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Participatory design of farm level adaptation to climate risks in an arable region in The Netherlands

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ABSTRACT

In the arable farming region Flevoland in The Netherlands climate change, including extreme events and pests and diseases, will likely pose risks to a variety of crops including high value crops such as seed potato, ware potato and seed onion. A well designed adaptation strategy at the farm level can reduce risks for farmers in Flevoland. Currently, most of the impact assessments rely heavily on (modelling) techniques that cannot take into account extreme events and pests and diseases and cannot address all crops, and are thus not suited as input for a comprehensive adaptation strategy at the farm level.

To identify major climate risks and impacts and develop an adaptation measure portfolio for the most relevant risks we complemented crop growth modelling with a semi-quantitative and participatory approach, the Agro Climatic Calendar (ACC), A cost-benefit analysis and stakeholder workshops were used to identify robust adaptation measures and design an adaptation strategy for contrasting scenarios in 2050.

For Flevoland, potential yields of main crops were projected to increase, but five main climate risks were identified, and these are likely to offset the positive impacts. Optimized adaptation strategies differ per scenario (frequency of occurrence of climate risks) and per farm (difference in economic loss). When impacts are high (in the +2 °C and A1 SRES scenario) drip irrigation was identified as the best adaptation measure against the main climate risk heat wave that causes second-growth in seed and ware potato. When impacts are smaller (the +1 °C and B2 SRES scenario), other options including no adaptation are more cost-effective.

Our study shows that with relatively simple techniques such as the ACC combined with a stakeholder process, adaptation strategies can be designed for whole farming systems. Important benefits of this approach compared to modelling techniques are that all crops can be included, all climate factors can be addressed, and a large range of adaptation measures can be explored. This enhances that the identified adaptation strategies are recognizable and relevant for stakeholders.

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1. Introduction

Agriculture in North-West Europe will likely be affected by both gradual climate change (higher CO_2 levels and temperatures, and changes in precipitation) and a changing occurrence of extreme events and pests and diseases (Alcamo et al., 2007; Olesen and Bindi, 2002). Most studies that assessed climate change impacts have focused on modelling the impacts of gradual climate change on crop production (Easterling et al., 2007; Soussana et al., 2010). It has been argued however that the impacts of changes in extreme events are more important than impacts related to gradual changes in temperature and rainfall patterns (Iglesias et al., 2012a, 2012b; Jentsch et al., 2007; Katz and Brown, 1992; Van Oort et al., 2012). Further, Rosenzweig et al. (2002) suggest that the impacts of pests and diseases are of particular importance for local adaptation. Only few attempts have been made to assess the indirect impacts of changed occurrence and abundance of pests and diseases that are harmful to crop production and quality (Cobon et al., 2009; Gregory et al., 2009).

The need for adaptation to climate change is recognized (Howden et al., 2007; van Vuuren et al., 2011). As Ewert (2012) and Wreford and Neil Adger (2010) point out, climate change can also provide opportunities for agriculture in North-West Europe and a wide variety of adaptation measures exist (Olesen et al., 2011). To identify the most appropriate adaptation measures for agriculture in a region, a comprehensive approach is needed looking at different levels of impact (Howden et al., 2007) and recognizing the importance of farm level decision making as opposed to only simulating crop yields (Reidsma et al., 2010). Crop models can be used to quantitatively assess the impact on potential and water

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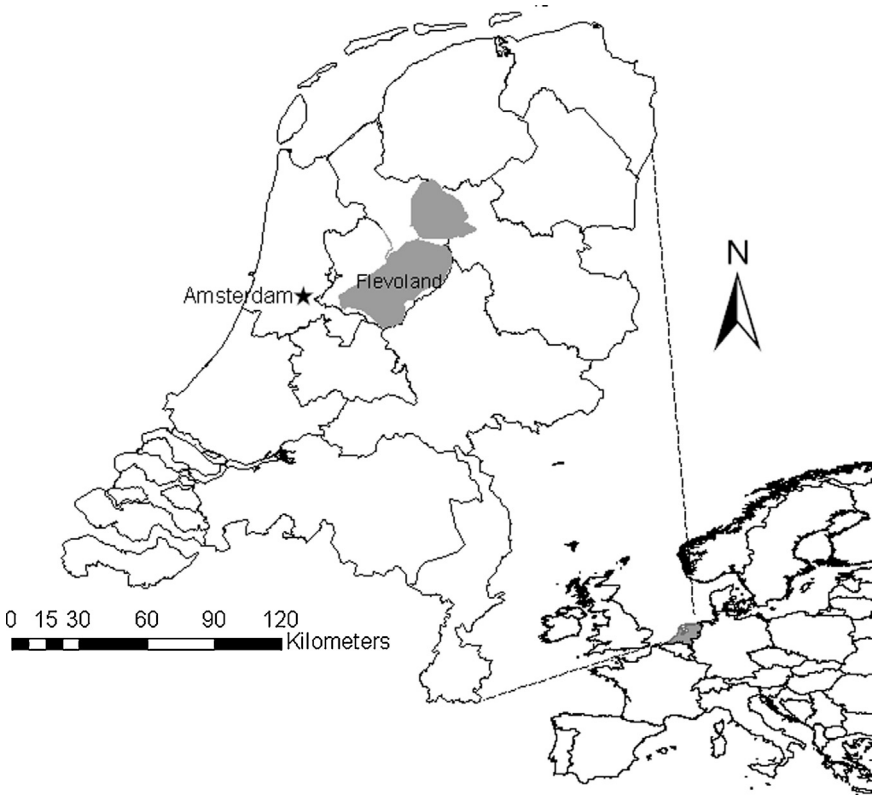

Fig. 1. Location of the case study area Flevoland in The Netherlands.

limited yields (Van Ittersum et al., 2003), and to assess the impacts of the adaptation measures like changing sowing dates, irrigation and changing cultivars. However, at present crop models are not suitable to assess climate risks related to extreme events and pests and diseases, they are not available for all crops, do not address crop quality sufficiently and therefore cannot address all relevant adaptation measures.

Relevant adaptation measures should be identified based on main climate risks in a region. Knowledge about the current state of the art adaptation measures is present in the farming community and policy makers in the water board are experts on regional water management measures. Also crop management experts such as extension officers and applied scientists are a valuable source of information on adaptation measures. Interaction between scientists and stakeholders is important to be able to use these sources of information (Doré et al., 2011) and to disseminate scientific knowledge.

In this paper we present a methodology that combines the strength of crop growth modelling with a semi-quantitative and participatory approach to assess impacts of gradual climate change, extreme events and pests and diseases, and that allows to develop an adaptation measure portfolio for a region for the most important crops and main climate risks. The overall aim is to prioritize adaptation and design farm level adaptation strategies for multiple scenarios using a cost-benefit analysis and a stakeholder process. Our definition of an adaptation strategy is a set of planned actions or adaptation measures that are needed for a farming system to become more robust against the adverse effects of climate change.

The methodology is applied in Flevoland, a province in The Netherlands (Fig. 1), where arable farming is the dominant land use and is one of the major drivers of the economy. Most of the farming systems are characterized by a substantial share of seed and ware potatoes in the rotation that are both high value crops. Other high value crops that are produced for the world market are seed onions and to a lesser extent sugar beet. Winter wheat is a relatively low value crop, used mainly for feed, and it is merely grown to keep disease pressures down.

2. Material and methods

The methodology is based on four complementary steps (see Fig. 2). The basis of the methodology is provided by Step 0, the scenarios. The followings steps are I: Identify climate risks and impacts, II: Create adaptation measure portfolio and III: Design an adaptation strategy for major risks and impacts considering the farm context.

2.1. Step 0: Scenarios on climate change and socio-economic development

To identify the major climate risks and impacts in Step I, climate change scenarios from the Royal Netherlands Meteorological Institute (KNMI) were used, i.e., the KNMI'06 scenarios (van den Hurk et al., 2006). We used downscaled daily weather data of weather station Eelde for the 30 year period 1976–2005 (1990) representing the historic situation, and 2036–2065 (2050) for future scenarios (Schaap et al., 2011). For weather station Lelystad in Flevoland such long time series necessary to assess frequencies of occurrence of extreme events with the Agro Climate Calendar were not available. For crop modelling a shorter time period suffices, and 1992–2008 (historic) and 2042–2058 (2050) data of weather station Lelystad were used. Two climate scenarios were selected: G+ relating to a global temperature increase of 1 °C, and W+ relating to a 2 °C increase. Both scenarios assume changes in air circulation patterns resulting in dryer summers. CO_2 concentrations of 478 μmol CO_2 mol^{-1} and 567 μmol CO_2 mol^{-1} for the W+ and G+ scenarios, respectively, were taken from the Integrated Science Assessment Model (Jain et al., 1994).

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