Project no: 2008 11 08

Project acronym: Climate-TRAP

Project title: Climate-TRAP: Climate Change Adaption by Training, Assessment and Preparedness

Instrument: Coordination Action

Thematic Priority:

Deliverable D4: Compilation of existing guidelines, surveillance, early warning & adaptation plans

Due date of deliverable: M9
Actual submission date: M9

Start date of project: 14/4/2009 Duration: 36 Months

Organisation name of lead contractor for this deliverable: MUW

Final document

Project co-funded by the Executive Agency for Health and Consumers		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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1. Introduction

1.1 What is Climate-TRAP?

Climate-TRAP is built on a consortium of nine Institutes and Universities. Climate-TRAP will strengthen the preparedness of the Public Health Sector on the health impact due to key stressors in climate change and in relation to key European action plans and adaptation strategies. The project will be important in making the implementation of existing warning systems and plans visible. Furthermore, it will disseminate the results emerging from an inventory, analysis and compilation of these plans (in addition to already existing overviews). It will examine the content and public health policy-related outputs from projects, networks and expert groups on adaptation plans in relation to the main expected health effects due to climate change, and its related early warning systems, surveillance and monitoring systems.
The public health sector needs to be prepared for changes or shifts in population based health effects due to climate change. An additional aim of this project is to inform health care workers and/or public health authorities, particularly the emergency doctors and hospital-personnel (first responders) on how to be better equipped and prepared. This means the knowledge about health effects in the public health sector, and the capacity of public health professionals with knowledge about climate change related health effects need to increase.

<u>What kind of activities?</u>
The collection, analysis of adaptation strategies, capacity and impact assessment are the cornerstones of this project. Furthermore, Climate-TRAP will prepare pilot trainings to assist medical professionals in their preparation of dealing with climate change impacts on the health sector.
Through data collection, analysis and the development of training modules, the Climate-TRAP partners will prepare the Public Health Service for the future. The project is working for the total European region. The Climate-TRAP project was initiated by the Public Health Services Gelderland Midden in Arnhem. A consortium was formed to serve the whole of Europe.

1.2 Talking about healthcare systems

Healthcare is a multifaceted term. People care for their own health and for the health of their family members. On a more professional basis curing, treating and tending the sick, advising people on healthy behaviours and preventive measures, producing drugs etc. is performed by many differently trained experts. But all this kind of healthcare is targeted at individual persons. If a doctor, a nurse, a pharmacist serves a patient, a client; she or he would do it to the best of her or his knowledge and with all affordable and available means. This is individual healthcare. Although technology and pharmacology might change and adapt to new emerging diseases and be improved with better knowledge and technology, the principles of the interaction between individuals need not necessarily change.
Apart from this individual healthcare there is also public healthcare: less visible but none the less important and maybe even more complex than curative healthcare. Public healthcare (PH) provides the legal and administrative framework for individual healthcare by ensuring the rules, quality, prices, and often finances (e.g. through insurance schemes) for individual healthcare. This includes quality control on every level, the organisation of training of professionals (Bell, 2010) and many other tasks like planning and preparing the resources for everyday and for emergency situations. In fact only public health makes healthcare a system and not just a simple enterprise. But public health is more. Like individual health it is not static. To ensure evidence based development it needs research as well. But unlike individual health it is not so much centred on cure but more on prevention. Much more so than cure prevention is a multidisciplinary task even involving so diverse expertise as architecture, city planning, safety technology, agriculture or product design and biohazards.
In this paper we will not focus to deeply on individual health although also each individual doctor will have to react and adapt to changing requirements and environments. We will rather discuss the PH system's aspect while trying to restrict ourselves to the health part, not neglecting the many interdisciplinary links in this system.

1.3 What is meant by “climate change” in this context?

From this healthcare system's point of view “climate change” is not just a meteorological phenomenon about some global trends in statistical weather patterns. As far as health effects are concerned causes are often so deeply interlinked that it is not possible to distinguish a single cause. Therefore it is sensible to use “climate change” rather as a code of global change of which the changing climate is but just one – although important – part. A spread of disease vectors and infectious diseases in new geographical areas might be supported by rising temperatures. But changes in global trade, migration, tourism, agricultural techniques or even urbanisation will certainly also contribute to the health impacts[1] and in the end it will be impossible to state which was the most important driving force (Morris, 2010; Moore and Kempton, 2009). For healthcare the driving force is not of primary importance in order to take action. Whatever causes the change, an adaptation is warranted.

1.4 The goal of this paper

In the following, likely changes that influence health directly are discussed. All these changes are linked to climate change. But this does not mean that climate change is the only or even the main cause for the possible health effects. Effects are rarely specific. Therefore it does not make sense to adapt to each cause separately. Reports from 18 different European countries concerning their ongoing adaptation measures form the backbone of this report. These reports were delivered by local experts in the (respective) fields in answer to a questionnaire and were further enriched by face-to-face interviews and input from additional experts.

The reports of the following countries were analysed: Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden and the United Kingdom. We included additional information (extracted through literature survey and personal correspondence) from Ireland and Spain and got feedback from Turkey.

A range of stressors (Butler and Harley, 2010) is discussed. For each of them after a short introduction the relevant adaptation measures will be presented in the same order: monitoring of the stressor, monitoring of the health effects, estimation of the dose-effect association, awareness raising campaigns, education of health professionals, warning systems, and preparedness plans. Not all these measures apply for every stressor.

Public institutes in several countries produced information material on various aspects of climate change and health. Often the main reports are only available in the national language (e.g. for German: Eis et al., 2010; Umweltbundesamt, 2009; Sperk and Mücke, 2009). But mostly we tried to cite English versions of the documents.

[1] At the same time these global processes will also affect climate change and are – on the other hand – influenced by each other and climate change as well.

2. Heat stress

2.1 Climate change, heat and health

Increase in greenhouse gases in the atmosphere leads to higher average temperature on the earth surface. Mammals, including humans, are bound to keep their body temperature constant within a small temperature range. When ambient temperature is low they must reduce loss of warmth by minimising the blood flow in the outer parts of the body and by producing more heat e.g. through enhanced muscle activity. This increases the amount of calories burned, thereby leading to changes in diet and an enhanced risk of inflammatory processes in peripheral parts of the body. A higher turnover in the fatty tissues also contributes to higher levels of inflammatory markers, but pathophysiological details still warrant further research (Cheng and Su, 2010).

High ambient temperatures make it more difficult to get rid of warmth produced inside the body due to metabolic processes and muscular activities. Even with temperatures higher than body temperature a cooling effect can be achieved through evaporation of sweat but this mechanism is limited in its range and effectiveness and bears the danger of dehydration (Bouchama et al., 2007).

So both (extreme) cold and (extreme) heat are stressful and dangerous to a living body. In fact the range of optimal ambient temperature where people feel comfortable and no additional physiological effort is needed to keep the constant body temperature is rather narrow. Certainly the optimal temperature also depends on other parameters like humidity of the air, state of physical activity, wind speed, clothing and other features.

Most of these features as well as temperature in the indoor environment (and even the outdoor environment by either seeking the sun or shadow) can be influenced by humans. This enables humans to dwell in all sorts of climate conditions ranging from tropical to Arctic regions.

It seems that societies have adapted well to the average temperature of their local climate. What is a cold spell or a heat wave in a given location is not defined in absolute terms of temperature but rather relative to this average temperature (Basu and Samet, 2002; Thommen Dombois and Braun-Fahrländer, 2004; Robert Koch Institut, 2004; Paldy et al., 2005; Anderson and Bell, 2009; Kovats and Jendritzky, 2006; Armstrong et al., 2010; Hajat et al., 2010).

With a slow change in average temperature people will likely adapt to this change. This complex adaptation process involves many different mechanisms including changes in physiology (e.g. a more sufficient production of sweat), changes in clothing, in housing conditions and in life style (e.g. shift in daily activity patterns). Since these different mechanisms also differ with regard to the speed of its change it is not easy to predict how fast a change of average ambient temperature will be followed by human adaptation.

The climate changes fast in comparison to pre-industrial times, but most of the aforementioned adaptation mechanisms are likely to act even faster. So change in average temperature is likely not the most pressing concern in respect to direct health effects. While an increase in average temperature is certain, estimates of future trends in the temperature extremes are less certain, but most models predict more and more severe extreme events, and a higher variability in temperature. If this is true, climate change will bring about more heat waves and likely also more cold spells although based on new threshold definitions. So it is still under fierce debate if climate change will reduce excess winter mortality and by that sort of balancing out heat-related mortality (Honda and Ono, 2009). Currently the casualties caused by cold spells and by heat waves seem to be in the same order of magnitude (Kysely et al., 2009), at least in Central Europe and in the Netherlands (Huynen et al., 2001). Interestingly Revich and Shaposhnikov (2008) report much lower numbers from cold spells than from heat waves in Moscow, Russia. Differences could be caused by choice of threshold level.

Adaptation could simply mean that a population finds a new, better fitting optimal temperature. Also this kind of adaptation does not happen automatically but in some parts requires systematic planning. Most of these planning processes are not in the responsibility of the healthcare system but nevertheless it should have a say in them.

In some instances, e.g. concepts for building new or renovating old hospitals, the healthcare sector is directly responsible.

With an increase in extreme temperature events, this kind of adaptation solely to the change of the mean would not be sufficient. There is plentiful evidence that optimal temperature differs between different climatic regions. There is some evidence that with climate change and increasing temperatures there is even already some small shift in the optimal temperature range. It is not so clear if this ongoing process also brings about a permanent adaptation to the extremes. There is some evidence e.g. from France (Fouillet et al., 2007, 2008) or Austria (Moshammer et al., 2009) that the relative risk of mortality during recent heat waves was smaller than in previous ones, especially after the heat summer of 2003. But it is not clear if this decrease in relative risk is sustainable or only due to the death of a high percentage of highly vulnerable people in 2003. An opposite trend was reported from Spain (Miron et al., 2010), Sweden (Rocklöv et al 2009) and Hungary (Paldy and Bobvos 2008). Ongoing surveillance and studies are needed to clarify this issue. Also it should not be forgotten (as pointed out by Sherwood and Huber, 2010), that physiological adaptation to heat has very narrow limits[2].

In the context of climate-change related health effects heat-wave related effects have generally been studied most intensively. Several countries have developed Action Plans in response to heat-stress. One example of such a heat-action plan is from Macedonia that with the help of WHO and German ministry for environment also produced an English language brochure describing the plan. This brochure together with other material on climate change adaptation can be downloaded from the internet[3].

2.2. Surveillance of heat stress indicators

In all analysed countries, the weather is surveyed by national or local meteorological institutions. Data are used to get the information about the weather in general, the forecasts, heat waves (both in the near future and in retrospect) and often the UV radiation as well. The definition of a heat wave differs by country or even within a country or between different studies. Usually temperature above a certain threshold is considered, but this threshold differs by geographic area (the hotter the average climate the higher the threshold temperature) and sometimes even by time of the year (with lower thresholds earlier in the summer, e.g. in Portugal or Italy: Michelozzi et al., 2010). For “temperature” several measures are used like daily maximal temperature or (less often) minimal night time temperature to account for impact on quality of sleep and the possibility to recover from heat stress. Less often average daily temperature is used with again differing strategies how to define “average”: either the arithmetic mean between minimal and maximal temperature or the average of the temperatures at specified hours of the day (usually morning – noon – evening) or a “true” average over the whole temperature course of the day. In addition to temperature often other parameters are included: Most often humidity or dew point, either as independent factor or more often by calculating “perceived temperature”. Wind speed also can influence perceived temperature but in urban settings it is not so easy to get representative estimates of wind speed and at least for indoor temperature wind speed is less important. But also temperature measured at a monitoring station is likely only a poor proxy of personal heat stress.

Monitoring stations of temperature are operated in many places throughout Europe since many decades or even centuries. Nevertheless changes in the neighbourhoods (e.g. increasing urbanisation, changes in land cover) can lead to local changes in temperature that are not representative of the temperature change in the larger surrounding area. Much work has been put into the generation of standardised temperature profiles that allow controlling for local influences on each monitoring station by comparing the temperature trends with similar and/or neighbouring monitoring stations. This is certainly important for long-term studies on climatic trends while for the monitoring of the health effects of acute heat this standardisation is likely less important.

In addition to temperature, often also duration of the event is included in the definition of a heat wave. A single hot day is usually not considered a heat wave. For a couple of days with increasing duration of the heat stress the health effects grow worse. On the other hand already after few (2 or 3) days of heat a significant health impact of heat is observed. In fact, heat effects on mortality are very acute with an increase in daily mortality being observed usually on the same and on the following day. This is quite different from cold spells where the weekly or even longer average temperature is a better predictor of disease and mortality risk. Based on local experience several institutions have suggested definitions of a “heat wave” that is best suited for the local situation: a heat wave is always a rare event (given the local weather patterns) but nevertheless does occur from time to time.

In many countries also country specific future weather scenarios based on global climate models have been developed usually based on the IPCC scenarios and different climate models.

2.3 Surveillance of health effects

There are specific heat related diseases like heat stroke (which is a result of failing thermoregulation leading to neurological and general symptoms) and cardiovascular effects (due to dilated skin vessels

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2 Despite the uncertainty in future climate-change impacts, it is often assumed that humans would be able to adapt to any possible warming. Here we argue that heat stress imposes a robust upper limit to such adaptation. Peak heat stress, quantified by the wet-bulb temperature T(W), is surprisingly similar across diverse climates today. T(W) never exceeds 31 °C. Any exceedence of 35 °C for extended periods should induce hyperthermia in humans and other mammals, as dissipation of metabolic heat becomes impossible. While this never happens now, it would begin to occur with global-mean warming of about 7 °C, calling the habitability of some regions into question. With 11-12 °C warming, such regions would spread to encompass the majority of the human population as currently distributed. Eventual warmings of 12 °C are possible from fossil fuel burning. One implication is that recent estimates of the costs of unmitigated climate change are too low unless the range of possible warming can somehow be narrowed.

3 http://www.toplotnibranovi.mk/en/downloads/Brosura_1_ENG.pdf

and loss of water and salts), but epidemiological studies show that heat effects have a further broad effect on health with increased risk e.g. for death of nearly every cause. Patients with pre-existing respiratory illness seem to be especially at risk. Deaths from respiratory causes display the largest relative mortality risks during heat waves. But also cardiovascular deaths and even deaths due to accidents increase during hot days.

One has to consider surveillance of heat-specific health outcomes like heat stroke and collapse. But more importantly one has to focus on general health indicators that are collected routinely and give a more holistic picture. Usually mortality and hospital admissions are analysed, but also emergency room visits, calls for ambulances, and other indicators can be used. These routine data are reported by the national health institutions and collected by national statistics institutes. In some countries (France: Josseran et al., 2008, Italy: Michelozzi et al., 2010; United Kingdom: Johnson et al., 2005) there are specific surveillance systems that enable a “real-time” monitoring of time trends and so to fine-tune intervention strategies.

2.4 Calculating effect estimates

Most studies on health effects of temperature are from urban areas. Many of the APHEA[4] cities have contributed to PHEWE (Biggeri et al., 2004) and EuroHEAT (Menne and Matthies, 2009) but also apart from this European research project studies have been conducted in many countries (Hutter et al., 2007; Paldy et al., 2005; Ishigami et al., 2008; Hajat et al., 2002, 2007; Kovats et al., 2004, 2006; Diaz et al., 2002; Garssen et al., 2005, Kysely, 2004; Grize et al., 2005; Larsen, 2006; Simon et al., 2005; Gosling et al, 2007; Montero et al., 2010). Very detailed information covering many urban areas in each country comes from France (Le Tetre et al., 2006; Poumadere et al., 2005; Vandentorren et al., 2004) and Italy (Michelozzi et al., 2004). Studies not only looked at the impact of heat days and estimated a dose response-association. Some looked at changes of the dose-response estimate over time indicating effects of adaptation and the action plans. But it is not clear if the reduction in the “slope” is due to a better handling of heat episodes or just because many susceptible people have died already during a previous heat wave (e.g. in 2003). Some studies also looked at the relationship between heat-related summer deaths and the winter mortality. While a Swedish study (Rocklöv et al., 2009) and a Study from Italy (Stafoggia et al., 2009) found a reduction in the heat-wave related mortality after a severe winter with increased excess mortality this was not so evident from Austrian data (Moshammer et al., 2009).

The only identified study from a rural part of Europe comes from Austria: in the rural area of northern Upper Austria (Mühlviertel) with a rough and comparatively cold climate we found a U-shaped association between temperature and mortality with a lower “optimal” temperature than in the nearby (warmer) city of Linz (Kromp-Kolb et al., 2007 – project report in German).

Some European (O'Neill et al., 2003) Australian (Khalaj et al., 2010) and United States studies (Reid et al., 2009; English et al., 2009) have tried to define susceptible subgroups: old persons, living alone, with pre-existing diseases (mental, cardiovascular and respiratory diseases, diabetes mellitus). Being hospitalised on the upper floor of the hospital without acclimatisation devices also increased mortality risk (personal communication). This is in line with findings that (a) hospitalised persons are especially at risk (Stafoggia et al., 2006, 2009) and (b) persons living on the top floor (Semenza, 1996; Kovats, 2006; Foroni et al., 2007; Hajat et al., 2010).

Children and especially very young infants are more affected by extreme temperatures because of a higher ratio of surface to volume, immature regulatory systems, and less developed coping options. Especially infants cannot protect themselves but depend on the care of adults. In time series mortality risk of children below one year of age increase substantially especially for boys. But because infant mortality is rather low in European countries the absolute numbers are small and the relative risks have wide confidence intervals.

2.5 Awareness raising campaigns

After the 2003 heat wave, Italy and France introduced ambitious awareness raising campaigns. Campaigns are also reported from Portugal. The Danish Ministry of Climate and Energy has an information Centre for climate change adaptations. In the Netherlands there is a National Heat Plan. This plan includes material in the form of stickers, a website and a free telephone information number for the public which provides information on how to behave during episodes of heat waves. Similar materials are available from Belgium[5]. In Hungary, there are some campaigns informing the public about the right behaviour during heat periods. Apart from the national warning systems several Hungarian local

[4] APHEA stands for „ Air Pollution and Health - A European Approach“. It is a European multi-city times-series study (Katsouyanni et al., 1995)

[5] http://www.health.belgium.be/eportal/Myhealth/Risksanddiseases/Healthrisks/Ozoneandheatwaves/index.htm?fodnlang=nl

governments (Tatabánya, Kincsesbánya, XI. district of Budapest, etc.) have prepared heat and UV-alert plans since 2008 in close cooperation with the NMS (National Meteorological Service) and the Public Health Institutions. These local plans are build upon local early warning systems and summarise all the measures to be taken by the relevant public institutions, authorities.

From the other countries we either have no information or there are no well defined campaigns. How information campaigns and evaluation of campaigns could work is best seen in France and Italy, where real-time monitoring allows controlling for effectiveness of campaigns. E.g. in France they observed an increase in cases with hyponatriaemia (low blood salt level) during heat episodes and duly changed their recommendation from drinking an increased amount of water to drinking liquids in general (Pascal, 2010).

2.6 Information and education of health professionals

Health professionals are generally trained at universities and there are also postgraduate training courses offered by universities, doctors' boards, and industry. Doctors learn about heat specific diseases but as these diseases are only the "tip of the iceberg" doctors are not generally aware of the much more severe impacts of heat waves. Health professionals need to be trained to recognise persons with an increased risk so that they are able to organise help (e.g. neighbourhood aid schemes for elderly people living alone, special care for hospitalised patients with poor health, etc.). Post graduate courses in public health with a special focus on climate change and heat waves preparedness especially were reported from several countries including Slovakia (University of Trnava).

2.7 Warning systems

In most countries (including Austria, BelgiumCzech Republic, France, Germany, the Netherlands, Hungary, Sweden, Slovenia) meteorological institutes inform the general public via mass media and the health professionals are informed directly. In the Netherlands, the Public Health Services provide information to the local stakeholders such as nursery homes, organisations for the homeless, local communities, etc. In most countries, there is no complete Heat-Warning-System compared to the following countries: Italy has a very detailed warning plan overseen by the Lazio Region Department of Epidemiology (Michelozzi et al., 2010) as has Portugal. A preliminary evaluation suggests a reduction of the impact of heat on mortality, but thorough evaluation should still take place (Michelozzi et al., 2010). In Italy each city has defined its own threshold levels (based on prior epidemiological evidence) to trigger local activities that include alarms to family doctors and social workers. In many cities the plans include a list of people that are likely most affected (like elderly people living alone or mentally ill people). Neighbourhood help is organised with the help of family doctors and social workers. The United Kingdom heat-wave plan (NHS, 2004) is updated annually during a workshop in winter where the responsible local authorities come together to discuss lessons learned from the past year (personal communication Leonardi G). In the other countries under study there is no systematic approach or no information about warning systems was available. But we were informed that some countries plan to develop such systems either in the framework of the National Environment and Health Action Plan (NEHAP, e.g. Slovakia) or independently, often in collaboration with WHO Europe (e.g. Turkey).

Some more efforts are needed to evaluate the warning systems, the advices given and to find out how to better reach the persons most in need.

2.8 Preparedness plans for disasters

In Sweden the National Board for Health and Welfare started an investigation in 2010, which will be reported in April 2011 concerning action plans for heat waves. In Hungary an action plan has been elaborated[6] and put on the web in a protected area for internal use of the NPHMOS (National Public Health and Medical Officer Service) built on previously elaborated guidelines. Hungary also offers shelter for homeless people in case of heat waves and disasters[7].

We received little information from Northern European countries. Indeed Scandinavian countries (Finland and Norway) were in the past more concerned with cold spells. This is not surprising considering their typical climate. Nevertheless even in FI heat waves with increasing mortality rates are observed (Näyhä, 2008) although cold related death rates are definitely higher.

The Former Yugoslav Republic of Macedonia has developed and action plan on climate change health adaptation strategy[8], including but not being restricted to heat wave management. On the Macedonian website http://www.toplotnibranovi.mk/en/ also additional information for the general public (leaflests also translated into English) can be found.

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6 http://info.antsz.hu/down/szabalyzat/tf_utasitasok/29-2009_7M_HoSeGRIASZTaS_03v_20110712.pdf

7 http://lakossag.katasztrofavedelem.hu/

8 http://www.toplotnibranovi.mk/en/downloads/Climate_change_adaptation_strategy.pdf

3. Air quality

3.1 Climate change and air quality

Climate change and air quality are linked in several aspects (Krüger et al., 2007; Damato et al., 2010):

1 Climate change might directly influence air quality. This is especially clear for ozone (Engardt et al., 2009; Doherty et al., 2009) and secondary particles (Ebi and McGregor, 2009): Under the influence of heat and solar radiation the formation of secondary aerosol and ozone is enhanced in the presence of precursor molecules. But there are also more variable influences of weather patterns on pollutant concentrations that cannot be so easily predicted in climate models. Mixing height, inversion layers, wind speed and direction, and precipitation patterns will likely vary considerably on a spatial and temporal scale and all these have an influence on local pollutants concentration.

2 Air pollutants and greenhouse gases have often the same sources. So the two areas are linked regarding mitigation strategies.

3 Air pollutants can either act as greenhouse gases (ozone, soot) or have a cooling effect (sulphate).

4 The combined impact of heat and air pollution (especially ozone) might have an over-additive effect (WHO, 2007).

This makes it imperative to consider both topics together. Especially from the mitigation point of view looking at both environmental stressors separately is a waste of financial resources and might even lead to unwanted side-effects. Considering the reduction of pollutants in impact assessments of climate change mitigation strategies has resulted in a much more favourable cost-benefit balance of the mitigation measures (European Commission, 2010). Contrary to greenhouse-gas emissions, the emissions of many key air pollutants decreased during the last decades and reduction benefits are more local and immediate than for greenhouse gases. Therefore, with air pollution the focus is less on adaptation but on mitigation. Nevertheless care must be given that neither climate change nor mitigation as well as adaptation measures targeting climate change bear the risk of increasing air pollution again. Air quality should be considered here because of its key role in environmental health. It could serve as an example of public health responses towards environmental stressors.

3.2 Monitoring of air quality

The surveillance of air quality, including SO_2, NO_2, NO, NO_x, O_3, CO and PM_{10}, is well managed in the observed countries. European data can be accessed via AirBase (a database managed by EEA: http://air-climate.eionet.europa.eu/databases/airbase). In theory, monitoring techniques are harmonised and the kinds of monitoring stations (urban and rural background, traffic, etc.) are clearly defined. Nevertheless even the most stringent definitions allow for some freedom in the exact placing of monitoring stations. Especially near pollution sources (e.g. busy roads) a strong spatial concentration gradient is observed. So even a small difference in the position of the monitor can have substantial influence on the resulting data. Background levels are usually more homogeneous. Therefore background concentrations are better comparable and easier to interpret. But a substantial part of the (urban) population lives near pollution sources like busy roads and pure background levels are therefore not representative of population's real exposure. Also some differences exist in measurement techniques. This is especially true for data on particulate matter air pollution. Although conversion factors have been provided for the various techniques, these are not generally valid and therefore local conversion factors are applied by some agencies instead.

3.3 Surveillance of health effects

Long- and short-term air pollution exposure may lead to cardiovascular and pulmonary morbidity and mortality (WHO, 2005). The health effects of air pollution are not specific. So a broad information system on the health status of the population (best on a daily basis) is warranted. Data on mortality, hospital admissions, sick leave, school absenteeism, medication use, ambulance calls etc. are relevant. These data are reported mostly by health institutions and collected by national statistics and epidemiology institutes. Susceptible subgroups for respiratory health effects are people with existing respiratory disease, such as asthma and Chronic Obstructive Pulmonary Disease (COPD). Susceptible subgroups for cardiovascular health effects are people with underlying cardiovascular disease, and possibly also people with obesity and diabetes.

3.4 European health effect estimates

Studies on short-term effects of air pollution exposure (daily changes in air pollution) were performed in many European cities (Katsouyanni et al., 1995, 1997). Only few data from rural areas were analysed. The main reason for this is the need for a large population base to detect small effects, but to gather a large population in rural areas a large area must be considered leading to imprecise exposure estimates. The only known rural European study comes from Austria (Neuberger et al., 2004) where effects of $PM_{2.5}$ and NO_2 on hospital admissions were somewhat stronger than in Vienna, but with a broader confidence interval. Interestingly, lag time (from pollutant episode till entry into hospital) was longer in the rural area likely indicating differences in the rapid response capability of the healthcare system in the rural area.

European and international studies provide consistent effect estimates for particulate matter. NO_2 is rather seen as a proxy of near sources of incineration aerosol. Effect estimates vary across studies. There were not so many positive studies on ozone performed in Europe. But in general they indicate an adverse effect of ozone on respiratory health and mortality. In the EuroHEAT project an interaction was noted between heat and ozone: adverse impacts of heat on mortality were stronger on days with high ozone concentration (WHO, 2007). But this finding was eventually due to the use of a simple binary “heat” indicator: even within “heat”-days high ozone levels might indicate hotter days with strong direct radiation from the sun. In that case this statistical interaction would not indicate a biological interaction, but ozone would just be an indicator of “even more severe heat” (Moshammer et al., 2009).

3.5 Awareness raising campaigns

Information on current air quality is provided in most countries through websites managed by the responsible authorities. These authorities (on the national and local level) also provide information (websites, leaflets, brochures) about the health effects of air pollution and tell people how to reduce air pollution. Information differing in scientific valour and clearness are also provided by interest groups, NGOs, academia and industry. A European website linking to a range of national information platforms is http://www.knowyourairforhealth.eu/.

Several EU-funded projects have set out to communicate scientific findings on health effects of air pollution to the general public and to policy makers (Apheis, Aphekom, PINCHE, Airnet, HENVINET,...) or to health experts (CHEST) and have collected best practices for dissemination between countries and regions (PRONET).

There are some examples of campaigns targeted to specific pollution sources like in Denmark on wood stoves where information was combined with guidance and legislation.

Awareness raising campaigns could/should include: (I) Information how to reduce air pollution. In the context of climate change this should especially be linked to climate change mitigation measures. Many initiatives like sustainable mobility, better housing or modernisation of heating systems would be a win-win strategy, but some measures might not be equally beneficial in all respects. Examples are biomass for heating and energy generation. (II) Guidance on how to behave in case of high pollution episodes. This will be discussed in more detail under 3.7.

3.6 Information and education of health professionals

Environmental health training is included in most medical curricula but generally the amount of information is low and there is little connection to the everyday work of medical doctors. Most curricula include theoretical concepts (in relation to toxicology and epidemiology) but doctors do not learn how to respond to the requests of individual patients with specific diseases and who are afraid that air pollution might worsen their disease. Doctors could advise patients with respiratory disease to avoid exercise during high air pollution episodes.

In Sweden, the Netherlands, Austria and Denmark, doctors can get a special diploma in Environmental Health. Maybe similar diplomas are offered in other countries. In Belgium, the Université libre de Bruxelles offers a Master in Public Health, Focus in Environmental health[9] and the Université de Liège offers a Master in Public Heath with a Focus in Promoting Public Health and the Environment[10]. But the healthcare system and especially the general health insurances usually do not support “environmental health” activities financially.

[9] http://banssbfr.ulb.ac.be/PROD_frFR/bwkkspgr.showpage?page=ESC_PROGCAT_S_AREREQ&pname=PPROGCODE&pvalue=MA-SAPU&pname=AREA&pvalue=SAPU5E&pname=TERM&pvalue=201112&pname=ARETERM&pvalue=000000

[10] http://progcours.ulg.ac.be/cocoon/en/programmes/TUR_MMSANPU.html

3.7 Warning systems (e.g. smog alarm plans)

The Air Quality Guidelines of the EU (EP and EC, 2008) set limit values for the key pollutants (a.o. O_3, SO_2, PM_{10}, NO_2, CO). Non-compliance with short-term limit values is usually reported to the general public and often discussed in the media. Non-compliance with long-term limit values (e.g. annual averages, number of days exceeding the 50 µg/m³ limit for PM_{10}) can only be assessed in retrospect and therefore is not relevant for early warning, although likely of greater health relevance than short episodes of high exposure.

Apart from non-compliance with limit values there is the possibility of (very) high pollution episodes ("smog episodes" mostly in winter and "summer smog", indicated by high ozone levels, in summer). Most countries have legally defined warning and alert levels and the public must be informed when these levels are exceeded or when there is (meteorological) evidence that they will be exceeded in the near future. In this case a standard information is issued via the mass media. Preferably, the warnings include measures to reduce exposures and include information on which people are susceptible. For ozone, the advice to reduce physical activity outside in the afternoon and evening is reasonable. Also during high fine dust episodes (susceptible) people could be advised not to exercise too much. During episodes of high outdoor levels, Indoor levels of fine dust are also increased, because particles also penetrate indoors. In addition to warnings to the public, also ozone alerts to public health professionals are issued, e.g. in The Netherlands, Belgium, or the Czech Republic.

3.8 Action plans for smog episodes

When smog alarms are raised, the administrative authorities are required to implement short term measures to reduce pollution. Since the costs of such measures are high while the impact of short term activities on air quality and especially on health are often questionable these alarm stages are only rarely pronounced. These are purely plans to reduce further production of pollutants, but usually are not set up as preparedness plans for the healthcare sector.

4. Floods

4.1 Floods serve as an example

"Floods" here are used as an example for disasters linked to climate. Under this heading also storms, thunder storms, avalanches and maybe even fires (Yocom et al., 2010) could be summarised. There are different kinds of floods that differ in predictability, duration, spatial extend and suddenness. Coastal areas are subject to a different kind of floods compared to river basins or small alpine valleys. Although fatalities are reported due to catastrophic flooding events the number of acute deaths (e.g. from drowning) are small and so even a possible increase in number and severity of floods will not have a major impact in regards of this outcome[11]. But with floods also secondary effects should be considered: infectious diseases (Ivers and Ryan, 2006), temporary or permanent relocation of people, loss of property and related (post traumatic) stress and mental disorders (Mason et al., 2010; Carroll et al., 2009; Lalande et al., 2000), damage to infrastructure hampering and/or disrupting health services or endangering drinking water systems, and last but not least dampness and mould in houses (Barbeau et al., 2010) that affect housing quality for a prolonged time.[12]

With the global scale in mind Du et al. (2010) summarise: "The health impacts of floods are wide ranging, and depend on a number of factors. However, the health impacts of a particular flood are specific to the particular context. The immediate health impacts of floods include drowning, injuries, hypothermia, and animal bites.

Health risks also are associated with the evacuation of patients, loss of health workers, and loss of health infrastructure including essential drugs and supplies. In the medium term, infected wounds, complications of injury, poisoning, poor mental health, communicable diseases, and starvation are indirect effects of flooding. In the long-term, chronic disease, disability, poor mental health, and poverty-related diseases including malnutrition are the potential legacy."

4.2 Flood monitoring

Prediction and monitoring of floods is usually not the responsibility of the health care sector, but of hydrological services and similar bodies. But in the monitoring of sequels of floods also public health institutions are involved. This includes control of water quality after overflow of sewage systems and ascertainment of housing quality after water damage. Because requirements differ in each case standardised protocols and reporting systems are scarce. Some long term frequency monitoring is undertaken by the several specific institutes.

The European Floods Alert System (EFAS) is an early flood warning system complimentary to national and regional systems. It provides the national institutes and the European Commission with information on possible river flooding to occur within the next 3 or more days.

Since flood warning is a Member State responsibility, only archived flood warnings can be made publicly available (http://efas-is.jrc.ec.europa.eu/). The real-time warnings are made available to the national partner institutes only (http://floods.jrc.ec.europa.eu/).

Hungary has a century long history of flood warning systems. Hydrometeorological and hydrological prediction, data collection and processing has been done for a long time by the National Meteorological Service of Hungary (OMSZ), the Environmental Protection and Water Management Research Institute (VITUKI) and the National Water Monitoring Service (Hydroinfo).

On bigger watercourses, water level predictions are based on data collected from the whole area of drainage basins with the use of hydrological models.

Predictions are made one day ahead and for a longer term as well, regardless if there is a flood alert or not. Flood prediction data are available on the internet (e.g. http://www.hydroinfo.hu/hidelo.html, http://www.vizugy.hu/).

The purpose of the flow monitoring network in Iceland is to watch, measure and warn against danger from floods originating in sub-glacial volcano and geothermal systems, or melt water, heavy rain and ice blockage of river-flow. The Icelandic Meteorological Office is the responsible agency and the information is available on the Internet: http://en.vedur.is/#tab=vatnafar

[11] In Austria for example the number of annual fatalities due to avalanches is much higher than that because of floods.

[12] Also other climate-related disasters have long-reaching side-effects as bush-fires or the current fires (summer 2010) in Russia with a severe impact on air quality demonstrate clearly.

4.3 Surveillance of health effects

Some countries document victims from floods (e.g. in the Netherlands and Spain) and insurance claims and payments from floods (Norway, Norwegian Natural Perils Pool, Norsk Naturskadepool). In France epidemiological studies were performed (Fabre et al., 2004) and in Germany routine data of water quality were evaluated in relation to flooding events. In United Kingdom studies have investigated long-term health consequences of floods (Tapsell and Tunstall, 2008) and showed that results based on an ecological setting were not convincing (Leonardi, 2010).

Acute fatalities (e.g. due to drowning) are easily identified. These numbers are often reported even in the newspapers and the data are comparatively easy to extract. But the secondary health effects that are of greater importance are not so easily discerned. Not all indirect health effects are specific. Also the chaos following a severe flooding hinders exact monitoring. The people most severely affected might be dislocated to other districts or have restricted access to healthcare. So counting the patients for example with mental illness in the affected district likely would underestimate the true impact. Routine data therefore are no valid source to estimate the long-term impact of floods. More targeted research studies are warranted (Fundter et al., 2008).

Susceptible subgroups for effects of floods include the elderly, children and people with disabilities, because they may need assistance to get themselves into the emergency accommodations or into a safe area (Rowland, 2007).

4.4 Calculating effect estimates

The secondary effects of flooding are exceptionally monitored and analysed in France, in short concluding that direct deaths from floods are rare in the developed world, but secondary impacts are not negligible (Verger et al., 1999; Fabre et al., 2004). Similar studies were conducted in United Kingdom (Euripidou and Murray, 2004; Tapsell and Tunstall, 2008). Apart from that, the collected information is very poor. It can be assumed that in most of the other countries no systematic research has been performed but some evidence on the health impact can be derived from studies outside Europe (CDC, 1993; Axelrod C et al., 1994; Ginexi et al., 2000; Kunii et al., 2002; Ping et al., 2004; Tyler, 2006; Feng et al., 2007) notwithstanding the fact that impacts might differ greatly between regions according to the overall conditions.

Studies have been in Hungary done by the Disaster Management Scientific Association (e.g. http://katasztrofa.hu/publikaciok/Bene_Krisztian.pdf), the National Public Health and Medical Officer Service (ÁNTSZ) and the National Directorate General for Disaster Management (OKF). Also the secondary effects of flooding are monitored and controlled by the National Public Health and Medical Officer Service (ÁNTSZ).

4.5 Awareness raising campaigns

In flood-prone areas usually there are some activities in place to educate the population. Education may include: not to build in these areas, no living rooms on the ground floor, emergency trainings on what to do in case of a flood. The education activities complement legal measures (e.g. zoning and building rules). Emergency relief organisations like Red Cross usually train their staff for disaster events and in these training sessions often also information to the general public is included.

More detailed information came from Estonia, where the NGO Tartu Consumer Advice and Information Centre is responsible for the campaigns. They have a web page in Estonian. In Sweden (and likely in most other countries) the insurance companies inform the house owners about flooding risk. In the Netherlands many campaigns are implemented, for example, "Nederland leeft met water" (Netherlands live with water), "Risicokaart" (Risk map) and "Denk Vooruit" (Think forward).

In Hungary the awareness of the population is low, even in areas that often get flooded**.** It is the local governments' task to keep the population informed during flood preparation period.

Several countries (e.g. Czech Republic) provide real-time data on flood risk on the internet. In most countries information is available to some degree from the national meteorological services.

4.6 Information and education of health professionals

Emergency healthcare is a part of the general education of health professionals including the curricula of medical doctors but without hands-on practise and only limited time within the curricula the impact is likely not very large. During the acute event the relief organisations like Red Cross and fire brigade, sometimes supported by the army, bear the greatest burden. In these organisations also health professionals are employed and they are trained specifically for disaster events. Cooperation with the routine health care system institutions (local GPs, hospitals) could be improved. In a disaster situation often requirements

and priorities do change and hospital staff is often not well prepared for that. Health professionals should be educated on possible indirect, psychological effects.
In Hungary in case of floods the heads of healthcare institutions take part in the local flood defense committees. They have to act in accordance with the local flood defense plans and the actual situation. The preparation and training of health professionals for flood events is the duty of healthcare institutions.

4.7 Flood warnings

The ability of hydrological and meteorological services to provide timely warnings depends on the local conditions. Floods in the large river basins are often predictable days in advance as the floods rise only slowly. Heavy coastal storms can come rather surprisingly although forecast efficiency has increased in the last decades. Very local floods in narrow mountain valleys are less predictable as to their extent and location. Regarding the European Floods Alert System (EFAS) see links provided in chapter 4.2.

4.8 Preparedness plans for disasters

The national authorities responsible for disaster management differ between countries. In some countries the leading ministry is the ministry for the interior, in others the ministry of environment or the ministry of agriculture. Preparedness plans are usually prepared on a local level with strong input from and cooperation with local emergency relief organisations. In flood-prone areas teams are already familiar with the situation and necessary equipment is usually stored. Routine training events are organised that also include other actors of the healthcare system. But with climate change it is predicted that areas so far only rarely exposed to severe flooding events bear an increasingly greater risk burden. In these areas there is less familiarity with such events and cooperation between relief organisations and the routine healthcare system still needs improvements.
Less frequently, plans how to proceed after a flooding have been developed. Which rules should apply when refugees want to return to their homes? Who decides when it is safe to go back? Which infrastructure needs repair most urgently? In low lying lands along the main rivers like in Lower Austria near the Danube flooding occurs quite frequently and therefore also plans for the “time after” are available. Only recently also health experts have been involved in Lower Austria e.g. regarding guidelines for water damage and moulds and similar housing problems in the “after the flood” time.
In Hungary in the case of floods the local flood defense committee – led by the mayor – is responsible for the control of the flood situation, with the help of the *National Directorate General for Disaster Management* (OKF). Professional tasks of flood protection on state owned flood defense structures belong to the regional *Environment and Water Directorates*, while the *National Public Health and Medical Officer Service* (ÁNTSZ) is responsible for preventing the negative health impacts of floods. The ÁNTSZ gives general instructions regarding the public health conditions in case of actual floods and monitors if these instructions are fulfilled. It obligates those who take part in flood defense to get the necessary vaccination. It also monitors drinking water quality.
The legal background of flood protection in Hungary is based on several laws and regulations (Law No. LVII. of 1995 on water management, Government Regulation No. 232/1996.(XII.26.) on water damage protection, Ministerial Regulation No. 10/1997.(VII.17.) on protection from flood and inland inundation, Ministerial Regulation No. 1/1991.(K.H.V.Ért.7.) on organizational and operational rules of the national control on flood and inland inundation protection). The Ministerial Regulation No. 10/1997 contains detailed rules for the preparation of water damage protection plans, for their content, and the water defense system. The Regulation specifies the technical duties of those involved in water defense, and the levels of governance regarding the issue.
From the Republic of Macedonia a Crisis Preparedness Plan for the health care system has also been published in English[13] and it deals with a list of topics including heat waves, floods, and land-slides, but also other topics not directly linked to climate change like influenza pandemics or earthquake on a regional basis.

[13] http://www.toplotnibranovi.mk/en/downloads/Krizni_sostojbi_ENG.pdf

5. Food and water borne diseases

5.1 The links between food and climate change

From a health perspective, food and water borne diseases have much in common. But when causal and especially weather related factors are considered, the two groups of diseases are fairly different. In many foods pathogenic bacteria can multiply. Therefore the risk of food borne diseases is rather linked to food handling techniques and temperature (both ambient and process temperatures). Water can be contaminated but growth of pathogenic bacteria in water is rare (we do not consider Legionella that grow in technical water systems: Baillie, 2010). With a good drinking water infrastructure, contamination is rather the result of rare events like flooding, overflow of sewage system, breaks in the distribution systems etc. Compared to this, temperature (e.g. seasonality like with food borne diseases) is of less concern and climate change impacts can be handled by good maintenance of drinking-water infrastructure (Britton et al., 2010). For some pathogens it was even argued that lower temperatures increase their viability in water systems. It has been suggested that part of the increase in respiratory diseases (like influenza) in winter is due to the fact that viruses persist longer in cooler water (Mauckner and Soddemann, 2007). On the other hand, Vandegrift et al. (2010) argue that climate change (among other factors) might enhance the distribution of avian influenza.

Apart from local production and handling of food, where microbiological quality especially of meat, milk and eggs (and products thereof) is of concern, climate change also is likely to influence food production quality and also quantity in other continents. Even in Europe, floods or droughts could reduce the harvest in one area but a general food scarcity is not to be expected for Europe in the near future. The outlook is likely worse for parts of Africa and Asia (Janes, 2010; Galal et al., 2010). While this is primarily of concern for the people living there Europe will also be affected as we now import considerable amounts of tropical fruits and more importantly animal feed from these areas. Apart from episodes of food scarcity also quality of food from tropical areas is at risk. This will be discussed by the example of aflatoxin in chapter 6.

5.2 Surveillance of food processing techniques, bacteria in food and in the environment

In general, industry is required (EP and EC, 2002) to observe good food production practices (Hazard Analysis and Critical Control Points, HACCP-concept, Mortimore and Wallace, 1998). Regional veterinary and food control centres are responsible for the inspections and for the control of the industries. The ministry in charge of these control centres differs between countries. The responsibility lies either with the ministry of agriculture, environment, consumer protection, or health. These authorities set the legal requirements and order a sampling scheme and regular analyses of production plants, retailers, and foodstuff.

5.3 Surveillance of health effects

Food borne diseases usually have to be reported to national institutes, but there is likely a high number of infections that pass unregistered. Not all diseases lead to hospitalisation and even in hospital not all diseases are diagnosed correctly (Newell et al., 2010). So only outbreaks with a higher number of cases get thoroughly evaluated and investigated. National institutes from EU-countries and Norway report cases to the European Food Safety Agency (EFSA). EFSA, in collaboration with the European Centre for Disease Prevention and Control (ECDC), prepares an annual European report (ECDC and EFSA, 2010). They report on the incidence of certain food borne diseases and the yearly trends.

Several communicable diseases including food borne diseases are to be reported by law but the list of these diseases differ somewhat by country. So for example in Slovakia the following diseases are obligatorily reported: monitors typhoid fever and paratyphoid fever, bacillary dysentery, acute viral hepatitis A and E, cholera, acute diarrhoeal disease, campylobacteriosis, salmonellosis, staphylococcal enterotoxicosis, botulism, listeriosis, infections caused by enterohemorrhagic Escherichia Coli and enteroinvasive Escherichia Coli, rotavirus infections, norovirus infections, giardiosis, teniosis, anthrax, brucellosis and echinococcosis. Hungary for example has also a notification system in place for borreliosis (see chapter 7).

5.4 Combining data to calculate effect estimates

Generally, seasonality in food borne diseases is observed with higher frequency in summer. Therefore, there is also a high correlation between average temperature (e.g. in the preceding week) and number of cases. But it is still debated to what extent the outdoor temperature is directly relevant for diseases. Higher temperatures promote bacterial growth. Most important is the behaviour of the consumers: how do they handle the food, how long do they keep the processed food out of the fridge, etc. Some have argued that barbecue and picnic parties are a main cause of food borne diseases. These are clearly more frequent during warm and sunny weather and therefore a correlation between weather and disease number is observable. The number of cases may increase in spring and fall some days will be warm enough to cause bacterial growth. This would at least extend the season at risk. In fact with salmonellosis, due to better control and awareness raising campaigns, a downwards trend is observed in spite of increasing temperatures. Nevertheless, increasing average temperatures call for even more efforts to keep food processing and transport safe.

Genetic fingerprinting allows to link bacteria found in environmental samples (foodstuff, animals, manure, sewage and water) to bacteria found in patients. So a close causal link can be shown in specific cases between a disease outbreak and an environmental source. Also the loop can be closed from the patients back to the environment.

5.5 Educating the public

Education of the general public on the correct handling of food is done repeatedly through media campaigns, leaflets etc. Some basic education is even provided in schools. Workers in the food and hospitality industry get a more thorough training and their performance is controlled by (national) food safety agencies.

On the one hand, with increasing industrialisation of food production, food gets safer and more uniform, which makes food handling easier. On the other hand, if there are pathogenic bacteria introduced in any step of the food production process, the possible health effects can be severe because of the large amount of food affected at a single site.

5.6 Teaching health professionals

Food borne diseases are part of the general medical curriculum. The diseases are frequent enough so that medical doctors also have enough opportunity for practical training. Currently there is no need for special education but health professionals should be reminded of their obligations regarding notification of diseases.

5.7 Alarms and emergency plans

Recently Austria had a scandal with contaminated cheese (Listeria) even with casualties (ORF, 2010). In the aftermath of this episode, the ministry of health was blamed for not issuing a timely warning when there were already grounds to suspect this special cheese to be the cause of the outbreak but without final proof. The ministry argued that according to law it was not allowed to issue warnings before there was final proof. This law was meant to protect the producers (in the case of wrong suspicion) and not the consumers. As a consequence, the law was changed so that now the minister must already issue warnings and remove the suspected food from the shelves when there is only reasonable ground for suspicion. Still the information chain from the laboratories of the food safety agency to the administration and from there to the public is too slow in some instances. We have no detailed information from other countries but it is reasonable that similar rules exist everywhere in Europe. The warning is efficient in most instances although too slow for some rare severe outbreak situations.

Routine sampling of food-stuffs is likely too scarce to sufficiently detect dangers before an outbreak. After an outbreak, quick detection of the source and its removal depends on a good reporting system and high quality laboratory and epidemiology response.

6. Cancer

6.1 Several environmental pathways can lead to cancer

We selected "cancer" as an example of long term impacts of environmental stressors. Regarding climate, several pathways are possible but we mostly thought of (I) food borne carcinogens like aflatoxins (toxins from moulds, present in e.g. peanuts and grains) and (II) UV radiation. But under this topic we accepted also input on other stressors from the various country reports.

Mycotoxin (toxins from moulds) contamination of food-stuff is mostly a problem in tropical areas and so it affects mostly imported food and animal feed (but through the latter also milk and meat of local produce can be affected: Bognanno et al., 2006; Nakajima et al., 2004; Boudra et al., 2007). With increasing humidity and untimely rains this problem could increase and indeed has been found to be of great concern after extreme weather events in African and Asian countries (Ruangwises and Ruangwises, 2009; Peng and Chen, 2009; Wagacha and Muthomi, 2008; Cotty and Jaime-Garcia, 2007; Tajkarimi et al., 2007).

Links of UV-radiation to climate change are more complex (Andrady et al., 2010). With decreasing ozone levels in the stratosphere until the 1990s there was an increase in UV-radiation also in temperate latitudes, but now stratospheric ozone levels are stabilising and even on average increasing again. This led to a reduction in average UV radiation. But at the same time local and temporal fluctuation in UV radiation increased due to faster chemical reaction times in the stratosphere with higher temperature and due to more frequent weather events reaching the stratosphere (strong thunderstorms). So the incidence of so-called "ozone mini-holes" increased. At the same time more sunshine during summer in at least some parts of Europe will increase ground-level UV radiation. Longer periods of warm and sunny weather might also lead to more outdoor activity and extreme heat might encourage people to spend their holidays at higher altitudes. The latter behavioural effects should be influenced by awareness raising and education. But a higher fluctuation of UV radiation makes preparedness and adaptation measures more challenging.

Apart from cancer, UV radiation evidently has also other negative health effects including damage to the eyes (cataract) and to the skin (sunburns, enhanced aging). Effects on the immune system and on the viability of microbes render effects on infectious diseases complex.

6.2 Surveillance of stressors

Of the many carcinogenic agents UV radiation serves as an example for successful behavioural prevention measures. Informing the public is more successful when underpinned by timely exposure data. Especially in mountainous areas like the Alps a high spatial variability is observed with UV radiation. Therefore Austria maintains a UV monitoring system with broad coverage over many regions and altitudes. Similar models exist in other countries like Denmark, France, Germany and Sweden. Based on monitoring data a daily UV-index is calculated.

Food contaminants including carcinogenic substances (like aflatoxins, but also other substances with no close relation to climate change) are monitored by the food safety or health agencies in the countries investigated.

6.3 Cancer surveillance

Most of the countries under study have cancer registries. Cancer notification is obligatory for medical doctors, pathological institutes and hospitals. But completeness of cancer registries differ by region and cancer type. Among the skin cancers only completeness of melanoma can be assessed by cross-checking with mortality data because it is the only skin cancer with high mortality rate. Cancer registry data are reported on an annual basis in most countries. Crude and age-standardised trends can already be seen from these annual reports. Usually there is a reporting delay of more than one year in most countries. Data from the latest years are often not complete because cancer incidence data usually are updated later on with additional information from mortality data bases. The International Association of Cancer Registries can assist in harmonisation and support of cancer registries.

Susceptible subgroups for skin cancer are people with light skin. The risk of aflatoxins may be bigger in malnutritioned people, and subjects with Hepatitis B infections.

6.4 Cancer trends linked to environmental stressors

In Austria there was an ecologic study on melanoma incidence by altitude (on the district level). Melanoma incidence increased over time and is higher in the mountainous areas and in urban areas of Austria (Moshammer and Kundi, 2009; Simic et al, 2008) than in rural areas of the Austrian lowlands. We got reports about similar incidence rates from Denmark, Spain, France and Hungary without any details regarding geographical variation.

Cancers caused by mycotoxins are likely not a large problem yet in Europe (although other contaminants in food not linked to climate stressors might contribute to the general cancer incidence). While in tropical countries liver cancer is related to aflatoxin exposure (and viral hepatitis as well, Liu and Wu, 2010), in Europe liver cancer is not so frequent and either caused by hepatitis or cirrhosis due to alcohol. In connection with the global climate changes, however, one has to take into consideration the importation and spread of "high aflatoxin producer strains" of fungi which might appear in dried red pepper and other food stocks and additives.

6.5 Awareness raising campaigns on UV protection, and food hygiene

Some awareness raising campaigns regarding personal UV protection are performed in each country. National institutions but also NGOs like national cancer leagues contribute. The information provided includes right clothing (e.g. material and long sleeves), sunscreen use for outdoor activities, discouraging of spending too much time outside on the middle of the day, and sometimes also consider solarium use. Some countries implemented laws regarding prohibition of solarium use for adolescents, e.g. Austria only recently (BGBl. II Nr. 106/2010) following a similar example from Germany. Hungary prepared guidelines and action plans and invented new ways to inform the public, e.g. publishing UV Radiation status in the underground stations.

There is also increased attention to occupational UV exposure, e.g. of construction workers, including information campaigns, provision of sunscreens etc.

Mycotoxins are still a problem of food production and storage in tropical areas, less so in European countries, so education of the European public is of less value. Strict control of imported goods is more effective.

6.6 Information and education of health professionals

Cancer related to these stressors is usually included in the general medical education. But doctors need to be reminded of their obligations to the cancer registries.

6.7 Early warning systems (regarding UV levels)

UV monitoring and forecasts feed into web-based information on current (or even next day) UV indexes. Those indexes come with specific advices on acceptable duration of sun exposure per skin type. In Ireland UV index now is even distributed via iPhone.

Accessibility and clarity of the websites vary between countries. There is still room for improvements especially regarding the link between these websites and more general campaigns. The internet is not used by all population groups. Especially elderly people still require other media. In some countries UV index forecasts are included in the daily weather forecasts on TV. Although current UV levels and short-term forecasts can be found on the websites of most national meteorological institutes this information is not very much publicised in most countries. Sunshine is usually only regarded as sign of "good" and "splendid" weather.

6.8 Disaster plans are not applicable

Cancer is a disease with long latency period. Environmental factors usually do not cause cancer after short high exposures but are rather acting slowly through long term low level exposure. Therefore disaster plans are not applicable in that case.

7. Vector borne diseases

7.1 Introduction

In this chapter we talk only about vector borne diseases that are already endemic in Europe and not about tropical diseases. Tropical diseases are also often vector borne diseases but they require different strategies by the healthcare systems (see chapter 8).
Disease vectors in the broader sense are animals that disseminate infectious diseases. Most of these vectors are arthropods (insects, ticks) but also some rodents serve as disease vectors. (Some definitions only include the arthropod vectors while diseases disseminated by mammals are not called “vector borne” but “anthropozoonoses”. In discussing climate effects this distinction is not helpful.) Climate change can affect the spatial distribution of disease vectors and can affect their life cycles thus leading to higher numbers or to earlier abundance in the year. Also viruses and bacteria can be affected by the temperature. This is especially true for arthropod borne pathogens because the body temperature of the arthropods and their activity patterns are strongly influenced by the ambient temperature (Bale and Hayward, 2010; Tabachnick, 2010). In addition to this the replication of viruses and protozoa in the tissues of arthropods require ambient temperature of about 20°C. The same virus-carrier arthropods will develop and survive, but will not infect mammals at lower temperatures (Paldy and Berencsi, 2009).
Not surprisingly, in retrospect seasonal trends of these diseases are evident and certain years with outstanding weather patterns (e.g. rainy spring, hot summer, etc.) were linked with an enhanced disease incidence. But disease frequency is influenced by many external causes. Preventive measures of the health care system like vaccination programmes are part of these causes. Pesticide application, changes in agricultural practices, changes in forestry and in behavioural patterns (e.g. recreational activities in the woods or near lakes) conceivably have much stronger impact than climate change. Nevertheless there are changing trends in the incidences of many vector borne diseases. The healthcare system must be aware of these trends and prepare for them no matter to which extend these changes are linked to climate change only and in spite of the fact that prediction accuracy is still poor (Rosenthal, 2010).
Non-arthropod-transmitted infectious diseases might also be affected by climate change. This is especially the case for zoonotic diseases that are therefore included in this chapter (applying a broader definition of vectors). But in general, climate change impact on these diseases is less obvious and often still under debate. So for example Dearing and Dizney (2010) argue that rather changing land-use patterns and not climate change are responsible for a spread in Hantavirus (rodent borne) infections, which seem to be heterogeneous in Central-Eastern Europe (Plusnina et al. 2009). Much can be learned about zoonotic diseases by looking at veterinary diseases. As diseases in wild animals are less influenced by direct anthropogenic influences they are more suitable to study climate change effects (e.g. Laaksonen et al., 2010, for philariasis (spread by worms) in reindeer, or Maclachlan and Guthrie, 2010, and Maclachlan, 2010, for blue tongue virus, spread by insects and mostly prevalent in sheep, and others).
It is difficult to decide whether Chikungunya (spread by mosquitoes) should be listed under “vector-borne diseases” or “tropical diseases”. The arthropod vector, the Japanese tiger mosquito is certainly not from Europe originally, but also not from a tropical country. In fact it was introduced by global trade first in the United States and later also in Europe. The virus also likely came by trade routes and has made its first appearance in Europe in Italy (Venturelli et al., 2008). Climate change is likely not the sole or most important driver of the spread of this disease, but climate stress on existing ecosystems might support immigrating species in their establishment.

7.2 Surveillance of vectors and infectious agents

We are not aware of any systematic surveillance of disease vectors. We received reports of isolated surveillance programmes in the course of research projects. These programmes were of limited spatial and temporal scope but yielded interesting results, for example regarding the spread of ticks to higher altitudes in Middle Europe or farther north in Scandinavia. Some projects not only collected ticks but also analysed them regarding virus carrier status. In Austria a project collected rabbits and analysed prevalence of tularaemia (spread by ticks and dear flies). A similar project was reported from Germany. in Belgium the project MODIRISK[14] inventories endemic and invading mosquito species.
Some countries investigated the spread of the sand flies (causing leishmaniasis) which was endemic in the Mediterranean but is now also found in some areas in Germany and Austria. So it is only a question of time until the first endemic cases of leishmaniasis will be reported from Middle Europe.

[14] http://www.modirisk.be/

West-Nile virus is transferred by the common European mosquito which would likely increase in abundance and have an earlier start with warmer winters (Reisen et al., 2010) but also other climate parameters like humidity are important (Ruiz et al., 2010; Wang et al., 2010). European mosquitoes are so wide-spread and most of the mosquitoes in Europe are still not infected so monitoring of the mosquito alone makes no sense. In Austria and Hungary West-Nile virus in (dead) birds and horses was monitored and the spread of two lineages was demonstrated (Bakonyi et al. 2006) before the first human cases were observed (Krisztalovics et al. 2008).
In Lithuania bloodsucking arthropods are monitored on the local level by the territorial public health centres, which collect and analyze monitoring data of ticks and mosquitoes. They provide relevant information for interested institutions and publish some data in the media. The data are centrally collected and analysed by the Centre of Communicable Diseases and AIDS.

7.3 Surveillance of health effects

In addition to obligatory reporting of some diseases, even more diseases are monitored by the institutes of virology. To estimate the prevalence of infections without sufficient clinical symptoms for detection also selected population groups are screened (e.g. hunters and foresters for tick-borne encephalitis (TBE), e.g. in Austria). European wide monitoring of tick-borne encephalitis was part of the European project EDEN (CORDIS, 2010). Detailed studies on tick-borne diseases (Lyme disease, TBE) have been reported from Hungary and from the Czech Republic.

7.4 Estimating trends

We are interested in spatial and temporal trends of these diseases to link these trends to weather parameters. This is of interest both on a short and a longer time-scale: special weather events like floods or early warmth in spring can affect mosquito abundance in the near future (weeks, months) and thus influence short-term disease incidence. It is not so easy to link long-term trends to climate change and to provide reliable predictions for the coming decades. The links between environment, cultural and societal behaviour, technological achievements and disease incidence are too complex and manifold for simple linear associations. Some trends have been observed (e.g. increasing trends for tick-borne encephalitis in the Baltic and some Eastern European states) but scientists question the relevance of climate change for these trends (Randolph, 2010). For example in Central Europe (Austria and neighbouring countries) data indicate a spread of tick-borne encephalitis to higher altitudes (Lukan et al., 2010). But most of the disease still occurs in the lowlands and disease incidence is more influenced by vaccination status than by geographical spread of infected ticks. Also in Scandinavia a spatial spread of ticks, infected ticks and disease was observed. But this spread was not much related to climate change as there was no pronounced spread to the north. So changes in land-use patterns are likely the more important cause of the spread in tick-borne encephalitis. The same was shown in Italy with changes in forestry while in Eastern European states most of the increase in disease incidence is attributed to societal changes (e.g. changes in recreation).
There are only few data on other vector borne diseases like on tularaemia in Sweden (Ryden et al., 2009) or in Austria (Deutz and Guggenberger, 2006). In Hungary tularaemia is amongst the etiologic agents reported weekly to the NPHMOS (National Public Health and Medical Officer Service).

7.5 Awareness raising campaigns

There are some campaigns (partly industry funded) regarding vaccination against tick-borne encephalitis in some Middle European countries. In the Netherlands there are leaflets informing people about Lyme disease (also spread by ticks) and possible prevention measures.

7.6 Information and education of health professionals

Frequent vector borne diseases are included in the general medical curricula. But with a spatial spread of diseases, doctors might get confronted with a disease they have never seen before. This situation calls for some targeted post graduate training. The Norwegian Surveillance System for Communicable Diseases (MSIS) publishes surveillance data in the internet and reports of specific diseases and increasing numbers in the internet. www.msis.no, www.fhi.no. The Norwegian Institute of Public Health (NIPH) provides information and education of health professionals.

7.7 No need for early warning systems or emergency plans

Awareness raising (e.g. regarding ticks, mosquitoes) can be linked to a timely information on vector prevalence (e.g. on the internet). But apart from that there seems no need for early warning systems or emergency plans with endemic vector borne diseases.

7.8 Action plans

The Former Yugoslav Republic of Macedonia has developed a manual for health workers regarding climate change and communicable diseases[15].

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15 http://www.toplotnibranovi.mk/en/downloads/Climate_change_communicable_deseases.pdf

8. Tropical diseases

8.1 Introduction

Tropical diseases are not yet endemic in Europe. But for some tropical diseases ecological conditions for the specific disease vectors already allow immigration and in some cases the disease vectors are already present in some areas in Europe (e.g. sand flies, causing leishmaniasis, in the German Rhine valley and in Southern Europe). This is not only but also due to climate change. Global trade has contributed to the introduction of alien species and tourism and global trade can serve as a vector to also introduce the pathogens that then already find a host reservoir present in Europe. So even malaria could be introduced in Europe and in fact it has been present in Europe in former times. But in an efficient health care system, persons with high fever are frequently isolated and cared for. Since humans are obligatory hosts of malaria parasites, this makes a dangerous spread of malaria unlikely in Europe even where the mosquitoes spreading malaria are present. It was also argued that large animal stocks prevent from malaria transmissions because most mosquitoes will suck on animals and only rarely will a mosquito first suck at a diseased person and then a second time at a healthy person. But this would be necessary to transmit the disease (Lindsay et al., 2010).

Less spectacular tropical diseases (like leishmaniasis: Ready, 2010; Morillas-Márquez et al., 2010; Galvez et al., 2010; Gonzalez et al, 2010) are more likely to spread in Europe (and North America) when first symptoms are overlooked because medical doctors are not well trained in the diagnoses.

Nevertheless, tropical diseases (also regarding climate change impact) are still of much higher relevance in tropical countries (Weaver et al., 2010; Mills et al., 2010; Aluwong and Bello, 2010; Tonnang et al., 2010; Tanga et al., 2010; Majra and Gur, 2009; Dhiman et al., 2009; Bomblies and Eltahir, 2009; Hii et al., 2009; Bambrick et al., 2009; Martin et al., 2008; Naidoo and Patric, 2002) but even in tropical areas public health measures have likely a much stronger impact e.g. on malaria incidence than climate change (Gething et al., 2010; Chaves and Koenraadt, 2010). It should be noted that – depending on local circumstances – climate change can also reduce malaria incidence (Parham and Michael, 2010). Even when a rise in temperature is associated with increased risks of some tropical diseases (like dengue), raised temperatures not necessarily lead to increases in risks, because of adaptations in human behaviour (Padmanabha et al., 2010)[16]. The repeated importation of Flaviviruses (including West-Nile virus, dengue virus, tick-borne encephalitis virus) increases the probability of hospital infections (Nemes et al. 2004) and double infections actually of increased clinical severity (Ferenczi et al. 2008). The recently imported African usutu flavivirus has not been detected in human beings yet (Bakonyi et al. 2007).

8.2 Surveillance of stressors

In Austria and other countries some research projects were performed that studied the spatial and temporal distribution of sand flies, tiger mosquitoes, and other alien species. In Germany a research project was conducted that studied the serology of dogs for leishmania. Some more research is being conducted on agricultural pests and these sometimes also inform about arthropods relevant for human health. In the United Kingdom a monitoring programme of mosquitoes is in place. EDEN (Emerging Diseases in a changing European eNvironment) is an Integrated Project of the European Commission (FP6) that aims to identify and catalogue those European ecosystems and environmental conditions which can influence the spatial and temporal distribution and dynamics of human pathogenic agents. The project (http://www.eden-fp6project.net/) develops and co-coordinates a set of generic methods, tools and skills such as predictive models, early warning and monitoring tools which can be used by decision makers for risk assessment, decision support for intervention and public health policies.

8.3 Surveillance of health effects

In most countries reporting of 'spectacular' tropical diseases like malaria is mandatory. In Denmark, analysis of tropical diseases is done by the Statens Serum Institute (SSI), for example the number of cases per year. In Spain, the National Health Board and Statistic Estonia are responsible. In Sweden, the Swedish Institute for Infectious Disease Control reports on communicable and tropical disease rates.

[16] The paper studied Aedes aegypti larval ecology that in Colombia and found that they dwell in water storage tanks. Human behavioural patterns of water use and as a consequence refilling frequency of the tanks were influenced by ambient temperature.

8.4 No health effect estimates for Europe

As tropical diseases still pose rare events (and most cases are still imported cases when tourists return home) such work would be premature.

8.5 Awareness raising campaigns

These mainly regard tourism to tropical countries. In Sweden, some campaigns are mentioned in a report from the National Board for Health and Welfare. In Austria and Germany, as most likely in the other countries as well, counselling is provided for travellers and tourists through service lines, leaflets and public institutions. Norway and Hungary reported web-based information tools as well.

8.6 Information and education of health professionals

In Norway the NIPH organizes courses for health professionals. Countries with former colonies (United Kingdom, France, Belgium, and The Netherlands) usually have more and long standing experience with tropical diseases and have large special institutes focussing on this subject. But even in small countries like Austria and Hungary a few specialists and university institutes for tropical diseases exist. Tropical diseases are usually a part of the general education of health professionals.

8.7 Early warning systems

WHO maintains an information system and issues warnings and updates on global trends with country reports. These reports also include information on drug resistance and other related issues.

8.8 Preparedness plans for outbreaks and imported cases

We got only information from Austria, the Netherlands and Germany. They have high security wards (quarantine wards) for infected people. We assume that the same is true for the other countries. Health professionals are employed at major airports to screen for incoming cases.

9. Atopic diseases

9.1 Rationale

Cecchi L et al. (2010) state in their abstract: “Climate change has already had an impact on living organisms, including plants and fungi with current scenarios projecting further effects by the end of the century. Over the last three decades, studies have shown changes in production, dispersion and allergen content of pollen and spores, which may be region- and species-specific. In addition, these changes may have been influenced by urban air pollutants interacting directly with pollen.

Data suggest an increasing effect of aeroallergens on allergic patients over this period, which may also imply a greater likelihood of the development of an allergic respiratory disease in sensitized subjects and exacerbation of symptomatic patients. There are a number of limitations that make predictions uncertain, and further and specifically designed studies are needed to clarify current effects and future scenarios.“

Ariano et al (2010) summarize: “Progressive climate changes, with increased temperatures, may modify the global pollen load and affect the rate of allergic sensitization across long periods“.

Schweiger et al (2010) add: “Two key drivers of anthropogenic environmental change, climate change and the introduction of alien species, affect plant-pollinator interactions. Both climate change and alien species will ultimately lead to the creation of novel communities. In these communities certain interactions may no longer occur while there will also be potential for the emergence of new relationships. Alien species can both partly compensate for the often negative effects of climate change but also amplify them in some cases. Since potential positive effects are often restricted to generalist interactions among species, climate change and alien species in combination can result in significant threats to more specialist interactions involving native species.“

Climate change has an impact on pollen counts and composition as well as on timing of pollen seasons. But the impact will vary strongly between areas. Apart from pollen there is concern about house dust mites in areas that are now yet too cold (high altitudes, Scandinavia) although housing conditions (heating, air exchange and humidity) likely do have a stronger impact. Moulds and other (bacterial) indoor bio contaminants are also to be considered.

9.2 Surveillance of stressors

In Estonia, there is a Pollen Monitoring Programme at Tallin University in the Institute of Gerontology and the Institute of Ecology. In Germany, the DWD and the “Polleninformationsdienst” (Pollen Information Service) are responsible for monitoring. The latter is a network with monitoring stations and partners also in other German speaking countries like Austria. In Hungary, there are 18 measuring stations and the National Institute of Pulmonology and Tuberculosis and the National Public Health and Medical Office are responsible for the results. The air quality and the amount of pollen in the air are measured indoor and outdoor. In Sweden, during the Pollen season, Astra Zeneca and the Museum of National History give a daily pollen forecast. The Belgian pollen and spore monitoring network[17] provides rapid information about these allergens to practitioners, pharmaceutical companies and allergic sufferers. Pollen monitoring is performed also in other countries like e.g. Lithuania either by public institutes or by university institutes.
Of special concern is the emergence of new plants with highly allergenic pollen. The most important example is ragweed (Ambrosia) (Kaminski et al., 2010; Alberternst et al., 2010; Behrendt et al., 2010). This plant originates from America but it is already firmly established in Hungary and Balkan countries, in parts of Italy and Southern France. Warm dry summers are beneficial for its spread but more important are local conditions like the dry and sandy grounds beside motor ways, on airports, near industrial sites etc. Along the main motorways but also introduced through contaminated seeds (e.g. for feeding birds) this plant is now found in many parts of Middle Europe although pollen counts e.g. in Germany are still rather influenced by long distance transport from the Rhone valley. Ragweed is also prevalent in the Netherlands to some extent, but it’s not considered a huge health threat yet.
Pollen are monitored from 15 April until 30 September in Reykjavik and Akureyri by the Icelandic Institute of Natural History in collaboration with the Icelandic Meteorological Office. The information is made available by televised teletext (http://www.textavarp.is/193/2.html) and in annual reports.

[17] http://airallergy.wiv-isp.be/sites/airallergy/index.htm

9.3 Surveillance of health effects

In Sweden, the National Board of Health and Welfare gives reports on health status in Public Health Reports. In Germany, there are only some local activities, for example for schoolchildren. In Austria, there is no general surveillance of atopic status, but some studies (e.g. in the ISAAC framework) exist. The regular health interview survey also asks about allergic diseases but this survey does not include children.

In Germany (Baden-Württemberg) they performed an extended study on allergenic status of children especially linked to ragweed (Gabrio et al., 2010). In atopic children sensitization towards ragweed is already prevalent but it is not clear to what extent this is already relevant for disease. But it is expected that with the spread of the plant in Southern Germany symptoms frequency will increase. Since the plant pollinates relatively late in the year (August, September) this also means that the symptomatic season is prolonged for the affected patients.

9.4 Combining data to calculate effect estimates

In Hungary a nation-wide questionnaire survey was performed in 2005 and repeated in 2010. In this survey, pollen, the prevalence of Asthma, Allergies and other chronically lung diseases were analysed for Children between the age of 9 to 11. In Sweden, there are some estimates in a report from the National Board for Health and Welfare.

Recently the problem of the transplacental transmission of nanoparticles have been discovered. Certain size classes of air pollutants fall into the nanoparticles which may pass the maternal-feltal barrier (Saunders 2009; Wicks et al. 2010) therefore extended research is needed to clarify atopic fetal consequences of the findings.

9.5 Awareness raising campaigns

In Estonia, there is a campaign from the Estonian Union of Allergists, “How to cope with Allergies?” In Germany, the Stiftung Deutscher Polleninformationsdienst is responsible for the campaigns. In Hungary, there are some courses and the public can ask for further information directly at the National Institute of Public Health.

9.6 Information and education of health professionals

In Hungary, there are some courses and the public can ask for further information directly at the Institute, moreover, there is some additional information in the internet. Usually the information and education of health professionals is a part of the general medical curriculum.

9.7 Early warning systems (pollen information services)

In Austria, Czech Republic, Germany, Hungary, the Netherlands and Sweden pollen forecast services exist. Eradication plans for ragweed are tested in Baden-Württemberg. Ireland recently launched pollen forecasts / warnings via iPhone. During the hay fever season (= allergy to grass pollen, from May 15 to July 15) in Belgium, information is given out by the monitoring network to the media through the press agency Belga.

9.8 No need for disaster plans

Disaster plans are not applicable. But some countries have special plans in place to fight new invading and highly allergic plants like ragweed or have guidelines for spas regarding planting of trees with high allergic potential like birches.

9.9 Additional aspects

In the EU project Henvinet house dust mites were also considered as a potential health threat that might be augmented by climate change. This is not so obvious in areas where house dust mites are already prevalent now. Better insulation and heating of sleeping rooms in winter were more important for the spread of house dust mites in these more temperate climates than the outdoor climate. But with changing weather patterns house dust mites might also increase in areas that were too cold for them previously (e.g. alpine areas, Scandinavia).

Sensitization towards house dust mites is routinely assessed in clinical and population based studies. So there is sufficient data material on the prevalence of sensitization. Studies have been performed on the effectiveness of measures to reduce house dust mites contact in symptomatic children (neurodermatitis, hay fever) and regarding prevention in high risk children, but the results are conflicting. We are not aware of any studies linking climate change with house dust mites' prevalence.

10. Other stressors and susceptibility factors

Under this chapter we allowed for a range of other possible stressors and also asked for specific susceptibility factors regarded and monitored in each country. In a brain-storming attempt we came up with a series of other possible health risks probably associated with climate conditions. They might not be relevant everywhere in Europe and this list is certainly far from complete. In our questionnaire three examples were mentioned.

10.1 Toxic algal blooms

Toxic algal blooms (both in fresh and in sea water) depend not only on water temperature but also on eutrophication and other factors. Nevertheless water temperature is an important influencing factor. “The increased risks to humans of shellfish toxicity from the prevalence of harmful algal blooms may be a consequence of large-scale ecological changes from anthropogenic activities, especially increased eutrophication, marine transport and aquaculture, and global climate change.” (James et al., 2010).
The Icelandic Food and Veterinary Authority monitors toxic algal blooms in collaboration with the Marine Research Institute. The information is continually updated and made available on the internet[18].

10.2 Processionary caterpillars

The toxic hairs of processionary caterpillars (thaumetopoea processionea) are just one example of a biogenic agent (neither fitting infectious disease nor allergens) and its abundance might be influenced by changes in climatic conditions. These caterpillars are present in central and southern Europe, but are moving up North, possibly due to climate change, even up to Sweden.
The German UBA presented a very detailed overview on German activities regarding processionary caterpillars. The management lies with local (“Länder” and municipalities) institutions. A similar approach has been taken by the Netherlands and Bulgaria. Some do report increasing trends and especially a spatial spread of the problem. In Austria local governmental agencies for forestry and gardens are responsible for monitoring. In case of an infestation in populated areas they consult with the local health authorities regarding management.

10.3 Swimmer's itch

Also swimmers' itch is a reaction of the skin after infection with waterborne parasites. It might be influenced by climate change. It mostly depends on the availability of lakes used by swimmers that also are home to the parasites and their hosts, i.e. snails and ducks. But water temperature above a certain temperature is also necessary for the normal parasitic host cycle. In fact the optimal temperature for the water snails has a rather small range. So while in some areas swimmers' itch might increase in prevalence with increasing temperature (and in fact is now only seen during exceptionally warm summers) in other areas water temperatures might get too hot already for this nuisance disease. Experts from Austria reported they did not see a clear trend so far. But Austria has no coherent monitoring system but only singular research projects have been conducted.

10.4 Other topics

It was suggested that indoor air quality might be an issue. Cooling systems and better ventilation could improve indoor air quality but with poor maintenance of the systems also problems might arise.

10.5 Susceptible groups

Who might be susceptible to climate change depends on the stressor under study. But often older people, very young children, socio-economically disadvantaged and chronically ill people are at higher risk. Illness both includes mental and physical diseases. Very few studies (Ramin and Svoboda, 2009) have considered the homeless especially. They are a really very exposed group combining illness, poverty and lack of protective resources. They are difficult to reach both regarding scientific investigation and adaptation measures. We only learned from Hungary that special measures are in place for the homeless (in case of heat waves). An analysis of vulnerable population groups in Macedonia was prepared by Vladimir Kendrovski[19].

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[18] http://www.hafro.is/voktun/ and http://www.mast.is/eftirlitsnidurstodur/skelfiskur

[19] http://unfccc.org.mk/documents/vuln%20report%20Health.pdf

10.6 Adaptation plans

Many countries now follow the lead of the European Commission by preparing national climate change adaptation plans. Adaptation plans often are in the national language only and tend to cover many fields. Health effects are often considered only in a minor chapter and are often only seen as a result of climate change and of adaptation measures in other fields while adaptation measures within the healthcare system are not discussed in detail.

Austria has recently included the healthcare system in its policy paper[20] that prepares for a national adaptation strategy. Also the Spanish adaptation strategy can be found on the web[21]. But these are certainly only some of several examples as more adaptation plans are being developed in Europe.

[20] http://www.lebensministerium.at/filemanager/download/68173/

[21] http://www.marm.es/es/cambio-climatico/temas/impactos-vulnerabilidad-y-adaptacion/pnacc_ing_tcm7-12473.pdf

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