In the low lying area the regional company has begun to shut down very small water works and is trying to concentrate on larger water sources, developing a regional pipeline system in order to increase the safety of water quality. They have also made a study of prospective refuges into which they can move their operations which would make the water system less vulnerable to extreme events.

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4.2.5 Climate Change *and Health in The Netherlands*

Country: Netherlands
Sector:
Scale: National
Organisation: Public
Decision-type: Strategic

Key Messages

This case study assessed the degree of uncertainty in various potential health effects of climate change in the Netherlands.

Key lessons learned were that:

- Potential health effects due to climate change were associated with large uncertainties and knowledge gaps.
- Analysing and characterising uncertainty by means of a typology combining a scale of 'Level of precision' with 'Relevance for policy' was very useful for the selection and prioritisation of robust adaptation policies.
- Recognition of uncertainty of various health effects due to climate change had implications for policy. For example, adaptation policies that focus on enhancing the health system's capability of dealing with uncertainties were most appropriate for climate related health impacts characterised by recognised ignorance.

Background

Climate change can influence public health in many, often subtle and complex ways. Some of these potential impacts are direct, such as the impact of heat waves on heat-related deaths. Others are more indirect, such as the effect of changing climates on the distribution of vectors such as specific types of mosquitoes, which affect the

Fig. 4.14 A warning of cyanobacteria for swimmers

Fig. 4.15 The oak processionary caterpillar which entered the south of the Netherlands in the 1990s and gradually spread north. A further spread and increase in population size is expected due to climate change

distribution and risk of disease outbreaks (Figs. 4.14 and 4.15). There is a colourful mix of information on the topic, ranging from qualitative discussions on plausible impacts, through lists of knowledge gaps and research needs, to detailed quantitative studies. Projections of health risks of climate change are surrounded by uncertainties, leading to difficulties in determining the policy approach.

The Netherlands Environmental Assessment Agency (PBL), being the Dutch national institute for strategic policy analysis in the field of the environment, nature and spatial planning, has recently produced the assessments "Impacts of climate

change in the Netherlands: 2012" (2012) and "Roadmap to a climate-proof Netherlands" (2009) for the Dutch government. Within these assessments it was important to account for uncertainties in a policy-relevant way and so PBL asked Utrecht University to characterise the uncertainties associated with various health effects, and to provide strategic options on how to deal with them in adaptation policy.

Process

The process carried out by the Utrecht University was as follows:

- A list of 33 potential health impacts of climate change was compiled based on existing Dutch impact assessments and international literature. These impacts were grouped into eight health themes: temperature, allergies, pests, vector-borne diseases, food/water-borne diseases, air quality, flooding/storm and UV effects.
- A questionnaire based on expert elicitation was completed. National and international experts (scientists and practitioners) were asked to indicate the level of precision with which health risks could be estimated given the present state of knowledge.
- Suggestions were made for dealing with uncertainties in climate change adaptation policy strategies.

Categories of health impacts of climate change included

- Temperature
- Allergies
- Pests
- Vector-borne diseases
- Food- and waterborne diseases
- Air quality
- Flooding and storm
- UV-related

The results of the study were used as input to PBL's impact and adaptation assessment. They were also presented at a World Health Organization (WHO) workshop on policy options for climate change and health.

Uncertainty Assessment

In the first part of the study the participating experts were asked questions to assess the 'Level of Precision' with which health risk estimates could be made given the

current state of knowledge. They were also asked to provide full backup for their scores. For example:

- Why is it possible to indicate the direction of change, but not provide a quantitative risk estimate?
- What factors prevent a more precise analysis (e.g. whether data is unavailable, or cause-effect relationships not understood)?
- What factors are available that allows a certain level of precision to be applied (e.g. whether well-established models or detailed data sets are available)?

Example of handling uncertainty: 'Level of Precision' scale

The following 'Level of Precision' scale was used to assess the degree to which health effects of climate change can be quantified:

1. Effective ignorance
2. Ambiguous sign or trend
3. Expected sign or trend
4. Order of magnitude
5. Bounds
6. Full probability density function (i.e. full quantitative risk assessment possible)

The scale provides a range from a qualitative indication i.e. whether it is good or bad for health, a rough estimate of the order of magnitude (i.e. 'hundreds of cases' of disease versus 'thousands of cases'), or a detailed risk-based assessment.

The questions covered the following categories of uncertainties:

- The climate system, e.g. heat wave frequencies and durations.
- The biological systems, e.g. the relationship between climate and insect distributions, and infection biology.
- The human systems, e.g. autonomous adaptation and responses of health systems, effectiveness of hygiene regulations, and disaster response.

The uncertainty typology or the 'Level of Precision' scale used is shown in the box 'Example of handling uncertainty'. The 'Level of Precision' question was relatively broad. Potentially, some participants could have scored health effects based on standard climate projections (e.g. the Dutch KNMI or global IPCC scenarios), while others could have assumed a broader ignorance regarding local climatic changes. Because the reasoning focused almost exclusively on uncertainties in assessing health impacts (i.e. translating a climatic change into its health impacts),

Health effects have:	Low policy-relevance	High policy-relevance
High level of precision health risk assessment	Tailored, prediction-based strategies (e.g. risk approach) Focus: low costs/efforts or co-benefits. **Example:** providing shelter for homeless people during cold spells.	Tailored, prediction-based strategies (e.g. risk approach) Consider (but critically reflect on) costly and extensive options. **Example:** financing/subsidizing air-conditioning or other (advanced) cooling systems in buildings.
Low level of precision health risk assessment	Enhance system's capability of dealing with changes, uncertainties, and surprises (e.g. resilience approach). Focus: low costs/efforts or co-benefits. **Example:** general improvement in health care including research, and regular impact & adaptation assessments.	Enhance system's capability of dealing with changes, uncertainties, and surprises (e.g. resilience approach). Consider (but critically reflect on) costly and extensive options, including precautionary options. Assess overinvestment risks and flexibility. Under which circumstances would "robust" measures be advocated and which? **Example:** changing building materials and increasing urban water and parks to reduce the impact of heat in urban areas.

Fig. 4.16 Appropriate adaptation approaches, considering uncertainty and policy-relevance of health effects (Wardekker et al. 2012)

rather than on climatic uncertainties, the scores were interpreted as 'given a climate scenario'. The individual scores, the expertise-weighted descriptive statistics, and the reasoning given for each score were assessed.

The second part of the study dealt with:

- The relevance of health effects to adaptation policy (e.g. where there are high health impacts, high societal or political salience, etc.),
- Specific uncertainties not mentioned in the reasons given for the 'Level of Precision' scores, and
- Uncertainty-robust adaptation options and strategies.

The relevance of health effects to adaptation policy was assessed by asking participants to select and rank the five effects they considered the most important, interpreting relevance in a broad way, and giving reasons for their choices. This separated the highly relevant from the less relevant effects, and highlighted the different reasons for relevance. For example: current vulnerability to the effect (heat-related mortality); large potential health and societal impacts, difficult to adapt to, and public fright factors (vector-borne diseases); and a large number of people affected and large potential economic impact (hay fever).

The implications of uncertainties for adaptation were discussed using various characteristics of policy options (e.g. costs, flexibility, encroachment, prediction versus capacity-enhancement). The results of this approach are summarised in Fig. 4.16.