exceptionally cold growing seasons, more often occurring hailstorms and downpours. The most recently shared experience was the 2015 late and exceptionally wet spring that challenged the starting of the season. *Intensified winds* were also a topic of concern raised by farmers who were practicing forestry – a common practice for farms in Uusimaa and in Finland in general. Strong winds can cause major losses for forestry and cause problems with working on the field. One of the interviewees had even experienced a tornado that had cut trees on its way, forcing him to hide under the tractor for keeping himself safe.

Sensitivity and vulnerability to climate risks

When it comes to the *vulnerability of the Uusimaa agriculture*, several different affected levels or topics were discussed: crop, cultivation, farm income and system, agricultural productivity of the region, soil quality, environmental effects and local economies. These could be categorized by the level of system or organization as farm, communal/local and regional level impacts or by the affected entity: cropping system, environmental, economic and social effects.

Crop yield and the quality of the crop were affected by all climatic challenges which in return affected the revenues of the farm. Regarding the time-scale of effects these are seasonal: occurring within a growing

season. As some of the farmers stated, they tend to look at things within this time-scale. Nevertheless, many of the discussed sensitivities were connected to long term visions.

It was often claimed that of the Uusimaa crops barley is the most sensitive for varying weather conditions. It is especially sensitive to excess precipitation in the spring and in case of drought in summer. Of the total yield of the grain crops in Uusimaa, 16% consists of malt barley so it also affects Uusimaa agriculture sector's sensitivity. Another weather condition sensitive but not as significant crop in economic sense as barley is the fava bean that has become more popular along with subsidies favoring it.

Excess precipitation in autumn challenges spring crop harvests and the whole winter crop husbandry since the sowing is performed in autumn. The right timing of precipitation is also crucial for spring crops, for they are very sensitive to early spring droughts. Downpours can be very harmful right after sowing and, if followed by sunny period causing crusting of the soil.

It is ultimately *soil quality* that determines the productivity of a crop farm. With good cultivation practices, it can be enhanced over time but soil type, for one, limits these possibilities. Increased precipitation and longer periods of continuous rain saturate the soils with water, causing plants to suffocate, sowings to wash off, machinery usage to pack the soil, machines to get broken or stuck to the fields, drying costs to rise and harvestings left undone. Uusimaa is sensitive as an agricultural region because the clayey soil type is especially prone to these effects. The main crops are annual spring grains and their success is highly dependent on the soil quality.

The lack of frost or soil freezing becoming later are experienced as very harmful events in Uusimaa because the soil type (clayey soils) benefit significantly from the frost, overwintering of perennial and winter crops dangers and the overwintering of harmful organisms to the crops is more likely.

On the other end, *increased temperature* seemed to worry the interviewees more in relation to the crop and crop yield than with the soil quality questions. There are optimal temperatures to different crop plants and varieties. The varieties used in Finland, for example, are usually targeted to lower temperatures and varieties bred for warmer climates are not suitable to Nordic conditions because of the different seasonal light conditions.

Variability and unpredictability of weather conditions was seen to lead to smaller yields on the clayey soil types because of the minimal water holding capacity and the tightly bound nutrients. These weather conditions also make it harder to manage the farm system in an optimal way, a problem emerging especially along with farm sizes becoming larger. Agriculture in general was described as a sector where timing and reactivity are key qualities of success. The biggest challenge is to be attentive to and thus follow and adapt to increasingly unpredictable and more extreme weather conditions to minimize the negative

impacts on the machines and working conditions and to avoid negative effects also on the crops yield, crop quality and soil structure.

Non-climatic factors that accentuate sensitivity to climatic challenges were also discussed in many interviews. Some of them are further scrutinized in the 'incentives and disincentives' sub-chapter. In brief, the market and policy fluctuations can cause farmers to invest less in the long-term. The rising share of rented fields is an example of this. Many of the interviewees stated this factor to make the whole Uusimaa agricultural sector more sensitive because it is assumed that rented fields receive less attention and care. Water management and soil maintenance measures, liming and drainage for example, are typically not implemented on rented fields if longer contracts are not in sight, and especially if the fields are distant or behind a population center.

The lack of long-term vision in farm scale and in the agricultural politics was mentioned by two interviewees who stressed that missing an optimistic future vision for the sector can lead to apathy among farmers and the enthusiasm of next generation farmers to dye down.

In summary, some of the interviewed farmers and officials were seemingly concerned about the future regarding climate risks while others perceived opportunities along the challenges. Anxiety about losses of income and physical assets by unexpected and changing weather conditions was experienced by most farmers and in regional perspective by officials as well. The weather variability was experienced to have increased during the experienced weather history of most interviewees and the probability of harmful climatic and weather impacts affecting the farms in Uusimaa was perceived high or inevitable by all respondents.

5.2 Adaptation measures

As there are no direct guiding policies to agricultural adaptation, agriculturalists were discussing the measures they themselves connected to adaptation. The environmental agriculture subsidies [14] mainly directed to the protection of waters were seen often as simultaneously benefitting the adaptation needs. The autonomously implemented adaptation measures are related to drainage, machinery and technology

[14] *"Agri-environmental aid is an environmental subsidy system funded by the government and the EU for reducing environmental burdening from agriculture, and promoting biodiversity and taking care of the cultivated landscape. The aid is mainly granted to crop growers and compensates the environmental protection expenditure they incur."* Retrieved 7.7.2017 from: http://www.stat.fi/meta/kas/maatalouden_ymp_en.html

investments, crop or farming skills/expertise. Categorization of measures with examples is presented in *Table 2* and the complete table of measures is attached in the appendices (Appendix III).

Adaptation measure category	Example measures
Agri-environmental subsizided measures	
• **greening subsidy**	crop diversification, permanent grass-land
• **environmental compensation: environmental pledge**	direct sowing, nature management fields, winter crops, nitrogen fixating plants, under sown crop
• **environmental compensation: environmental contract**	maintenance of subsurface drainage, protection of waters measures (e.g. buffer zones, catch crops)
• **organic production compensation**	turning production from conventional to organic
Aim of the measure	
1) **reducing risks**	soil packing and exposure preventive measures on the field (e.g. lighter machines)
2) **increasing coping capacity (short term)**	re-sowing
3) **increasing adaptive capacity (long term)**	crop rotation, adding soil enhancing crops (nitrogen fixating and deep-rooted crops) to circulation
4) **increasing benefits/ capitalizing on climate change**	investment on new land, taking up subsidized measure
Driving climatic stressor	
• **increased precipitation**	no-till, subsoil drainage maintenance
• **increased temperature& drought**	subsoiling
• **longer growing season**	taking up more productive crops
• **climate variability**	leaving the crop to minimal care/ unharvested
• **climate change in general**	measures enhancing soil structure (e.g. adding organic matter)

Table 2. Agri-environmental subsidized and autonomous adaptation measures (Source: Maaseutuvirasto: hakuopas, 2015; Juhola et al 2017)

The measures targeted to reduce risk are typically related to increased precipitation and climate variability. These are connected to the climate risk perception driven adaptation directly (type 1). Whereas, the types of measures targeted to increase the rather short term coping capacity or a longer term adaptive capacity (indirectly driven by climate risk perceptions) are related to all climatic stressors. It is worth noting that categorizing of measures is partly overlapping. For example, while buffer zones were implemented as an adaptation measure directly aimed to reduce the risk of river flooding on the fields (type 1), it is also mentioned to be used for increasing benefits as non-profiting marginal lands are turned into subsidized lands.

5.3 Adaptation assessment

In the analytical framework, adaptation assessment follows a climate risk perception threshold crossing – when farmer starts to think that adaptation is necessary. The studied *adaptation assessments* are divided to *perceptions of* a) the efficacy of the adaptation measures themselves, b) the efficacy of farmers on implementing the measures, and c) on the cost of the measures. Other affecting factors on the assessment observed within this framework are habit, subjective norm and belief in climate change. Also, incentives and disincentives can affect the assessment but they are discussed in the 'systemic context' chapter.

Farmers seem to reflect their successes as agriculturalist in more general manner, when talking about successes and failures of adaptation measures, and their own capacity and efficacy on implementing them. Adaptation efficacy and cost are the most likely discussed topics of the three affecting factors, whereas self-efficacy is only seldom implied to.

5.3.1 Perceived self-efficacy

Assessment of the self-efficacy of farmers in front of adaptation shows varying results. Some farmers seemed to have a very negative aspect on their capabilities and some were fundamentally optimistic whereas a rather realistic viewpoint was the most often occurring one. Questions of external factors, such as markets and politics, were often referred to in relation to future visions. More interestingly, however, farmers were discussing their expert knowledge, communality, networks and family as resources that affected their perceived self-efficacy.

Farmers who perceived their self-efficacy higher tended to have also more clear strategies for adaptation than those less confident in themselves in front of climatic challenges. Strategies such as growing the variety of cultivated crops and changing the production orientation were mentioned. These are type of adaptive capacity building and opportunity seeking measures. A certain type of attitude was also connected to the higher self-efficacy appraising farmers. An illustrative quotation for this is from a large-scale farmer with a recognized successful farm corporation:

"*Bad decisions? They aren't worth remembering."* (farmer 7)

The less optimistic viewpoints regarding self-efficacy were emphasizing the role of chance or luck. Factors outside the farm were emphasized more and self-efficacy was seen to be dependent on them. Even the most optimistic interviewees were, nevertheless, pointing it out that success in crop cultivation is always at last hand up to a chance.

Extension officers rated farmers' self-efficacy high in the Uusimaa region. They were rather optimistic about the adaptation in general and saw opportunities in new crop plants/ varieties, growing the farm size and new technologies. One official stressed that farmers *will* eventually change their practices when it is *inevitable* for securing the economy of the farm.

5.3.2 Perceived adaptation efficacy

Efficacy, in other words: how effectively does the measure provide adaptation, was a topic of great interest to the interviewees. Varying perceptions were based on experience, observations or information from varying sources (e.g. other farmers or extension officers, agricultural publications and varying internet sources such as forums). An example of conflicting conversation pieces is the no-tillage method.

No-tillage is a sowing method where the seed corn is directly sowed on a stubble field. Lighter versions of the measure were also used where tillage is done lightly or only when necessary. Farmers appreciate the method because it decreases the field work and erosion. However, no-tillage leads to greater usage of pesticides, which can harm the field ecosystem and raise opportunity costs. The controversial pesticide glyphosate is typically used in no-till fields. It was also stated that no-tillage causes the surface soil water-containing capacity to decrease compared to tilled soil and therefore increases the risk of flooding on fields but this can also be other way around, depending on the soil type and quality. On the other hand, lighter tillage or no-till were also perceived to provide a more steady and reliable crop yield that secure the farm income. No-till, however does not work with winter crops.

Winter crops are becoming more popular in Uusimaa because of their erosion risk reduction potential and for distributing the intense field work periods. The success of winter crop yields is dependent on the wintering conditions and it is yet often insecure. Nitrogen fixing plants have not been established on the winter crop variation. One of the farmers was, however, planning to experiment with autumn sowing of green pea.

Among the adaptation measures valued most efficient, especially in long term, are good crop rotation and subsoil drainage renewing. Subsoil drainages in Uusimaa are mostly old and they are not sufficient for the changing precipitation conditions. Renewing them is costly, even though it is partly subsidized and many farmers cannot afford or will not make the investment that will not pay itself back in their lifetime. On the other hand, there is crop rotation, that is a good farming practice but too labor intensive for part-time farmers and possibly requiring too much planning and learning, if new varieties are introduced to circulation. Even the obligation for three crops in circulation per season was assessed as too much for some farmers and it was seen to cut the ground from small scale farming.

Discussion on production orientation circled around the efficacy assessment theme as well. The distortion of animal and crop husbandry oriented farms in Uusimaa was generally seen problematic for the long-term adaptation because cultivating permanent grass-lands and other soil enhancing fodder crops is only half profitable since there is rarely a buyer for the crop yield and getting rid of the product then becomes a problem.

Organic farming is relatively popular in Uusimaa on the Finnish scale and it is expected to become even more so. This was assessed as good adaptation trend since organic farming is based on many of the good farming practices valued as good adaptation as well. Also, the markets for organic products are good in the capital region and possibilities for on-farm upgrading and direct selling of the products and, for example, community supported agriculture (CSA) and urban agriculture were assessed as good local economy development.

5.3.3 Perceived adaptation cost

Perceptions of the costs of adaptation measures were connected to perceptions of managing the farm economy more generally. In the analytical framework this part of the adaptation assessment at farms is thus highly relevant. It was often noted that aiming for steady economy of the farm is the basis for any adaptation attempts. This was often the single most ruling factor to affect farmers' adaptive behavior, as a quotation of an extension officer implies:

" *All measures are primarily done in order to decrease labor and expenses*." (farmer 1)

Nevertheless, many agriculturalists emphasized the role of good farming practices as leading principle in their occupation. For example, two interviewed farmers had formed a co-op of three farms to increase their capacity of production, diversity of crop rotation and chances to experiment with more sustainable solutions. They were part of a local farmers group supported by extension services where economy of the farm was assessed systematically. Extension services in other farms also were mostly used for this purpose and for the subsidy related paper work, but seldom for supporting actual farming practices.

It was often mentioned how the market prizes for grains have been low for some time and subsidies have been cut, while production costs have become higher. Therefor such adaptation measures that would require developing the production are kept in minimum, income is searched outside the farm and pending tasks at the farm, subsoil drainage renovation for example, are kept undone. This applies mainly to farms where investments were appraised impossible or unwanted.

5.3.4 Habit and subjective norm

The assessment of habit showed results connected to attitudes towards change. Objectivity or reluctance to change was sometimes connected to obligation of farming as the farm was inherited. Some farmers expressed their perceptions of habit by determined statements that they *must* manage with the equipment that they have or that changes simply *are too difficult* for them (for further unexplained reason). One of the farmers was under the impression that climate change would not affect farming during his lifetime and stated that:

"*I will continue this way until the end. It is difficult to make changes then.* "(Farmer 4)

Some farmers with less determined attitude towards change rather followed the lead of others in making changes (e.g. neighbors) or stated how they know they should make certain changes but for a reason or another have not yet been able make them. Characteristic expressions were, for example: "*I'm so slow to adapt new things*" (farmer 5), and "*I've thought about cumin…but…*" (farmer 6). Generally, according to an official, decisions at farm tend to be made carefully, in order to avoid failure.

On the other end of the spectrum, some farmers were more open-minded towards changes but yet had their doubts about making changes to already set plans or applying new measures on the farm. One younger farmer, for example, explains:

> *"Making decisions of changes is always a bit… at least, I have noticed, that I find it much easier sticking to plan-a than changing it to plan-b somehow*. "(Farmer 2)

However, the quoted farmer was planning to make big adaptive changes in their farm management, and they had a habit of appraising and ameliorating their cultivation practices constantly. In officials' interviews the "passion for farming" was often referred to as describing these types of farmers.

The assumed or known opinion of neighbors, field landlords and other farmers in their different communities (e.g. producer associations, local groups or village community) influence farmers' practices. Farmers' pride was sometimes referred to when, for example, farmers keep up cultivating erosion sensitive field plots or water body edges event though the subsidized option was available. As one farmer put it:

> "*I wouldn't dare to do that* (nature management fields) *because the landlord would think I wasn't taking care of the fields."* (farmer 6)

5.4.5 Belief in climate change

In the interviews, no explicit skepticism towards climate change was observed. A few by-passing mentions were made, though, that it was not certain of what caused the observed changes in climate and weather. More often, the uncertainty around specific details of climate science related to agricultural professions was expressed: *How much is precipitation going to change? When are the mean-temperatures rising significantly? How often can extreme events be expected?*

Some interviewees also expressed their worry about the agricultural sector not being prepared enough for adapting because of lack of long term vision. One of the officials stated that if Uusimaa agriculture was to keep up with the productive capacity by the end of century when changes will be inevitable, the preparations should be started now for enhancing soil quality, water management and larger structural planning for agriculture.

General notations on difficulty to separate normal weather variation from climate change were presented, for example, a farmer talking about difficult growing season:

"*But this has nothing to do with climate change. It was just one of those odd summers and growing seasons."* (farmer 2)

In this study this has no relevance, though, since adaptation is treated as adaptation to both weather and climate related changes. It is, nevertheless, interesting how much interviewees were deliberating on the specific climate science- and climate policy topics. Many participants regretted not knowing more and for not having sufficient information available.

5.4 Adaptation intention

In the analytical framework of this study, adaptation intention is seen to follow the adaptation assessment – it is only then when farmer appraises adaptation both necessary and possible.

With efficacy and cost of the adaptation measures in mind and a picture of their capabilities of implementing the measures, farmers' plans for future included a variety of new adaptation measures in addition to holding on to the already established ones, presented earlier in chapter 5.2. The intended measures are categorized and presented in *Table 3.* Aim of all the intended measures was to increase adaptive capacity or benefit from climatic changes.

Adaptation measure category	Planned adaptation measures	Aim of the measures
New crops	introducing: flax, fava bean, winter grains, green pea and cumin to crop rotation	• increasing long term adaptive capacity • increasing benefits/ capitalizing on cc
Cultivation or other field work measures	under sown crops, permanent grasslands, direct sowing of green pea, using more precision machinery, diversification of crop circulation, and going back to the field management strategy of ploughing and deep soiling (from no-till).	
Field improvement	drainage improvement, liming, and shaping fields	
Changing the production structure or orientation	giving up animals, taking up organic farming, direct selling, upgrading special products, turning farm into a limited company, and increasing storage	

Table 3. Planned adaptation measures (by category & type)

The officials predicted that their support in future is needed especially for productivity calculations generally and more specifically on "environmental conservation measures" which included the adaptation measures in the interviewer point of view. Officials were also assuming their help to be necessary at providing better information on the spreading of plant diseases and on allocating the subsoil drainage reparations more accurately based on field specific analyses on soil permeability.

5.5 Systemic context

The impact of systemic context, for example; the cultural, economic or institutional context where adaptation decisions are being made, is here presented as the interviewers perceived it. Throughout the interviews, the global markets, EU, Finnish government and agricultural and environmental policies were referred to as the context that dictates the possibilities within which the adaptation decisions can be made. These are partly discussed already in earlier parts of results. Here, some of the before unmentioned factors, including crop insurance, are presented. Observations on incentives and disincentives are presented as a summary on the agri-environmental policy influences on adaptation decision-making at farm level.

The closeness of the capital city in rural Uusimaa with its other jobs tempt farmers to rent their fields and take a steady job. According to the officials this has been an ongoing trend since 1970 along with decreasing of animal husbandry in the region. Closeness of the city also tempts farmers to do more contract machinery work (janitorial services, field work for other farmers) which takes time away from doing the field work on optimal time.

One of the interviewed officials was concerned of the lack of *governmental long term vision* for the sector. It was often implied to that the current development in agriculture is economy and market driven. On the other hand, some agriculturalist saw that the current development is good because there is much "unused market potential" in Uusimaa agriculture (e.g. local meat production and special products). One of the farmers had experience that the retailers are more interested in the sustainability of the whole production line and that the development is now accelerating, which according to the farmer implies to a larger scale change in ways of doing farming:

> "*Others get stuck where they stand and others give up totally. But when thinking about agriculture generally, it has been reinvented that agriculture can be developed*." (farmer 2)

Crop insurance

As the interviewed farmers and officials did not have experiences with crop insurance, two insurance company representatives were interviewed for their perceptions on the influences of crop insurance emergence to the farm scale risk management repertoire. They were basically describing the current crop loss insurance market situation in Finland.

According to the representatives the demand for the crop insurance products has not yet been significant (approximately 300 insurances in total in Finland). Most of purchased products were from the center and western parts of Finland where, for example, spring floods can cause significant crop losses and where animal husbandry is ruling form of agriculture.

The future of the market potential of crop loss insurance was estimated much up to government support, for example, by easing the insurance taxation of the cop insurance products. The available products are mainly EU recommended index based insurances (frequency of a harmful weather event and average regional crop yields as indices). Mixed models of traditional farm-specific- and index-based insurances are possibly being developed.

According to the representative from the insurance company OP Vahinkovakuutus, the restrictions for compensable damages are in the crop insurances much more timid than in the crop loss compensations by the government, but the share of excess is more beneficial for the insured. The indemnity assessments are done by using weather radars (accurate data available even on the farm scale) and the agricultural extension services. The conditions for the crop insurances limit the indemnities to be paid only on rare (once in ten years) and exceptional (three times in hundred years) weather events.

So far, the feedback from farmers had been positive regarding the products, but rejected indemnity applications were typically causing irritation although the conditions in the contract had been clear.

Incentives and disincentives

All interviewees described that there are big challenges of dealing with national and European policies and legislations. For example, a rule established in 2015 that obliges farms to cultivate at least 3 different crops at the same time to stimulate crop rotation was mentioned in a couple of occasions. Crop rotation as such is regarded as a good farming practice. In a viewpoint of one interviewee, the rule is restrictive to small scale farmers and inhibits local planning. The last-minute implementation of the permanent grasslands

enactment in 2015 was also considered harmful for farmers who had to make difficult changes with short notice and for those who had animals close to the farm, albeit establishing permanent grasslands was seen as a good measure for soil enhancement.

Nevertheless, subsidized environmental measures have allowed farmers to cultivate new plants that have good effect on soil quality and this has encouraged farmers to try new plants. Compensations from nature management fields, buffer zones and no-till worked as incentives for all farmers but for some more than others. The following statement of a farmer exemplifies the mentality of using subsidized measures in mainly profit-seeking manner:

> *"If the subsidy will be cut one bit, the buffer zones will be taken back to cultivation immediately."* (farmer 4)

The "subsidy driven" decision making was seen problematic by some of the interviewees who were opposing this type of "quasi-farming" as it could lead away from food production and good farming practices. Critique was especially acclaimed towards farmers who use good field plots for gaining the environmental subsidies.

Some farmers claimed, though, that in order to survive economically they had no other option than to utilize the subsidies and accordingly implement farming measures that they themselves too thought were not representing good farmer skills or practices. This means that fields are cultivated with such crops and manners that are not giving the best yield or are not optimal for the soil quality.

One farmer who is also a spokesperson for the local farmers union says he cannot trust that he is doing everything according to the rules because keeping up with the changes in policy and legislation is too difficult and time consuming for him. In general, the Finnish administrative sector was seen to be too strictly following the EU rules and creating even more environmental controls on top. For some of the farmers who had practiced farming before Finland joining the EU, the change in regulatory conditions was seen to have become stricter. One farmer implies to this in the statement describing the change along joining the EU:

> *" It was really... with animal and all... it was really depressing. When you are attuned to doing all decisions, and everything, by yourself. And then it was like:* everything *is regulated and all the regulations were* not *reasonable. Even the administration could not argument for them."* (farmer 2)

As already discussed earlier, the markets have a strong effect on the farmer adaptation decision making. An interesting note was made by farmer who had experienced a reversed correlation between oil price and his organic nitrogen fixation attempts. With similar economic incentive logic, one farmer increased liming usually when levelling of taxation was needed (in case of budget heading to surplus). Another market related disincentive for measures aiming for good soil structure is the well acknowledged high field rent prices and short rental contracts (1-5 years) in Uusimaa.

5.6 Maladaptation

In addition to adaptation and intended outcomes presented in the beginning of the results, the interviewed agriculturalists had encountered various maladaptive outcomes and were anticipating more to come. The term itself was new to all interviewees and required explanation.

Many of the maladaptive outcomes are already presented in the earlier parts of this chapter (see e.g. 5.3). As a summary, *Table 4* presents rough categorization and examples of maladaptive outcomes experienced or observed by the interviewees. It is worth noting that maladaptive outcomes are not inevitable consequences of the adaptation measures and they could be avoided by better planning and implementation of the measures. However, often in the everyday life on the farm, there are not enough resources (e.g. economic, human or information) for the optimal decision making, as many were claiming.

Type of maladaptation	**Example adaptation measures leading to maladaptation**
profit losses	nature management fields
increased need for labor/ labor intensity	from buffer zone, crop rotation
soil packing	subsoiling
anxiety about the uncertainty related to measure	overwintering of winter crops, taking up new crops to circulation
increased use of pesticides	direct sowing

Table 4. Maladaptation types and example measures causing maladaptation

6 DISCUSSION

The aim of this study was to examine the influence of climate risk perceptions of the Uusimaa agriculturalists and the adaptation policies on farm-scale adaptation. In this chapter, results are discussed in relation to the research questions:

1) *How do farmers' climate risk perceptions affect farm level adaptation?*
2) *What type of adaptation measures are implemented in the Uusimaa agriculture?*
3) *How are the current adaptation policies affecting Uusimaa farm level adaptation?*

6.1 Risk perceptions reflect risk response types: profit-seeking, careful and experimental

The analytical framework worked well on drawing a picture on the factors affecting decision making in farm scale. Generally, the Dang et al (2014) PMT framework with modified maladaptation (Noble et al 2014), adaptive measures (Smit & Skinner 2002; Juhola et al 2017) and climate risk variables (Norman, Boer and Seydel 2005; Comoé et al 2014; Li et al 2017; Wilke & Morton 2017) showed results that can be generalized to adaptation decision-making in other domains as well.

It seems that there are patterns of risk perceptions leading to adaptive action, and the protection motivation theory variables affecting the process. Especially often occurring perceptions of risk, self-efficacy, adaptation costs, disincentives, incentives and implications of habit are connected to certain types of climate risk responses: 1) priority on the economic benefit - "everything is done with profit firstly in mind", 2) careful - "not putting all eggs in the same basket" and 3) visionary and experimental mentality "passion for farming".

The findings suggest even a more general risk response typology than what is here examined in the adaptation context: 1) profit-seeking, 2) careful and 3) experimental. The interesting finding is especially that opposed to typical utilitarian 'risk aversive – risk seeking' dichotomy (see e.g. Kahneman & Tversky 1979) used by, for example, insurance industry, the third type of risk response (3) seems to leave risk as such to secondary role in decision-making, and focus on experimenting for better practices in general. Better practices were sometimes connected to "strategies" where farmers were emphasizing or relying on a certain way of farm management.

The farm management strategies detected from the results were: a) intensification, b) "extensification", c) taking care of the soil, d) diversification e) long-term planning, and f) part-time farming. Also, giving up on farming was a strategy in Uusimaa that the interviewees had observed and the statistics confirm. Adaptation was guided by the farm management strategies. The leading principle of strategies was often the varied definitions of "good farming". A "good farmer" identity has been connected in literature to adaptation strategies with the notion that driving values and beliefs of these identities are not well understood (Morton, McGuire & Cast 2017). In this study, the motives for detected farm management strategies were not studied and only the connections to risk perceptions could be made.

The risk response types and adaptation strategies are partly overlapping, for example, "extensification" (as opposite to intensification i.e. less intensive way of farming) can be done with firstly economic profit in mind: "the greening subsidies pay better off than crop yield" or as a visionary way of adapting: "full-time crop coverage is best for the soil in long-term". Diversifying and taking care of the soil, on the other hand can be part of careful practices on some farms and visionary farm management on others. Nevertheless, these generalizations reflect the points of departure for adaptation assessments and implementations. Examples of risk response types and strategies found in the results are discussed next.

Adaptation measures that are beneficial for the farmer (subsidized, soil enhancing, labor intensity decreasing, market profit potential) are preferred over risky or purely non-beneficial measures with higher probability by most farmers. Nevertheless, the viewpoint on benefit and its probability varies somewhat. Economic benefit prioritizing part time farmers, for example, value their time and aim to optimize the time spent on field. Intensive large scale farms are taking more risks with aim to larger profits and capacity to handle the losses. Careful and visionary farmers follow their conception of good farming practice and mind the costs accordingly.

Yield losses, for example, do not directly endanger the farm economy because main share of crop farm income comes from subsidies. Thus, profit-seeking risk responses would not value yield losses high in the scale of harm, whereas, a visionary farmer would respond to yield losses with higher interest as they represent developing needs (e.g. better crop choices). A careful farmer would avoid yield losses to an extent where larger losses could be prevented (e.g. machinery getting stuck to too wet field).

Sometimes the general agricultural regulations leave loop-holes that might be enthusiastically used with an economic underpinning. Currently, for example, the subsidized no-tilling practice is the only way of getting a permission to use the notorious pesticide glyphosate. Some farmers are valuing the increased use of pesticides as an economic way of controlling weeds and thus utilizing the opportunity for applying

glyphosate. Careful and visionary responses, following a strategy of long-term planning, would deliberate on the ecological sustainability of pesticide increase.

On the other end, regulations were seen to inhibit good farming practices which, according to many of the farmers, require more flexibility than what the regulations nowadays allow. For some, enthusiasm and motivation for development of the farm has lowered in fear of sanctions and because of the overwhelming task of trying to stay on the map with constantly changing regulations. Certain attitude towards change or sticking to old habits can also explain the observed challenges.

The influence of habit divided farmers into those who were basically objecting changes, those who were willing to change but felt it difficult and those who were seemingly not affected by restricting habit, or had the habit of being more open to new plans, ideas and experiments. The statements of officials confirmed this division. The culture of neither communicating nor co-operating with all neighbors and locals equally was recognized as a typical feature for many farmers with reluctance towards change. The objection towards changes could be part of a careful risk response, but could also underlie plans to quit farming.

If the farmer is not planning to continue farming or there are no successors for the farm, the current uncertain market and policy conditions could lead careful or economically thinking farmers to exploit what is possible until a collapse of resources (e.g. soil quality and field work input). Long-term systemic soil maintenance plans, including well planned crop rotation, in general are not in the interest of a farmer who cannot trust the future. For the economic profit seeking farmer, the uncertainty of markets can be a chance to take profitable risks. In the visionary farm management, the uncertainty of outside-of-farm conditions can, on the other hand, drive to seek for more sustainable inventions and adaptation practices.

6.2 Adaptation measures in Uusimaa are aimed at building adaptive capacity

Variables of risk perception seem to affect the ways in which Uusimaa farmers deliberate and act in front of climate risks. The decision-making process prior to adaptation measures implementation is complex and relational to farm specific factors. Nevertheless, adaptation measures are implemented in Uusimaa agricultural context partly driven by risk perceptions.

The observed adaptation was targeted in many ways only indirectly towards climate change, and it was firstly driven by non-climatic factors such as political and market fluctuations. This could be called "hidden adaptation" (Grüneis, Penker & Höferl 2016). Similar tendencies have been detected in other Nordic

countries as well where adaptation was rather seen as part of somewhat normal farm practices (Asplund 2016).

The most often occurring type of adaptation, regarding the adaptation aim -typology, were the long-term adaptive capacity building practices which are usually seen to represent good farming skills. The types of 'capitalizing on climate change' measures were also often mentioned, especially in the officials' discussions. The official stand on focusing on the opportunities for agriculture brought about by climate change is also in line with the 'profit seeking' farmer types. However, the potential negative consequences of measures were usually duly discussed in the same context and it seems that officials were well aware of, though with varying attitudes towards, the potentially maladaptive outcomes of the planned and implemented measures.

The concept of maladaptation in this study is relational to the perceptions of risk and adaptation and self-efficacy of the farmer as can be noted from the examples of risk response types. From a more objective viewpoint, the discussed maladaptive outcomes are a real concern that threat the future of agriculture and society more largely in terms of food-security, environmental concerns and societal development. Farming may become difficult or unattractive because adaptation requires taking measures that cause income losses at farm, anxiety for the farmer and labor intensity.

For concluding the discussion regarding the connectedness of climate risk perception and taking adaptive measures: risk perceptions can be generalized to types of risk responses that are partly driving the adaptation measure implementation at farm level along with farm management strategies. Acknowledging them could help to develop better guiding policies for agricultural adaptation and development of the agricultural sector more generally. Next, the current adaptation policies are discussed.

6.3 Adaptation policies do not guide farmers

Adaptation in Nordic countries is widely studied from the social scientific and interdisciplinary perspective, but this does not yet reflect to the adaptation policies (Klein & Juhola 2014). In the case of agriculture in Uusimaa, this statement was also found accurate. Farmers were experiencing many uncertainties and lack of resources in their adaptation practicing. The only intentional government agriculture adaptation policy at the time of interviews: giving up crop loss compensation for insurance sector to handle, seemed to follow the IPCC recommended risk management approach in adaptation (Noble et al 2014).

There were yet few experiences with *the policy change* from crop loss compensations to insurance company provided crop loss insurance. None of the interviewees had experienced significant help from the early governmental support in case of weather related crop losses before and their assumptions on the necessity of the new crop insurances were mainly based on those experiences. The compensations had not been big, and the required "paper work" was assessed difficult and time consuming. Similar expectations were laid on the insurance. In addition, doubts concerning the insurance industry in general were raised. The industry was seen to aim for its own profit and not for securing the farmers income.

The future of crop loss insurances, according to the insurance company representatives, was acclaimed to depend on government support since their profitability for the insurance companies was not expected to be high. Hopes on insurance taxation relief were raised. Different ways for government support, presented by Garrido et al (2011, 420), are: premium subsidization, direct insurance participation, market regulatory frameworks and providing reinsurance.

Many studies suggest these types of *private-public models* of climate risk management (e.g. Aerts & Wouter Botzen 2011) since, for example, the actual implementation of adaptation is more likely if the costs and benefits are shared (Smit &Skinner 2002, 104). A very careful planning and preparation of the private-public policies is nevertheless stressed in order to avoid harmful and distorting arrangements in case of insurance industry inclusion (see e.g. Ignaciuk 2015; Liesivaara & Myyrä 2017). Further studies on how the crop loss compensation privatization influences farmer adaptation decision-making should be done to better understand the farm-scale adaptation consequences of the policy change and to guide future policy planning.

On the other end of affecting policies, the agri-environmental subsidies, currently guiding strongly to water protection, were found to partly guide adaptation at farm level. As an example of the policy influences, the implementation of fulltime vegetation coverage (permanent grasslands, nature management fields and buffer zones) which is generally regarded as good adaptation, has increased multifold in recent years. Nevertheless, the vulnerable areas benefitting most from full-time vegetation coverage were charted in the policy preparation but the actualized implementations did not hit the target areas but partly.

Regardless of agricultural and environmental regulations and subsidies guiding and affecting adaptation, they are not adaptation policies. They are not purposefully enhancing adaptation but can potentially cause maladaptation and confusion for farmers regarding environmental concerns, climate change mitigation and adaptation.

It is a great advantage for agriculture, in comparison to other sectors in society, that farmers are capable and proactive in adaptation. However, larger scale successful adaptation is not going to take place without coordination (Otto-Banaszak et al 2011). The example of buffer zone implementation is an example of good attempt to coordinate regional scale water management in agriculture, although it was unsuccessful in targeting the most vulnerable areas. Adaptation policies are indeed being developed at the moment. Analogous experiences in agri-environmental policies could be learned from and synergies crossing the administrative sectors could be recognized.

In the report of the state of adaptation in the administrative sector of the ministry of agriculture and forestry regarding the climatic sustainability (Peltonen-Sainio et al 2017) policy guidelines to agricultural adaptation are presented. The guidelines were set after the study interviews and can thus only be discussed generally and not in relation to agriculturalists' perceptions on 'other affecting factors' to their adaptation decision-making.

The three concluding remarks on the report suggest adaptive action to focus on 1) "*increasing the preparedness for weather variation and extreme events*", 2) "*developing water management and by enhancing the expansion potential of winter crop cultivation*" and 3)restriction of "*[t]he wide spreading of the risk of plant enemies* (Peltonen-Sainio et al 2017). Of the suggested ways to achieve these targets (Peltonen-Sainio et al 2017, 62) almost all were discussed by the interviewees of this study: locally adapted crops, resistant varieties, taking care of the soil quality, diversification of cropping systems, crop circulation, development of insurance products and plant breeding.

The multitude of other factors affecting and challenging agricultural adaptation (Muller, Osman-Elasha & Andreasen 2013) did not seem to be acknowledged in guiding policies. The need for planning and overcoming barriers of adaptation for example were not expressed in the proposal for action in agriculture (Peltonen-Sainio et al 2017), although good specific recommendations to the most pressing climatic risks were noted. Taking the socio-cognitive aspects in consideration when planning for adaptation policy implementations further, should be noted in the light of research showing their significance to adaptation intention. Participatory policies and stakeholder inclusion to the adaptation planning process seem to be relevant ways for this (see e.g. Renn 1998; 2008, 171-200). In the light of results of this study, farmers especially could be more involved.

The examination of vulnerability of agriculture and the recommendations in general in the report are done with a national scope. Nevertheless, the bio-physical conditions affecting the vulnerability in Finland vary regionally regarding soil types, vegetation zones, and slopes of fields, for example. Thus, adaptation needs and means vary regionally as well. Some elements affecting the agriculture, however, are typical across the country and in Nordic countries in general: proximity of water bodies, strong seasonal variation on light

conditions and the distinctively different annual seasons in general. However, a regional perspective and take on coordination of the adaptation policy-implementation could enhance the success of adaptation efforts. Probably the most flexible of actors for the coordination of agricultural adaptation could be the municipalities. It is already shown that the risk management in municipalities could be linked to climate risk management in general and how the existing municipality networks are a potential facilitator for these aims (Räsänen et al 2017).

In conclusion, the current adaptation policy seems to be leaving actors at different sectors alone with their attempts to adapt. The absence of adaptation policies for agriculture in Finland is apparent when looking at the farm level decision making in front of climate change. Farmers are left with inexplicable confusion regarding the future of their livelihood in front of climate change. Adaptation is understood but often confused with mitigation. Mitigation is seen as something they are not rightfully demanded for and attitudes towards the whole climate change discussion are colored with blame. Adaptation is already happening at farm level but it is neither a topic of discussion nor fully understood by the farmers. Attempts to inform agricultural actors about adaptation have risen in the past years but are not yet seeped into the minds of farmers as something essential and beneficial for their future rather than an obligation steered from a distance. Better participatory practices and stakeholder-inclusion on adaptation and risk management policy planning is suggested.

Limitations / reliability

A typical pitfall of a case study approach is to lack external validity by failing in generalizing the findings on a suitable domain. A tactic used in this study to tackle this pitfall was finding sound theoretical background (of climate risk perceptions in adaptation and climate risk management) on the research subject and sticking to it systematically. (Yin 2014, 45-49). It was, however, sometimes hard and as the process of writing the thesis lengthened from the original plan, new ideas of the discussions where the results could take part kept arising. They could, however, be focused on in future studies.

As part of validating the construct of the study (Yin 2014, 45-49), unit of observation in this study is narrowed to the individual perception. It sets limits to what can be said about the results. Mostly the unclear cases were left out of the results. However, a couple of individual cases require examination here to avoid misapprehensions.

When discussing the climate risks, agriculturalists were divided by the assessment on whether the increased precipitation or droughts are more significant. Emphasis was put on precipitation. Reasons behind it might be that a) excess precipitation has been more common recent years than droughts and b) problems with precipitation cause the farmer more extra work than problems with drought. Similarly, when asked to remember the most influential experiences with extreme weather events, most answers were concerning the past five years. This does not necessarily say that the extreme events have increased lately, but that our memory tends to work better regarding the more recent history.

Some of the respondents saw environmental sector as hindering agriculture and thus might have had prejudices against the interview as well, since climate change issues in general where often related to environmental issues. To soften these possible prejudices, when necessary, it was explained more thoroughly how adaptation is tightly connected to the survival of the farm. Reliability of the results is, anyhow, considered strong. Presented results are based on several manifestations in the interviews and single experiences or point of views are not generalized.

Dang et al (2014) stressed the need for further research on developing the methodology on PMT framework based adaptation analysis. Some concluding remarks regarding the methodology can be made based on this research, although the original framework of Dang et al (2014) was modified for this study. The framework seems to fit for guiding the one-on-one interviews with stakeholders. The operationalization and interview skills are, however crucial in defining the success of the interviews. In this study, for example, results suggest that subjective norm does not play a significant role on farmers' adaptation decision-making, as not many mentions were detected. More plausible, however, is that the operationalization of the variable was not good. More generally, the PMT framework works well for guiding the interviews and analysis of internal drivers and affecting factors for decision-making in front of risk. The influence of external factors is not that well included in the original framework and it was aimed in this study with modifications on the framework. Analyzing the internal and external factors separately is, however, very difficult and an overview of the research topic was gained in this thesis. More thorough examination of each affecting factor would bring depth to the study of adaptation decision-making.

7 CONCLUSIONS

The experiences of extremities and variation with weather were common among Uusimaa agricultural stakeholders. Most are convinced of intensification or prevalence of these changes, yet some claimed that the changes would not influence their farm management significantly. Adaptation for the changing weather and climatic conditions is happening in the farm scale and farmers in Uusimaa are able and willing to adapt. The idea of a good farmer guides those types of farmers in Uusimaa who aim for successful farming. The 'good farmer' identity influences decision making at farm operations. The implemented measures are aimed mostly on long term adaptive capacity building and capitalizing on climate change.

In the case of agriculture in Uusimaa, the qualitative insight to farmers adaptation decision making showed that climate risks are deliberated at farm scale but not enough knowledge, time, nor economic resources are available for implementing well scheduled long-term visionary adaptation measures that with big certainty would also avoid maladaptive outcomes. Adaptation measures are implemented in the farm-scale, but they are neither coordinated nor guided by policies. The measures are rather reflections of the risk response strategies of farmers.

The results help to picture the multitude of factors affecting farm-level decision-making and adaptation in general. The influence of adaptation policies is not visible on the farm-scale adaptation which implies to need of better policy guidance in order to grasp the challenges in agricultural adaptation and to avoid maladaptive outcomes. The strength of this study in comparison to other adaptation studies based on the protection motivation theory is that farmers in Uusimaa have already experiences on implementing adaptation measures. It could thus be shown that the intentions led by climate risk perceptions are materialized as farm-scale adaptation measures.

Further studies on agricultural adaptation decision-making, risk and adaptation perceptions of other agricultural stakeholders and other affecting factors to adaptation implementation in Uusimaa could provide useful viewpoint on how to develop efficient participatory policies in agricultural adaptation and how farmers could be provided with sufficient support for their adaptation intentions. Other relevant agricultural stakeholder groups include at least interest groups: farmers unions, producer associations; retailers, local communities, municipalities, agricultural administration and educational establishments with agricultural education. The future studies may benefit from group interview format where a larger sample and broader viewpoint on the topic could be reached in one session.

Study also raises questions regarding climate risk management: how to combine private and public risk management and how to include participatory practices better into risk management policies? The

question of private-public risk management should be discussed more in further studies on adaptation policy effects on agriculture. The different risk response types (profit-seeking, careful and experimental) should be examined more to better understand them and to see how the currently developing adaptation policies affect them. Further study on values and beliefs behind farm management strategies could also broaden the picture of adaptation decision-making at farm-scale. Finally, research on how to simultaneously secure food production, agriculture as a livelihood and Nordic agriculture as a benchmark for sustainable agriculture now and in the future under the changing climatic conditions, is recommended.

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APPENDICES

Appendix I

Interview guides 2015: A) farmers and B) extension officers

A. Farmer interview guide

BACKGROUND QUESTIONS

Name. Farm size, type and location. Crop variety. Years as farmer.

1. VULNERABILITY/SENSITIVITY

What are the most challenging weather events for your crop cultivation in Uusimaa so far, in your experience?

- Which weather events have affected your crop production the most? How do they affect? How sensitive is your crop husbandry on these events?
- Are there other factors, in your opinion, that have an effect on the vulnerability of your crop cultivation towards weather and climate related factors?
- Do you remember a certain year when your crop cultivation was especially vulnerable?
- Did they cause effects on the crop yield/revenue? Other effects?

2. ADAPTATION MEASURES

What kind of adaptation measures have you taken? / How did you handle the challenging weather event? / What do you do when the challenging events occur?

- How did you except this/these measure(s) to work out?
- What do think about the results of your adaptation measures?
  - Do you think it caused successful adaptation? Why?
- Are there adaptation strategies that you would prefer in certain situations? Why ?
  - What could you have done differently to avoid the harms or to minimize vulnerability?
- What is your attitude towards adaptation strategies? (doubts, fears?)

3. MALADAPTATION

Have the measures you took affected you or others negatively?

- When you decided on the measure, did you deliberate the negative outcomes? (to crop yield, revenue, other farmers)
- Are there other measures you think you might need to use in the future?

4. VULNERABILITY AND ADAPTATION IN FUTURE

What is the most challenging weather in the future, in your opinion?

- How do you think you will manage when it occurs?
- How do you think you will act in future to better adapt your farm for the changing weather and climate events?

B. Extension officer guide

BACKGROUND QUESTIONS

Name. Job decription and experience. Farming experience.

1. VULNERABILITY/SENSITIVITY

What are the most challenging weather events for the crop cultivation in Uusimaa so far, in your experience?

    - What weather or climate related factors affect the crop cultivation in Uusimaa most at the moment? How?
    - How sensitive is cultivation and the crop plants for these events?
- Are there other factors, in your opinion, that have an effect on the vulnerability of Uusimaa crop cultivation towards weather and climate related factors?
- Do you remember a certain year when Uusimaa agriculture was especially vulnerable?
- Did they cause effects on the crop yield/revenue? Other effects?

2. ADAPTATION MEASURES

What kind of adaptation measures are taken in Uusimaa (policy driven or by individual farmers)?

    - What were/are you expecting as a result of these measures?

- Are there adaptation strategies that you would favor in certain situations?
- What is your attitude towards adaptation strategies? (doubts/ fears?)
- What do you do when you meet a farmer who would like to adapt as well as possible?

3. MALADAPTATION

Have you encountered adaptation measures that have affected the farmer or others negatively?

- How do you advice farmers with adaptation? Do you deliberate possible negative effects (to revenues, crop yield or other farmers)?
- Are there such adaptation measures that you should advice farmers with in the future?

4. VULNERABILITY AND ADAPTATION IN FUTURE

What weather events are most challenging for agriculture in Uusimaa in future?

- How do you think that agriculture will manage if those occur?
- How do you think that farmers will handle the changes and adapt to them?

Appendix II

The thematic interview guide: crop insurance expert interviews

1. Overall view on the role of insurance companies on adaptation?
2. How much demand and sales there has been and is expected to crop insurance products?
   A. Enough for keeping the products at the market?
   B. Possibility/necessity of governmental support?
3. Indemnities. How much? What crops? Where?
4. Why different insurance providers have different products? What kind of new products are developed?
5. What are the most remarkable differences to the old governmental crop loss subsidy?
6. How do you perceive these statements from the Finnish Meteorological Institute: Climate Info – website?
   A. Insurance industry can have a significant role in future on anticipation and adaptation to climate change because it is in their interests to increase risk knowledge among insured and analyze the nature, impacts and probability of risk.
   B. Changing the flood risk insuring from public to private sector, would establish the indemnity policies and probably shorten the treatment of appeals.

Appendix III

The adaptation measures and categorization.

EXPLANATIONS:

Level of intention:

Intended or assume to be intended (PLAN), implemented or assume to be implemented (ACT), should be implemented (SHOULD)

Climatic stressors:

Increased precipitation (p), increased temperature& drought (d), longer growing season (g), climate variability (v), climate change in general (cc)

Aim of the measure:

1. Reducing risks
2. Increasing coping capacity (more short term)
3. Increasing adaptive capacity (rather long term capacity)
4. Increasing benefits

The adaptation measure		**Subsidies / other economic benefit ($$save/ earn more money)**	**Level of intention**		**Climatic stressor**	**Aim**
FARMERS	**OFFICIALS**		**FARMERS**	**OFFICIALS**		
direct sowing (no-tillage)	**X**	env. comp. (ep)	ACT4	ACT4	p, d	1(4)
light tillage / tillage only when necessary	**X**	$$	ACT3	ACT3	p, d	1(4)
green fallows	**X**	greening	ACT5	ACT2	v/p	3

nature management fields	**X**	env. comp. (ep)	ACT3	ACT4	v/p	3
buffer zones	**X**	env. comp. (ep)	ACT3	ACT5	p	1(4)
crop rotation	**X**	greening	ACTall(7)	ACTall(6)	v	3(4)
adding and changing the variety of crops (eg. More productive, adaptive to changing conditions)	**using more productive crop varieties; using crop varieties of a longer growing season (corn, winter grains, fava bean)**	possible: greening (fava beans, etc.)	ACT2, PLAN3	ACT1, SHOULD1	g	1, 3, 4
wintercrops	**X**	greening /env. comp. (ep)	ACT6, PLAN1	ACT2, PLAN2, COULD1	g	3, 4
nitrogen fixating plants/ biological nitrogen fixation/ green manure grass	**nutrient circulation**	greening/ env. comp. (ep)/ crop reward	ACT2	ACT2, COULD1	p, g	3, 4
X	**deep rooted crops**	greening	ACT1, COULD1	PLAN1	p	3
undersown crop		env. comp. (ep)	ACT3		p	3
changing the crop/relation of crops in spring	**X**		ACT3	ACT1	v	1
resowing			ACT1		p, d, v	2
leaving the crop unharvested		$$	ACT4, COULD1		p, v	2
subsoiling	**X**		ACT1, PLAN1	ACT1	p, d	1

structural liming	**X**		ACT1		p, d	3
avoiding unnecessary driving/ minimizing autumn field work /good planning of logistics	**X**		ACT5	ACT2	p	1
co-operation with neighbor farms	**X**		ACT3	ACT1, SHOULD1	v	2
lighter machines, broader / double tires, precision machinery	**X**		ACT3	ACT1	p	1
maintenance / adjustment of the subsurface drainage	**enhancing overall drainage (including wetlands)**	env. comp. (ec)	ACT2, PLAN4	ACT1, COULD3	p	3
supplementary subsurface drainage on best fields		$$	ACT1		p	4
investments on new land		$$	ACT2, (WISHx)	SHOULD1	g	4
shift to organic production	**X**	greening/ organic production comp.	ACT2, PLAN2	ACT5, PLAN1	v	1, 4
taking up animal husbandry			COULD1	SHOULD2, COULD1	v	4
shift to crop husbandry intensity (from			ACT1, PLAN1	ACT4	v	1

animals)						
	bioenergy production	greening		PLAN1	v	3
changing the form of enterprise (farm concern)			ACT1		g	4
digging up the river bed			SHOULD1		p	1, 3
X	**enhancing soil structure (by eg. adding organic matter) *explicitly***		ACT5	ACT4, COULD1	cc	3
X	**protection of waters as the explicit driver (*buffer zones*, wetlands, wintertime field coverage, catch crops)**	env. comp.	(*ACT3*)	ACT4 (*ACT5*)	cc, p	3
X	**intensifying and optimizing production in general /on certain field segments (best, worst)**	$$	ACT2, PLAN1	ACT4	cc, v	3
breaking the crusted surface soil with harrow in spring			ACT1		v, (d, p)	2
shift to using peat-manure mix (instead of liquid			ACT1		p	3

manure)						
grains are left to minimum care if the yield appears to be left small		$$	ACT1		v	2

Appendix IV

Coding of the analytical framework.

Analytical framework		
	Keywords /themes	Predetermined themes
Risk perceptions	surviving, securing, harm, weakening, challenges, bad thing, worry, risk, problem, disturbing, wasting, loosing, stress, learning and depressing.	climatic challenges, vulnerability, severity, probability
Adaptation assessment	costs, benefit, success, profitability, value, decision, invention, timing, enhancement, effectiveness, planning, long-term vision, diversification and misinvestment.	effectiveness of adaptation measures, cost of the adaptation measures, self-efficacy
Adaptation intention	deliberate, ponder, consider, prepare, learn, plan, study, interest, possibility, update, improve, modernize, project, synergy benefit, uncertainty and cooperation	
Maladaptation		unintended harmful outcomes of adaptation measures
Adaptation measures		Implemented measures to avoid harms and risks of climatic/weather related events
Other factors	focus, target, dis/incentive, subsidy, compensation, prize, lure, development, savings, profitability, risk and misinvestment.	belief in climate change, habit, subjective norm, incentives, disincentives