Climate-TRAP

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Introduction

The objective of Climate Trap is to analyse the combined data of the compiled plans/guidelines and the results of the impact assessment (Forsberg 2012,Moshammer 2011). The applied climate change adaptations, plans, strategies, guidelines, tools, across countries, together with the impact assessment results were streamlined and harmonised in an integrated manner. This compilation of available systems (on surveillance/monitoring) in the various health sectors in Europe and the results of the impact assessments were brought together. The systems were linked to climate change adaptation strategies. The validity, the practical implementation and the barriers of the collected systems were evaluated.

The assessments were conducted for different health effects expected from climate change as well as across different spatial and time scales. The system design builds upon previous experience in similar related projects, applying state-of-the-art techniques in distributed systems development, model applications, database applications and networking (Zuurbier 2007). The parameters derived from the scenario assessment were used for initial assessments of policy alternatives.

Role of the health care sector

The public health sector needs to be prepared for changes or shifts in population based health effects due to climate change (Costello 2009,Frumkin 2008,Frumkin 2008). It is necessary to prepare for national, regional and community based adaptation, engaging proactively stakeholders (Ebi 2008). An additional aim of this project is to inform health care workers and/or public health authorities, in particular 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. Furthermore, the technical support and preparedness of the health sector needs to be upgraded according to a long term impact assessment of climate change effects on population level. Adaptation strategies, capacity and impact assessment and training are the keywords in this project (Costello 2009, World Health Organization 2004, World Health Organization 2010).

Heat

Health Effects

There are specific heat related diseases such as heat stroke. However, deaths from respiratory causes display the largest relative mortality seconded by cardiovascular deaths. A minor fraction of deaths are directly related to heat.

There are specific risk groups for heat related health effects (D'Ippoliti 2010,Donaldson 2004,Ebi 2010,Johnson 2005,Josseran 2009,Pascal 2010,Vandentorren 2006):

- People over 65 years of age, living on their own, or in a care home;
- People suffering from mental disorders, e.g. those with dementia; or with chronic neurological diseases, e.g. Parkinson disease;
- People, including chronically ill children, with chronic respiratory disorders;
- People, including chronically ill children, with chronic cardiovascular disorders;
- People who rely on help from other people to manage day-to-day activities including babies and small children; and/or are bedbound;
- Non-legal drug users, workers in jobs with elevated environmental temperatures in everyday work – heavy metal industry, construction, glass factories;
- People who live socially isolated;
- People living on the top floor under the roof, or in (old) buildings with poor ventilation or insulation.

Expected Impact

Excess deaths are not just deaths of those who would have died anyway in the next few weeks or months due to illness or old age. There is strong evidence that these summer deaths are indeed 'extra' and are the result of heat-related conditions.

In the European PHEWE Study, including 15 cities, the relative increase in mortality per 1°C increase in temperature ranged from 0 to 5.5% (Baccini 2008). The effect on hospital admissions in 12 cities in the PHEWE Study was limited to respiratory related admissions. For a 1°C increase above the threshold, respiratory admissions increased by 3.1% in the 75+ age group in North- Continental cities (Michelozzi 2009) .

The climatic data in this project (Forsberg 2012) were obtained from the SMHI (Swedish Metrological and Hydrological Institute) for the MATCH-RCA3-ECHAM4 climate model (based on the A1B SRES scenario) and MATCH-RCA3-HADLEY model (based on the A2 SRES scenario). The data consisted of daily maximum temperature and daily mean of relative humidity for the time period 1961-2050. The baseline period is defined as the years 1961 to 1990.

Population data for the year 2000 for Europe were collected from the HYDE theme within the Netherlands Environmental Assessment Agency (Klein Goldewijk 2011). Mortality and hospitalization data were collected from the WHO European health for the years 2000 to 2005. In order to highlight the effect of a warmer climate only, we assume population distribution and base line rates to be constant. The temperature-response functions come from the European PHEWE Study both for mortality (Baccini 2008) and respiratory hospital admissions (Michelozzi 2009).

"The annual mortality in 2035 is estimated to increase by 1.25% according to the A2 climate projection due to heat related mortality while under the A1B scenario the annual mortality is estimated to increase with about 1.42%. When looking at the countries separately the estimates show an exclusive increase in number of deaths in 2035 for all countries when compared to baseline (Table 1). This increase differs between countries and range from practically zero to as much as 4.69% of the expected annual mortality. The two climate models however, yields different results. Even though the estimates under the A2 scenario estimates a higher number and a larger increase in total number of cases across Europe, the A2 scenario does not produce higher estimates for all countries. The two scenarios differ in the sense that A1B predicts a larger increase in temperature in the Mediterranean while the A2 predicts larger temperature increases in the central and northern part of Europe with a more moderate increase in the south of Europe. The additional numbers of respiratory caused hospital admissions due to respiratory causes in the future period is clearly lower than the mortality numbers. The annual increase in additional hospital admissions for Europe reached approximately 0.36% and 0.33% for the A1B and A2 scenario respectively. The increase in expected hospital admission attributed to the additional cases in 2035 range between 0,08% to 0,76% for the different countries" (Forsberg 2012).

We received very little information from Northern European countries, except Sweden. Studies of Stockholm (Rocklov 2011,Rocklov 2008,Rocklov 2009) and three Swedish regions (Rocklov 2010), using only June-August as the summer period, indicate that the increase of mortality could be larger than estimated for Sweden by PHEWE.

Early Warning and Surveillance

The health care system has to look at two aspects of heat waves: the degree of the heat exposure (susceptibility); and the facilities and capacities to adapt (resilience). Heat wave reduction programs lower susceptibility and strengthen resilience. Local public health units play an important part in adaptation strategies.

Heat waves can be predicted in advance. In most countries (amongst others: France, Germany, the Netherlands, Hungary, 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 some countries local authorities have written a local prevention plan. The measures vary from social interventions to health care interventions.

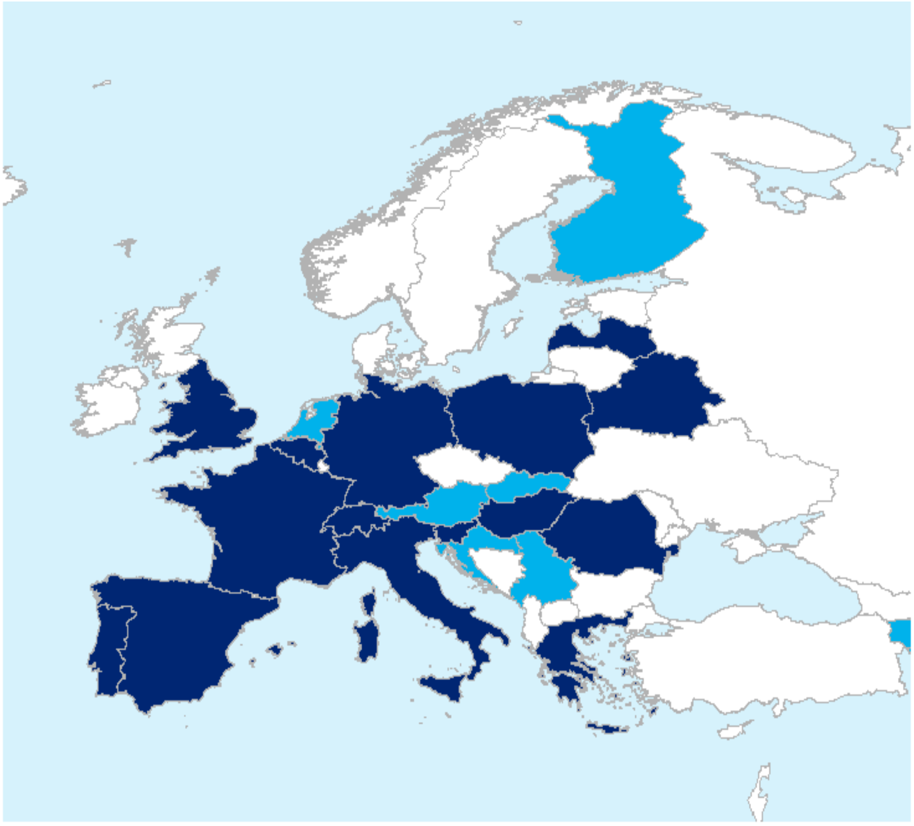

Figure 1: Countries with Heat Health Warning Systems – dark blue operational systems, light blue planned HHWS (C) 2006 EuroHEAT (http://www.euroheat-project.org/dwd/hhws.php#) When proceeded to the website one can click on each country in the map to get country specific data.

The European Union project "EuroHEAT" is a medium range heat information system. It does not substitute the national Heat Health Warning Systems (HHWSs). But it is a supportive tool to provide within 0 to 3 days deterministic heat warnings, and within 3 to 10(15) days probabilistic medium range heat information (http://www.euroheat-project.org/dwd).

The England heat-wave plan could serve as example of what is needed for a national or regional heat plan (NHS, 2010). In Italy several regions have a very detailed warning plan e.g. one by the Lazio Region Department of Epidemiology (Michelozzi 2010). A preliminary evaluation suggests a reduction of the impact of heat on mortality, but thorough evaluation should still take place (Michelozzi 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.

"In each city, the central component of local prevention plans is the active surveillance of high and very high risk patients by GPs, medical and social personnel. The active surveillance is operated through a dedicated telephone line that triggers a network of health and social services in case of an emergency. In particular, GPs play a central role in actively monitoring patients through specific interventions such as telephone calls and home visits, modulation in pharmacological treatment, home-based treatments, special attention towards at-risk patients discharged from hospital and favoring the access to nursing/residential homes when necessary. When level 2 and level 3 warnings are issued, activities like home visits and treatments are enhanced" (Michelozzi 2010).

The “Heat Plan for England” is well written and available as a good practice example (NHS 2010).The general outline is shown in the figure below. It comprises various levels of preparedness. Each country has its own risk levels depending on the baseline weather patterns in that region or country. The health care system for each country or region should be able to define the necessary steps and to list the responsible authorities needed to implement such a heat plan.

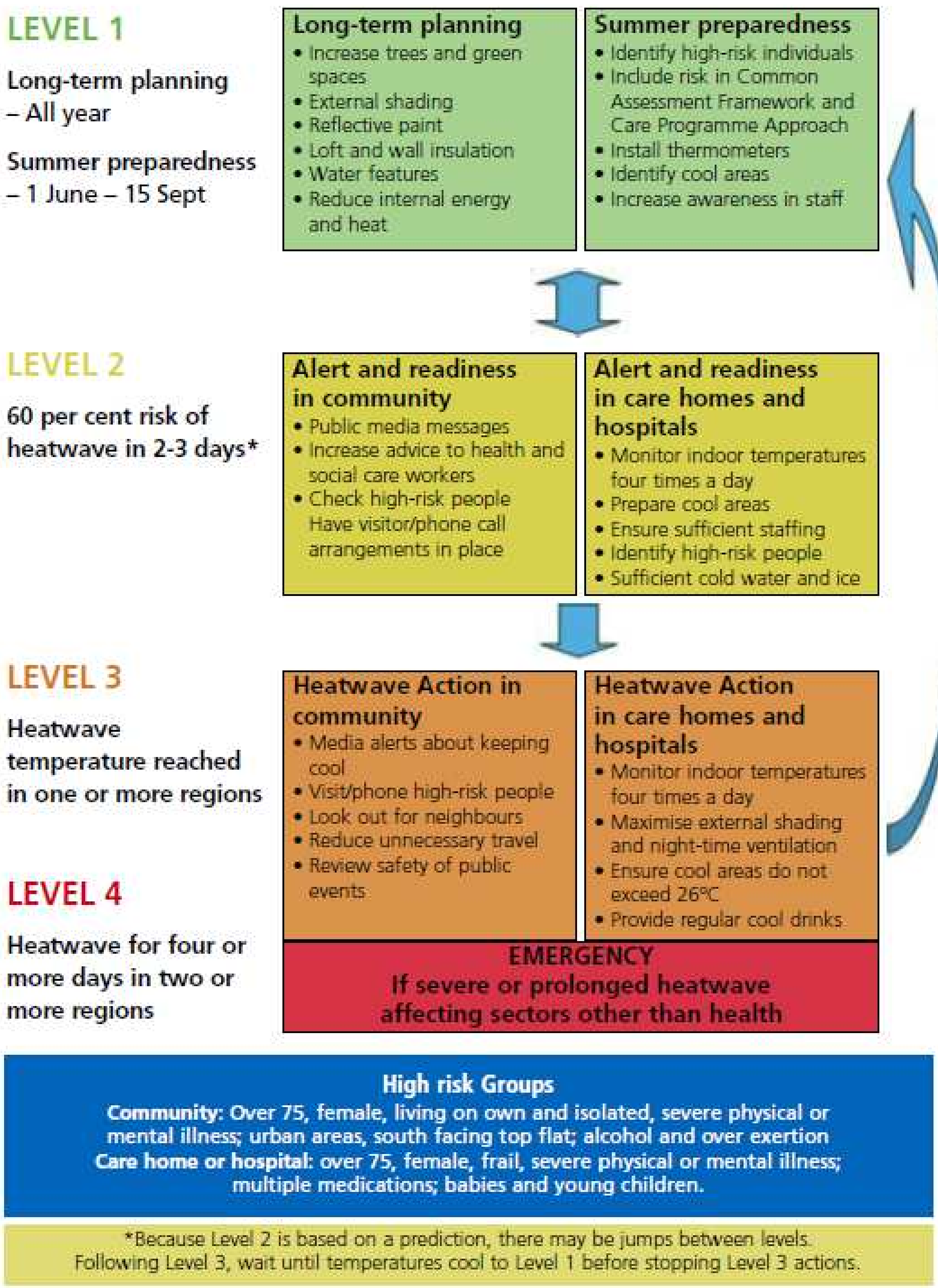

Figure 2: Heat Plan 2010 for England

Capacity Needs
The capacity need focuses at hospital level. During the capacity need days there will be an extra demand for nursing and medical staff at hospitals. Emergency departments and hospitals will see during heat waves a 3.1% increase of patients above 75 years of age (Michelozzi 2009). Depending on the size of the hospital this can be a substantial number of beds.

Additional staff is needed at physician and at nurse level, specialised in respiratory health care. At the hospital there will be an additional burden on pathology and moratorium staff due to the increase of mortality. Involvement of public health stakeholders (e.g. home health care organisations) should be established and personnel trained to deal with a higher demand from elderly people. More beds are needed for patients with respiratory problems (both in hospitals and in hospital wards of nursery homes). More general hospital staff is needed during periods of heat waves, but this should be dealt with as a logistical problem due to the fact that more personnel is not needed during the rest of the year.

More medical trained staff, like GPs or home care providers, is necessary to deal with patients at home. At nursery homes more staff is needed during heat waves. An increase in medication is related to this increase of respiratory problems at different health care facilities. At public health care institutions personnel needs to be available for implementation of warning systems, health promotion activities and event support with medical advices. Additional personnel are needed with regard to the number of deceased persons. Pathology facilities, registration, undertakers, transport logistics will be in greater demand.

Training
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.).

No special health care training for hospital staff is needed in heat stress related disorders. There will be an increase on the demand for public health personnel, including staff at nursery homes during heat waves. It is expected that after incorporation of training in the public health sector, including nursery home staff, during the coming years up to 2020, the knowledge on heat stress effects are incorporated in more basic training of health personnel. However, this asks for an increased effort at medical curricula for health care personnel training, including physicians and nurses.

In relation to the fact that heat waves are appearing seasonably, the proposed measures by public health services providers represent a very high level of cost and public funding. More reasonable would be to educate additionally primary health care workers about the impact of heat waves on people´s health, and related symptoms due to higher temperatures. The health services should be organised in such a way that the risk groups would have a priority in access and better treatment (air conditioning in treatment room and situated at lower levels of the building). More activity should be planned at local level (peers self help groups, education of the general public about symptoms of heat wave impact on health). Permanent and systematic education of people employed in health services and social institutions that are consulted by the risk groups (schools, elderly homes, kindergartens, sport parks, etc.) should be permanently implemented.

Atopic Diseases

Health Effects

Atopic diseases are related to respiratory health effects. Data suggest an increasing effect of aeroallergens on allergic patients, which may also imply a greater likelihood of the development of an allergic respiratory disease in sensitized subjects and exacerbation of symptomatic patients.

Expected Impact

During the last two decades the pollen season has become longer. For a range of plants and trees the season has been lengthened from 6 to 19 days. Due to the expected temperature rise the pollen season may become even longer. However, there are also a few restricting factors such as the length of a day, and precipitation, which prevent a limitless growth in season duration (Eis 2010).

Increasing temperatures due to climate change will alter the global pollen load leading to an increased number of allergic sensitization (Ariano 2010). Introducing alien species will together with climate change affect plant-pollinator interactions. (Schweiger 2010).

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 (Eis 2010). A spread of new species towards the north is seen, while some problems in the south disappear.

Moulds and other (bacterial) indoor bio contaminants are also to be considered. Mould depends on temperature and humidity, but there is little known about mould and climate change. Flooding would increase the likelihood of indoor moulds.

Increased temperature and CO2 levels can be expected to increase pollen production according to experimental studies of ragweed as well as field studies (Wan 2002). In experiments a doubling of CO2 levels from current to projected future levels, ragweed pollen production increase by 30–90% is predicted (Rogers 2006,Wayne 2002,Ziska 2000).

Plant distribution

A warmer climate results in altitudinal and latitudinal plant migrations, changing plant species' diversity and density. Such changes in the pollen producing vegetation will alter the local aeroallergen pollen exposure. An extension of the northern limit of birch, olive trees and ragweed and a corresponding increase in height of the altitudinal tree line and contraction of its range in the south have been projected (Emberlin 1994). A northward expansion of some species of grasses due to global warming and increased CO2 concentration is expected (Olesen 2002). However, time trends in pollen counts are difficult to interpret. Changes in land use, urbanization, often occur in the urban and sub-urban areas where the pollen sampling stations usually are located, and this could explain a decrease in herbs and grass pollen counts observed at some stations (Emberlin 1994).

To summarise: an increased prevalence of atopic diseases is likely, due to a longer exposure period for primary sensitisation, a higher allergen dose, and a higher dose during following exposure periods. Especially the spread of ragweed pollen will be noticeable.

Early Warning and Surveillance

The European Aeroallergen Network Pollen Database is a forum using data from over 600 pollen counting stations across Europe. Scientists can use these data for evaluation including modelling of trends of pollen distribution (https://ean.polleninfo.eu/Ean/start). The website www.polleninfo.org is open for everybody, given actual data on regional, actual pollen counts. This site might be the best example to use for predictions on pollen in the near future. Also the Finish example provides European based pollen prediction on birch, grass and olive. This site is easy accessible and provides quick information for the whole of Europe for those who are travelling to other countries. There are also regional examples such as in Germany (Baden-Württemberg) where they performed an extended study on allergenic status of children especially linked to ragweed. 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 (Boehme 2009). Since the plant pollinates relatively late in the year (August, September) this also means that the symptomatic season is prolonged for the affected patients. 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. At the pollen diary (https://www.pollendiary.com/Phd/en/start) people can compare their complaints with the actual pollen counts. In this way some indication for specific allergies can be obtained. This service is available in 9 languages. In the table below there are examples given of different forms of information services. There are more countries with similar information services, they can be accessed through www.polleninfo.org.

Country	**Information source**
Europe	https://ean.polleninfo.eu/Ean/start and www.polleninfo.org
Austria	Pollen forecast services https://www.pollendiary.com/Phd/en/start
Belgium	Institute of Public Health, section of MYCOLOGY-AEROBIOLOGY provides daily counts and warnings
Estonia	Pollen Monitoring Programme at Tallin University in the Institute of Gerontology and the Institute of Ecology
Finland	http://pollen.fmi.fi/
Germany	Polleninformationsdienst (Pollen Information Service) http://www.pollenstiftung.de/
Hungary	National Institute of Pulmonology and Tuberculosis and the National Public Health and Medical Office:pollen forecast services
Ireland	Pollen forecasts/warnings via iPhone.
Spain	forecast available on pollen at www.uco.es/rea/pol_abierto.html
Sweden	National Board of Health and Welfare gives reports on health status including allergy prevalence; Astra Zeneca and the Museum of National History give a daily pollen forecast
United Kingdom	Met Office provides pollen forecasts at http://www.metoffice.gov.uk/public/pws/invent/weathermap/

Table 1: Pollen information services

Capacity Needs

In most countries adequate medical care and treatment are available to treat asthma and other allergic diseases. It is expected that atopic related exposures will slowly change over the coming decades. The medical care systems of many countries should be able to accommodate the increase in patients (Samet 2010).

Climate change may alter the production, potency, distribution, and timing of aeroallergens. This may increase the prevalence of allergic diseases and result in an increased burden on the health care system. In many countries the health care systems are already struggling with inadequate resources, and an ageing population that will increase the needs. More persons with asthma and allergies mean more need for consultations and medications.

However, many drugs against hay fever are sold without any diagnose or prescription. Improved asthma medication could balance the need for acute health care.

In some areas new types of allergies may be established, such as mite or uncommon plant species, which makes testing for more allergens necessary to have a correct diagnosis. There are some preventive programs focusing on asthma or allergies within the public health sector, but more actions should be planned and implemented. Better city planning, landscaping and building constructions could protect against water damaged or damp houses.

In many countries there are pollen measurements and/or pollen forecasts to inform the general public on pollen concentrations. These systems could, but usually do not take interactions with air pollutants into account.

Training

Health professionals should improve their knowledge especially for new and spreading aeroallergens such as ragweed (Samet 2010). Laboratories need to be prepared for testing new allergens and a greater demand on the number of tests.

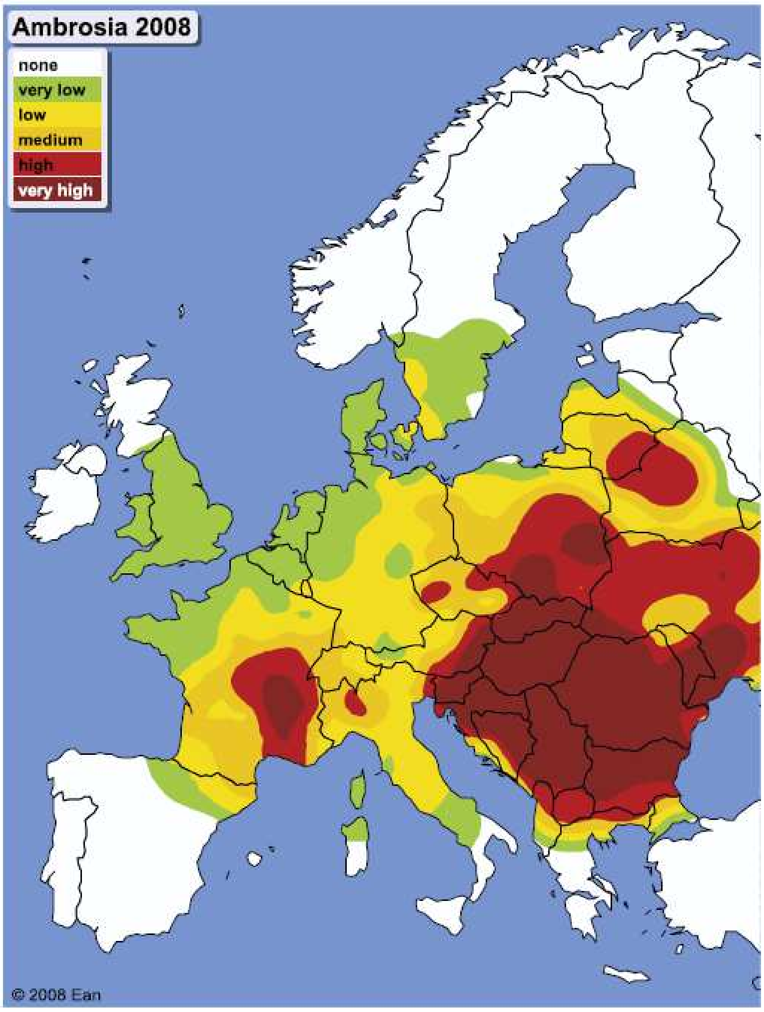

Figure 3: Distribution of ragweed in Europe.

Vector-Borne Diseases

Health Effects
Temperature rise will change the spectrum of transmission from animals to humans. There will be other spatial spreads of vectors and thus other ways of contact, including change of human behaviour. Furthermore characteristics of the disease pathogen or the immune response of the host might change. The health effects are related to a broad range of communicable diseases. Ticks are the vectors for Tick-borne encephalitis (TBE), Crimean-Congo hemorrhagic fever (CCHV) viruses, and Lyme borreliosis. Mosquitoes are the vector for malaria, West-Nile virus, Dengue and other diseases. Vampire bats might play an important role as vectors in the future (see work package 5).

Vulnerable groups are those persons within the population with high exposure due to profession (forest workers), recreation activities, unhygienic living conditions or comparable situations.

Expected Impact
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. 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. This is of importance 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. But disease frequency is influenced by many external causes. Preventive measures of the health care system like vaccination programmes are only one of them. 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. The links between environment, cultural and societal behaviour, technological achievements and disease incidence are too complex and manifold for simple linear associations.

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 extent these changes are linked to climate change only and in spite of the fact that prediction accuracy is still poor (Rosenthal 2009).

Tick-borne encephalitis: 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 2010,Stanek 2005). 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. Alimentary infections with goat milk and sheep or goat cheese can facilitate the spread of tick-borne encephalitis virus (Balogh 2010, Holzmann 2009, Zeman 2004). Also in Scandinavia a spatial spread of ticks, infected ticks and disease was observed (Lindgren 2001). But this spread was not overly related to climate change as there was no pronounced spread to the north. So changes in land-use patterns are the more important cause of the spread in tick-borne encephalitis. Climate change may be an additional factor. The same was shown in Italy with changes in forestry whilst in Eastern European states most of the increase in disease incidence is attributed to societal changes (e.g. changes in recreation).

Additional data on the vector tick Ixodes ricinus suggest that an extension of its northern and altitude range has been accompanied by an increased prevalence of tick-borne encephalitis. Increased winter activity of the vector tick Ixodes ricinus is probably due to warmer winters and a retrospective study suggests that hotter summers will change the dynamics and patterns of seasonal activity, resulting in the bulk of the tick population becoming active in the latter part of the year. Climate suitability models predict that eight important tick species are likely to establish more northern permanent populations in a climate-warming scenario. However, the complex ecology and epidemiology of such tick-borne diseases as Lyme borreliosis and tick-borne encephalitis make it difficult to implicate climate change as the main cause of their increasing prevalence. Climate change models are required that take account of the dynamic biological processes involved in vector abundance and pathogen transmission in order to predict future tick-borne disease scenarios" (Gray 2009). There are no clear data which predict the increase in number of patients.

Tularaemia: There are only few data on other vector borne diseases like on tularaemia in Sweden (Rydén 2009) or in Austria (Deutz 2005). In Hungary tularaemia is amongst the etiologic agents reported weekly to the NPHMOS (National Public Health and Medical Officer Service).

Leishmaniasis: 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. Some scientists expect endemic cases of leishmaniasis to be reported from Middle Europe in the future. But again, no numbers can be given.

West-Nile virus is transferred by the common European mosquito which will likely increase in abundance and have an earlier start with warmer winters (Reisen 2010) but also other climate parameters like humidity are important (Ruiz 2010,Wang 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. However, there are voices which say the tiger mosquito should be monitored as vector for some emerging diseases. In Austria and Hungary West-Nile virus in (dead) birds and horses was monitored and the spread of two lineages was demonstrated (Bakonyi 2007) before the first human cases were observed (Krisztalovics 2008).

Chikungunya (spread by mosquitoes) has an arthropod vector, the Japanese tiger mosquito. 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 2008). Climate change is likely not the sole or most important driver of the spread of this disease. Globalisation in general is the main cause, in the case of Chikungunya by importing the vector. But climate stress on existing ecosystems might support immigrating species in their establishment.

Malaria: Plasmodium malariae would be a serious threat for the Mediterranean countries. To analyse the risk new model systems were developed (see report of work package 5).

Early Warning and Surveillance

There is a need for routine monitoring programs. For that it is necessary to define which vectors and which germs to monitor. This definition depends on the different regions and climate zones. The following gives a few regional examples.

In Scandinavia the spread of ticks farther north is surveilled. In Middle Europe, e.g. in Italy and Hungary, the spread of ticks to higher altitudes is surveilled. 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. European systems for the surveillance and control of ticks exist in 22 locations (Skarphedinsson 2005,Vollmer 2011).

In addition to obligatory reporting of some diseases, even more diseases are monitored by the different national 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, e.g. in Austria). European wide monitoring of tick-borne encephalitis was part of the European project EDEN (EDEN 2010).
EDEN (Emerging Diseases in a changing European eNvironment) is an Integrated Project of the European Commission (FP6) that aims to identify and catalogue 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.

Even if a disease has not yet established itself in a country it is good to know that the vectors are there in case a disease is imported and establishes itself. Monitoring insects (e.g. sand flies for leishmania) might be important. Knowing about the tiger mosquito in Italy did help to target sanitation measures. A routine analysis of bird carcasses can study the spread of West Nile Virus. One can collect the insects (or other vectors) or one could monitor vectors or animals (agricultural and wildlife) or humans for the disease. Another (working) example is a monitoring system placed in Hungary for borreliosis. **Capacity Needs**
The outbreak of certain infectious diseases can be predicted by models when there is a link to weather related parameters. To monitor the activity and density of some arthropods an excellent veterinary geographical bio-meteorological model has been developed (Beugnet 2009). However, it is difficult to predict these outbreaks in the number of patients or frequency of occurrence. The general expectation is that the disease outbreaks will become more frequent. The size of the impact depends on many factors. Vaccinations e.g. can restrict spreading tick-borne encephalitis.

The public health response can be effective in controlling acute epidemics of disease, but needs a timely delivery of curative therapy and prevention to prevent a further spreading of the disease. Certain vector borne diseases show a seasonal trend and will burden the health care system during specific periods of the year. The demand will be mainly on the clinical health care for treatment and on the public health care for monitoring, case control and epidemic control. Clinicians are needed with specific knowledge in recognizing the occurrence of sentinel cases as the beginning of a possible outbreak. Infectious disease specialists and public health experts are needed to control the occurrence of both, acute or chronic, epidemics. For certain professional groups the application of vaccination is foreseen to protect their health. A clear example in this is the vaccination against tick-borne disease for forest workers.

Training
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.

E.g. the Norwegian Surveillance System for Communicable Diseases (MSIS) publishes surveillance data and reports of specific diseases and increasing numbers in internet (www.msis.no , www.fhi.no). The Norwegian Institute of Public Health (NIPH) provides information and education for health professionals.

Etiologic agent	Vectors	Risk of establishing new foci health	Impact on public	Dependence on climate	References
P. malariae	mosquitoes	local, regional	enormous	high	(Sainz-Elipe 2010)
Granulocytic anaplasmosis	ticks	low	low	low	(Walder 2006)
F. tularensis	mosquitoes	high	BSL4 agent	unknown	(Triebenbach 2010)
L. borreliosis	ticks	moderate	moderate	low	(Walder 2006)
West-Nile V.	mosquitoes birds	high	limited, but transfusion	high	(Savage 1999)
Usutu virus	mosquitoes	low	negligible	low	(Weissenbock 2002)
Dengue viruses	mosquitoes	moderate	high	high	(Cao 2010)
Japanese enc.	mosquitoes	low	vaccination	low	(Cao 2010)
Chikungunya v.	mosquitoes birds	low	limited, but transfusion	low	(Martin 2010)
VEEV	mosquitos, rodents, birds	moderate	low	low	(Pfeffer 2010)
WEEV	mosquitoes, birds	moderate	low	low	(Pfeffer 2010)
EEEV	mosquitoes, birds	moderate	low	low	(Pfeffer 2010)
Rift Valley FV	mosquitoes, life stock	high	low	low	(de Boer 2010)
Powassan v.	ticks, rodents	moderate	low	low	(Pfeffer 2010)
Tick-borne EV	ticks, rodents goat milk	moderate	low	low	(Balogh 2010) (Gao 2010)
Crimean-Congo	ticks, rodents	moderate	low	low	(Gao 2010)
Many agents	bats, fruit bats	unknown	unknown	unknown	(You 2010)

VEEE = Venezuelan equine encephalitis virus; WEEV = Western equine encephalitis virus; EEEV = eastern equine encephalitis virus

Table 2. Possible risk of reintroduction or introduction of arthropode-transmitted etiologic agents into the European region (Forsberg 2012).

Food-Borne Diseases

Health Effects

Food-borne diseases show a range of health effects, covering gastro-intestinal and more systemic health effects. The severity of health impact varies from mild disorders to severe diseases and even mortality.

Expected Impact

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 the number of cases. 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. Increasing average temperatures call for even more efforts to keep food processing and transport safe. In many foods pathogenic bacteria can multiply. Therefore the risk of food borne diseases is mainly linked to food handling techniques and temperature (both ambient and process temperatures).

Salmonellosis increases by 5 - 9% for each one-degree increase in weekly temperature (Kovats 2004). Climate TRAP calculated relative increase in food borne disease for Salmonella Enteritidis of 2%, %% and 10%per one-degree increase in temperature. For 2% per degree the range of relative increase across European countries is 3% to 5% when used the Echam4 A2 model. For the 10% per degree increase this range is 15% to 28%. These data are for the year 2035 (Forsberg 2012). Also campylobacteriosis is positively associated with temperature.

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 will lead to food scarcity 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.

Early Warning and Surveillance

In general, industry is required (European Parliament and European Commission 2002) to observe good food production practices (Hazard Analysis and Critical Control Points, HACCP-concept (Mortimore 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 differ 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.

Surveillance of health effects

Food borne diseases usually have to be reported to national institutes, but there are likely to be 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 2010). 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), prepare an annual European report (European Food Safety Authority 2010). They report on the incidence of certain food borne diseases and the yearly trends.

Capacity Needs
The outbreak of food-borne diseases can be predicted by models to become more frequent (Forsberg 2012). However, the size of the impact depends on many factors. The public health response can be effective in controlling acute epidemics of disease, but needs a timely delivery of curative therapy and prevention of further spreading of the disease. Certain food-borne diseases show a seasonal trend and will burden the health care system during specific periods of the year. Clinicians are needed with specific knowledge in recognizing the occurrence of sentinel cases as the beginning of a possible outbreak. Infectious disease specialists and public health experts are needed to control the occurrence of both acute and chronic epidemics.

It is important to improve short term local prediction models. Reacting after the outbreak has started means being always too late for preventive measures. Capacity is not only about timely delivery of therapy and about the training of clinicians, but also of the preventive training of local/national public health experts. To have better data is also part of the capacity needs: there is severe underreporting. Training of clinicians and institutional measures must ensure a better surveillance which is vital for good predictions of outbreaks. Finally personnel (epidemiologists, statisticians) are needed at the local public health institutions to develop and validate the prediction models and to establish thresholds (e.g. based on weather forecasts etc.) above which it is deemed necessary to implement some preventive measures (like e.g. stricter control of foodstuff, issuing of warning messages, etc.).

Training
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.

Water-Borne Diseases

Health Effects
Water-borne diseases show a range of health effects, covering gastro-intestinal and more systemic health effects. The severity of health impact varies from mild disorders to severe diseases with even mortality.

Expected Impact
Climate directly has an impact on waterborne infectious diseases through effects on precipitation patterns (variability and intensity) and water temperature-(European Environment Agency (EEA) 2007). Climate change will also influence the quality of raw water in several ways. According to IPCC extreme events are likely to increase both in frequency and in intensity as the average temperatures rise during the 21st century (Solomon 2007).

Climate models provide rainfall projections for Europe with an increase in rainfall in the north and a decrease in the south. In some areas groundwater levels could be lowered along with decreasing run-off. Droughts can reduce the volume of river flow and increase the concentration of effluent pathogens, which might pose a problem for the treatment plants (Senhorst 2005). Some regions will face problems with extreme amounts of rain and unpredictable flood discharges. The combined sewer systems, still used in many communities, continue to pose a major threat to water quality. These old systems are designed to carry both storm water and sanitary wastewater through the same pipe to a sewage treatment plant. During periods of extreme rainfall, the volume of water in the sewer system can exceed the capacity of the system or treatment plant (Delpla 2009). In such situations, the system will overflow and discharge the excess wastewater directly into surface water bodies. Separate sewage and drainage water systems are a better solution than the old combined systems. Small-scale water supply systems without appropriate measures for inactivating or removing pathogens are an endemic risk of infection (Delpla 2011).

Water sources are also polluted by run-off from farms and areas with cattle, horses, sheep and other animals that may pose a risk for waterborne zoonoses. Run-offs can also pollute poorly protected aquifers such as alluvial and karst aquifers (Dura 2010). The use of private wells for drinking water has been associated with a high relative risk of infection. Drought in summer may increase the problems with water pipe pressure being too low. Low and negative pressure in the water distribution net may result in intrusion of pathogenic microorganisms if a source of contamination is present, e.g. a leaking sewer main. Increasing water temperatures may change the ecology of freshwater ecosystems and this may give more cyanobacterial algal blooms and degrade water quality. Restriction on fertilizer use is one approach to deal with the cyanobacterial threat against a water resource.

These emerging conditions can reduce the raw water quality. The impact on drinking water will to a large extent depend on protection of raw water sources and the water treatment plants and their efficiency at removing pathogens and hazardous chemicals. The frequency of cyanobacterial blooming is expected to increase with a warmer climate. Higher water temperatures in summer will stimulate the growth of cyanobacteria, producing toxins with a potential to cause acute poisoning of consumers. The toxin production may also be affected by a warmer climate, but the effect is not well known.

Reduced rainfall during summer periods and droughts in coastal areas and on islands may increase salinization of freshwater lakes and ground water used for drinking water. Climatic forcing scenarios show that Lake Ijsselmeer in The Netherlands is vulnerable to climate-induced salinization, drought may in the future result in chloride concentrations well above the maximum allowable concentration of 150 mg/l for chloride in drinking water (Bonte 2010).

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.

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 2010). For some pathogens it was even argued that lower temperatures increase their viability in water systems.

Quantitative calculations of disease outbreaks of water-related illness in Europe due to climate change seem to be missing. Higher water temperatures might raise the disease burden due to parasites and bacterial infections (Stark 2009).

The main expected impact will be (Forsberg 2012):

- Changes in raw water quality (pathogens, cyanobacterial algal blooms, organic matter)
- Changes in water treatment processes (disinfection by-products)
- Changes in consumer's behaviour (change in consumption patterns)
- Contamination of recreational water, private wells or groundwater due to heavy precipitation and overflows leading to contamination of drinking water sources.

Early Warning and Surveillance

Drinking water quality is monitored all across Europe. Private wells are not monitored as a standard. The surveillance of health impacts associated with drinking water could include both water quality and health outcomes. Acute gastrointestinal illness should be monitored in relation to extreme weather and indicators of drinking water quality indicators.

Capacity Needs

Models predict that the outbreak of water-borne diseases will become more frequent. However, the size of the impact depends on many factors. The public health response can be effective in controlling acute epidemics of disease, but needs a timely delivery of curative therapy and prevention of further spreading the disease.

Certain water-borne diseases show a seasonal trend and will burden the health care system during specific periods of the year.

Clinicians are needed with specific knowledge in recognizing the occurrence of sentinel cases as the beginning of a possible outbreak. Infectious disease specialists and public health experts are needed to control the occurrence of both acute and chronic epidemics.

Flooding, landslides and avalanches

Health Effects
Floods can cause health effects both directly and indirectly. Floods and related disasters such as land-slides and avalanches can directly lead to injuries, death (e.g. by drowning). But more severe are the indirect effects that result from damage to goods and infrastructure: mouldy buildings and furniture, temporary or permanent displacement of people, disrupted services including health care services, destruction of farm-land and food-stores, exposure to chemical contamination of surroundings and buildings, contamination of food-stuff and drinking water. All these can impact the physical and psychological health of people long after the floods have receded.

Whilst acute casualties can be counted, the indirect health effects are more difficult to quantify. Displacement of people and disruption of infrastructure often hamper a straightforward study. But in general it can be said that in the short run traumas are most relevant. Secondly infectious diseases, mostly diarrhoeal diseases and wound infections must be considered. In the long term stress related health effects are more important.

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.

Impact	**Features**
Mortality	Main cause is drowning, other causes inadequately studied include heart attacks, hypothermia, trauma, and vehicle-related deaths
Injuries	Mainly soft tissue injuries (contusions, lacerations, abrasions, cuts, bruises, sprains, strains, puncture wounds)
Communicable diseases	Arbo-virus disease, West-Nile virus, leptospirosis. Oro-faecal infections include diarrhoeal diseases and gastroenteritis. General infections include ear, nose, and throat infections; conjunctivitis; skin irritations; skin rashes; and dermatitis. Respiratory symptoms reported include colds, coughs, flu, headaches, acute asthma, allergies to moulds, and pleurisy
Chronic diseases	Asthma worsening, high blood pressure, cardiac arrest, heart attacks, kidney or other renal infections, joint stiffness, and erratic blood sugar levels
Mental health impacts	Anxiety, panic attacks, increased stress levels, mild/moderate/severe depression, irritability, nightmares, sleeplessness, post-traumatic stress disease (PTSD), anger, tantrums, mood swings, increased tensions in relationships (e.g., arguing), difficulty in concentration, suicidal thoughts, alcohol dependence, and psychosomatic disorders. Aggression, bedwetting, depression, and PTSD in children and youths ages 11–20 years
Miscellaneous	Carbon monoxide poisoning, toxic fungal spread, insect or animal bites, earache, lethargy, spontaneous abortions mainly due to mental and physical stress

Table 3: Summary of the health impacts of flooding in Europe (Microdis Report 2010)

Vulnerable groups
Population groups that live in a flood-prone area are considered a vulnerable group. But often people can adapt to repeated floods and learn to be prepared. Poverty on the one hand

makes people choose less secure land; on the other hand poor people cannot afford to pay insurance fees and are less capable to deal with loss or damage of property. Susceptible subgroups for effects of floods include the elderly, children and people with disabilities, as they may need assistance to travel to the emergency accommodations or into a safe area (Rowland 2007). A vulnerable group for infections by moulds are the immune-depressed persons. A special risk group are the emergency helpers, having an increased risk of accidents, infections and traumatic experiences.

Expected Impact

For many parts of Europe a shift in the rain distribution is predicted e.g. it will rain less frequently, but with more down-pour per rain-fall. Therefore, it is expected that many river-plains in Europe will experience an increase in the frequency and severity of floods. Record floods and other disasters occur more frequently over the past decades. Flood damage is influenced by human behaviour, such as land use changes. In many regions, the number of people living in flood-prone areas has increased. People believe levees offer 100% protection, while levees are generally designed to withstand a design flood (a one per 50 or 100 year event), but not more. The Netherlands are an exception where the Flood Defence Act set high safety standards with the return period of design floods at the level of 1,250 to 2,000 years. (Kundzewicz 2010). Areas in Europe should therefore be prepared for floods by e.g. suitable planning of housing and action plans, including the health sector, on floods.

In small alpine valleys even very local thunderstorms easily surpass the carrying capacity of the brooks and rivers, leading to local floods. These kinds of floods are less predictable and tend to affect a very limited area but with a serious impact.

In the alpine areas also other related disasters such as avalanches and land-slides may occur more frequently. Land-slides may follow heavy rains but the yould also be caused by the thawing of permafrost. In some alpine areas while less rain is predicted in summer more snow is predicted for winter which could lead to an increase the risk of avalanches as well.

Landslides are mainly triggered by meteorological events that are quite different from climate change, therefore the impact of climate change on occurrence of landslides is not clear (European Environment Agency (EEA) 2010). Mainly the increase of storm intensity could cause stronger and more frequent landslides (Bonnard 2008). The effects of climate change on landslides are studied in the ongoing EU project SafeLand (http://www.safeland-fp7.eu/).
The effect of climate change on occurrence and size of avalanches is unclear, as on the one hand snow coverage is reduced, but on the other hand more heavy precipitation events may occur (European Environment Agency (EEA) 2010).

Most of these changes have already been observed in recent years. There is an ongoing debate as to a) what percentage of the increase in these events is due to climate change b) what is due to better reporting or more thorough coverage by insurance claims c) what is the role of changes in land-use patterns, sealing of surfaces, change in forestry and agricultural practices.

The impact on the health sector is based on the single events which are climate related, but maybe not so much influenced by climate change. Due to the increased pressure on land use for inhabitation the number of casualties will increase if flooding occurs. Based on previous flooding the following minimum impact can be expected. Injuries will occur in 6% of the victims (Ahern 2005). Diarrhoea will occur in 30% of the victims who live in a house which was flooded. Vector-borne diseases occur only rarely after flooding. Mental problems occur in children up to 49% in the first year after flooding (Osofsky 2009) and 28% of the adults) (Mason 2010).

These numbers may vary due to local circumstances and the response by authorities.

Early Warning and Surveillance

Early warning systems depend on good meteorological and hydrological data. Hydrological services claim that there is a need for more monitoring stations and data along the main European rivers but even more so there is a need for harmonisation of existing data, also to look for an analyse of long-term trends. Local hydrological and meteorological data are the basis for risk assessment, effective building standards, planning controls and other regulations that enable houses and other infrastructure to meet adequate safety criteria for the users and the occupants. An efficient early warning system should deliver accurate information on likely events in a timely manner. This includes monitoring the safety of drinking water, spreading of vector-borne diseases and monitoring of mental health.

It requires a rapid, dependable and people-centred distribution system for forecasts, advisories and warnings to all interested parties, and a prompt and effective response to warnings from both the government and public.

In several countries information of the population is secured via mass media and also local networks (e.g. fire brigades using sirens, police cars with loud-speakers). Warning systems must be tailored to the local needs. As no two floods are the same, the preparedness plans should be very different in detail and scope for the respective areas. Mostly they are prepared at a local (city or district) level.

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/).

Capacity Needs

Increased referrals more than double in flooded households for the year following the floods) (Microdis Report 2010). Some hospitals were built in areas which could be affected by severe floods in future. Disruptions of health care service are likely. An appropriate regional risk assessment to maintain necessary capacities is advisable.

During direct impact of flooding, hospitals need to be prepared for increased hospitalisation and emergency department visits. The treatment of health effects are within the current range of specialisation of hospital staff.

Fire brigades, Red Cross, the army, and hospitals work together in cases of emergencies. Often additional institutional and private help is organised in severe cases. Long-term help after the acute event is often not so well organised. For example it was claimed that financial aid provided by the state to rebuild or renovate damaged houses often depended on whether elections were being held in the near future or not. Long-term support of flood victims would also need to include psychological consultations and help in dealing with administrative issues. This is not very established in many parts of Europe.

The main impact from floods will be on mental health. The numbers of victims, both adults and children, are substantial and need professional care. This should be included in the education of mental health professionals. The mental health sector should be involved in action plans and early warning systems. Because of the international scale of floods, early warning systems should be developed together with the other countries of e.g. the river region. The public health care system needs to have more personnel available on demand to support areas of flooding.

Transport capacity for aid personnel, refugees, and goods is vital and this transport must also function under pressure of rain, flooded streets and broken bridges.

Medical doctors play a vital role in first aid activities. But there is a need to also strengthen the contribution of other professionals including psychologists and social workers. Public health experts should be part of the teams and especially should have a say in the aftermath of a flooding event when it is decided if and where houses and infrastructure should be rebuilt; if remaining houses can be re-inhabited or need be torn down and built anew, or if areas should be abandoned totally because of high risk. Public health experts also are important in the prevention of the adverse effects of floods. They should be consulted during the preparation of emergency plans and in the course of land-use planning. In many cases this would imply the need of additional staff and additional training for public health institutions.

Training

In flood-prone areas training events should be staged to evaluate the plans and the cooperation of the different expert groups. The health-care sector needs to prepare for this, as well as for increased mental health care in the aftermath of a flooding or landslide event.

Air Pollution Diseases

Health Effects

Long- and short-term air pollution exposure leads to cardiopulmonary morbidity and mortality. Ozone (O_3) and particles are the major air pollutants of concern (Jacob 2009). Ozone levels will increase due to climate change, mainly in Southern Europe. Particles might not alter too much (Forsberg 2012). The focus will be therefore on ozone. 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 diseases, and possibly also people with obesity and diabetes. A special risk group are prenatally exposed infants later on in life.
If ozone is inhaled and enters the airways it triggers oxidative stress due to its high reactivity. In higher concentrations ozone can damage the lungs. Epidemiological studies have shown the manifold effects of ground-level ozone on health resulting in increases in daily levels of mortality and morbidity. Significant negative health effects have been demonstrated for different causes, mainly for respiratory and (to a lesser extent) cardiovascular diseases (Gryparis 2004).

The exposure to ozone has been shown to increase the likelihood of wheezing, chest tightness and asthma (Mortimer 2002). The other main effects include emergency department visits for asthma, respiratory tract infections, exacerbation of existing airway diseases (Amann 2008) as well as the decline of lung function (Peters 1999).

The epidemiological evidence of chronic effects is much less conclusive. Chronic exposure to ozone could induce significant changes in airways and systemic inflammation.

Expected Impact

Climate change and air quality are linked in several aspects (D'Amato 2010,Krüger 2007):

- Climate change might directly influence air quality. This is especially clear for ozone (Doherty 2009,Engardt 2009) and secondary particles (Ebi 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.
- Air pollutants and greenhouse gases have often the same sources. So the two areas are linked regarding mitigation strategies.
- Air pollutants can either act as greenhouse gases (ozone, soot) or have a cooling effect (sulphate).
- 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 nor 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.

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. There is a positive effect of ozone on respiratory health and mortality. In the EuroHEAT (http://www.euroheat-project.org/dwd/index.php) 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).

In work package 5 an assessment was performed, projecting the effects of climate change on ozone levels, coming to the conclusion that mortality and morbidity across Europe will be influenced (Forsberg 2012): *"There would be increase in ozone induced mortalities in Southern-, and Central Europe and slight decrease in Northern-Europe. Compared to baseline period (1961–1990) it might indicate that smaller part of the climate induced ozone increase effects have appeared currently and more of them will happen in the future (until 2021–2050 and 2041–2060) and the decline of air quality will in turn affect the public health sector as well. ECHAM4 (A2) gave generally larger health impacts for 2021–2050".*The estimated increase if up to 0.2% in total mortality and respiratory hospitalizations will have an impact on the health sector.
We use ozone coefficients (RRs) adjusted for temperature, and the increase is not limited to heat waves. However, there may be an interaction during heat waves. The modeled effects on PM are too inconsistent and small to be used in HIAs.

Early Warning and Surveillance
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. 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 such as 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. Even so, there are plenty of surveillance systems in place to keep track of the air pollution in European countries. Time-trends of these air pollutants are analysed in many major cities. However, due to the numerous determinants of concentrations of air pollution, it is doubted if the specific contribution of climate change can be seen in these analyses.

Surveillance of Health Effects
Long- and short-term air pollution exposure leads to cardiopulmonary 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.

The Finish Meteorological Institute developed a model called SILAM which presents concentrations and depositions for the whole Europe with 0.2 degree spatial resolution and 1 hour time step. Maps are presented in two forms: (i) as 72-hour-long mouse-controlled animations for the 00-analysis time and (ii) as sets of still maps of all species grouped for specific forecasting length. The set of substances, which concentrations and depositions are forecasted, includes:

- Sulphur oxides – SO_2, sulphates
- Nitrogen oxides – NO, NO_2
- Ozone O_3
- Carbon monoxide CO
- Fine particles smaller than 2.5 µm $PM_{2,5}$, total particles smaller than 10 µm PM_{10}.

Capacity Needs
An increase in cardiopulmonary morbidity and mortality warrants for clinical specialists at hospitals or outpatient clinics. This attention will focus particularly on the elderly persons with chronic heart disease and lung diseases. At the public health level it is expected that a larger number of patients need care at home. The possibilities to decrease the level of air pollution by taking measures and by reducing fossil fuels may cross out the need for adjustments in capacity in the health care sector.

Training
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.

see also for media attention on Dutch television: http://www.youtube.com/watch?v=Q1_OWtJIKns

Capacity need

The Capacity Needs Assessment (CNA) was planned, organized and conducted under the auspices of the Climate TRAP Project. The purpose of the assessment was to determine operational capacity needs in providing leadership and coordination, monitoring and implementing activities related to the response to climate change in the public health sector. The findings from the assessment are to form the basis for developing a capacity building plan. Within the Climate TRAP project, considerable attention is being paid to strengthening capacity so that key stakeholders have the enhanced skills and knowledge that will allow them to participate more effectively in the development and implementation of new and improved skills to counteract health effects within the general population caused by climate change.

The challenge in the CNA was to develop a process which was detailed enough, but also flexible enough to respond to the wide variation in project focus and implementation due to the different kinds of health effects caused by climate change. At the same time the system should be robust enough to allow defined outcomes to be achieved. It was not foreseen that some of the health effects could not be predicted quantitavely for different points in time in the future. A semi-quantative method is needed in those cases.

Capacity strengthening

Definitions are important to develop a shared understanding in the sometimes complex world of capacity strengthening and capacity needs assessment. It is important that a shared understanding of capacity strengthening is developed. The following definition is provided to help this discussion. The most widely recognised definition of capacity development or strengthening was published by the United Nations Development Programme:
"*The process through which the abilities of individuals, institutions, and societies to perform functions, solve problems, and set and achieve objectives in a sustainable manner are strengthened, adapted and maintained over time..*" (Capacity Development Group 2010).

This definition has been expanded to generate a common understanding of capacity strengthening, by considering the dynamic context in which strengthening occurs (Stephen 2009). Capacity strengthening is:

- Set within a dynamic context and involves individuals, networks, organizations and even societies. It involves processes that include more than just a single organization.
- A process about change in a changing environment.
- An ongoing process of continuous learning, adaptation and innovation in dealing with unanticipated problems or issues. It is concerned with an individual's or organization's long-term ability to learn and solve problems.
- A process in which issues today must be dealt with efficiently and effectively, but the relevance for future work must also be considered. It should allow individuals and organizations to maintain relevance and effectiveness over time by assessing and reacting to future needs.
- Concerned with the role of an outside entity in supporting and enhancing the capabilities of an individual or organization. This support may be conditional in part on the merging of goals and priorities between those supporting and those being supported.

What is a needs assessment?

We can consider a difference between a need and a want. A *need* is a necessity, a *want* is a desire. A need is considered as a gap between "what is" and "what should be", and is an essential element required for change. A want is an element recognised and desired by a stakeholder in a change process, but it may not be necessary for change.

Defining needs is often difficult and subjective. The outcome may depend on who asks the question and who responds. Participation, transparency and a systematic approach are therefore essential in assessing needs and prioritizing resources to meet these needs.

What is being assessed?
Capacity for change or reform by key stakeholders has a number of prerequisites. These are:
Awareness, Understanding, Skills (Technology), Attitudes, Aspirations and Resources

The CNA process focused on awareness, understanding, skills and attitudes/aspirations if we look at the individual stakeholders or experts. It is the human resources that this CNA focused on in the Climate TRAP project. However, it is also important to consider technology and resources in the broader assessment of capacity needs. In considering the focus of the CNA process key capacities required for change are identified and prioritized. Using the expanded context of capacity strengthening, within these boundaries, the process is:

- Identifying capacity gaps influencing current results and desired ones (situation analysis);
- Prioritizing the capacity gaps (needs assessment);
- Selecting the most important to work on (action plan).

A CNA is not only about recognising gaps, but also about identifying existing capacity and latent capacity – current capacity that is neither used nor recognised – and ensuring that both are enhanced and clearly linked with outcomes to achieve a desired result.

Within the context of the climate change problem in relation to health and the resources available, a capacity needs assessment that can be conducted at one or more levels: individual, organization or sector. However, a CNA must take account of the interconnectedness of capacity issues between the targeted level(s) and the enabling environment. This assessment will focus on the sector level, incorporating the medical professionals as main target stakeholder.

CNA is not a strategy, but rather a starting point for developing a strategy. It should also not be a stand-alone, poorly resourced or poorly integrated process. Such an approach would run the risk of raising unrealistic expectations, leading to disappointment, frustration and possibly further disadvantaging stakeholders in the process. The CNA must be clearly integrated with other strategic planning, implementation, and monitoring and evaluation processes of the prediction of climate change processes.

When to conduct a capacity needs assessment?
This CNA is used for the analysis of capacity-strengthening needs before climate change surprises the public health sector with a substantial impact on the health of the general population. The assessment of needs should not stop after the initial phase. It is a continuous and iterative process, so best considered as part of an ongoing management and programming process.

Stakeholders
Capacity needs can be seen at different levels within the health care system, distinguishing between clinical care and preventive care. This CNA focuses on the Public Health Sector as it will be an important stakeholder for most of the climate change related health effects. For example, Public Health Services/Organisations provide information to the local stakeholders such as nursery homes, organisations for the homeless, local communities, etc. In some countries local authorities have written a local prevention plan to deal with heat waves. The measures vary from social interventions to health care interventions.

The impact on the health sector is influenced by several factors. Some of these factors are related to demographic features, like a shift in the average age of a population which is rapidly aging. Other factors are related to socio-economic aspects, or accessibility to the health care system. These factors are not considered in this project.

The Climate Trap project looks at the impact caused by climatic change. There can be a distinction made between the impacts on primary health care, such as on general practitioners or home care providers and on the clinical health care, with emergency departments or high-care hospital treatment. Climate trap focuses on the health care interventions and not on the social interventions.

There are several levels which are considered in the capacity assessment of the health care sector.

At the primary health care level:

- The general practitioner and its staff
- The pharmacy for medication
- Home health care for home ridden patients

At the public health sector:

- Public health services with medical staff, with health promotion staff; with policy staff
- Vaccination services
- Health care insurance organisations

At secondary health care sector:

- Clinicians
- Nursing staff
- Transport and other supportive staff
- Medication and equipment

The CNA has different phases:

- Review
- Analyse
- Document
- Reflect

Part of the review phase is the **action analysis.** The assessment focuses on key actions to move from "what is?" to **"what could be?".** This stage of the assessment slots the information together in a logical, transparent and strategic manner. It is time to ask the question: **What are the critical actions** that must be implemented and by whom? It includes the identification of critical actions that must be implemented and those stakeholders responsible for implementation and action. In the Climate TRAP project the changes caused by climate change were predicted for different stressors, such as air pollutants, heat, flooding and vectors (water-borne, food-borne, rodents, insects).

Part of the analysis phase is the current **assessment of individual, organizational or sectoral capacities.** The action analysis framework clearly identifies critical actions that must be implemented and performed to a satisfactory level if desired governance outcomes and adaptations are to be achieved. The next step is to assess whether key stakeholders have the capacity to implement these actions and achieve the desired action outcomes. This stage of the assessment must be the most systematic. As we are using calculated information for a future situation this stage is also the most difficult one. This is the key stage in the assessment process. It is time to ask the question: **Who has/needs the capacity to implement these actions** and where are the gaps? These gaps could vary across the different fields of interest which are considered within Climate TRAP.

It is important to understand the importance of the data being collected, the source of the data and the limitations of this data. An effort has been made to use valid models to predict the future impact in order to reduce inconsistencies. The interpretation and analysis of the information will be much stronger if it comes from several different validated sources.

Part of the document phase is the development of an **action plan.** The main question to be answered is**:** "**What resources are required, for what activities and when?**" This requires the documentation of required actions, interventions, resources, responsibilities and time lines. Another step is the **strategy** assessment process. Here the question is asked: "**How are the outcomes communicated, implemented and evaluated?**". The documentation of the assumptions, objectives, process, outcomes, feasibility, monitoring and evaluation is organised in this phase. These steps of the CNA have not been considered, as they depend on the organisational structure of the stakeholder organisations in different countries. It is up to the member states to realise the development and implementation of an action plan.

Some additional considerations are important for a successful capacity need assessment.

The first one is *feasibility:* It is important to consider that only key stakeholders and key individuals will be able to answer the feasibility to address the capacity change in their organisation. Full participation in the development of the action plan will ensure a feasible, realistic and logical set of capacity-strengthening interventions.

The second consideration is *resources and costs:* The identification of required resources is essential, but a calculation of costs may also be needed to assess the feasibility of the action plan and the success of the needed change. These costs should include fixed costs, variable costs, direct costs (such as salaries, allowances, logistics, materials and transport) and indirect costs (such as power consumption and opportunity costs such as salaries for the training period).

The third consideration is *capacity-strengthening providers.* The main question is: Who is responsible? It is important to consider other capacity-strengthening providers who are capable and can provide the appropriate services for the identified need. These providers may be at the local, national or international level depending on the target group, action, topic and mandate.

In the reflect phase the process of the capacity needs assessment needs to be reviewed and reflected on to identify lessons and improvements for future assessments. Reflection is an integral contributor to learning and creating – it seeks to make sense of processes, problems, issues and constraints that become apparent after actions are taken, or not taken. Reflecting allows for an understanding of complex issues and circumstances to develop (Stephen 2009).

Each of the identified levels in the health sector of the capacity need was assessed according to the above mentioned phases of the CNA. Table 5 shows the different human and material resources on which climate change will have an impact. The degree of impact on those resources has been graded in a semi-quantative manner ranging from no impact on capacity to substantial impact on capacity. These differences in impact have been applied in table 4 for each of the analysed stressors. The colours for the capacity impact match with those in table 4 on the different stressors.

Table 4 describes for different stressors the different phases of the CNA. Under key figures the data refer to the question **"what could be?".** Under capacity we have noted the critical actions which are expected. Under sectorial capacity we have recommended the key stakeholders who should have the capacity in the future to implement these critical actions.

Under policy recommendations we have mentioned some potential policy actions which could be incorporated in an action plan.

Primary sector	*No impact on capacity*	*Slight impact on capacity*	*Moderate impact on capacity*	*Substantial impact on capacity*
General practitioner and its staff	-	Only seasonal variation in demand	Increase in patients with 'new' disorders	Structural increase of patients
Pharmacy for medication	-	Increased self-medication	Prescribed medication increase	Disease specific medication increase
Home health care for home ridden patients or nursery home	-	Occasional patient	Each episode increase in patients >2%<5%	Each episode increase in patients >5%
Public health sector				
Public health services with medical staff, with health promotion staff; with policy staff	-	Support in planning of capacity	Some increase in staff demand for episodes of burden by stressors	Structural activities to deal with epidemics, health promotion
Vaccination	-	Only high risk group need vaccination	Vulnerable groups need vaccination	Whole population needs vaccination
Health care insurance organisations	-	Some epidemic costs	Increased costs >2%<5%	Increased costs in health care > 5%
Secondary health care sector				
Clinicians	-	Only seasonal variation in demand	Increase in patients ad hoc	Structural increase of patients
Nursing staff	-	Only seasonal variation in demand	Increase patients with moderate care	Structural increase of patients with high care
Transport and other supportive equipment and staff	-	-	Some diagnostic tools needed	Intense diagnostic tools, transport
Medication and equipment	-	-	Prescribed medication increase	Disease specific medication increase

Table 4

Stressor	Key figures	Critical actions needed on:	Sectoral capacity	Policy recommendations
Heat	100,000 -131,000 deaths in 2035 Gives 54,000-61,000 increase; 30,000-35,000 respiratory hospital admissions; Additional 0,14% to 1,07% respiratory hospital admissions	Primary health care during heat wave Clinical support Medication Increased hospitalisation	Clinicians, GPs to recognize heat stress. Pharmacies to be prepared for increased medication use. More flexible hospital beds available.	Training Finances Overflow beds available at other institutions
Atopic diseases	Gradient increase of number of morbidity days; Longer pollen season; Shift to other areas (e.g. mites); Increase ragweed pollen; New plants in new areas;	Medication increase Only seasonal variation in demand Increase in patients ad hoc (geographic) Increase of patients with moderate care Testing for allergens	Pharmacies to be prepared for increased medication use. Clinicians, GPs to recognize new allergens. Laboratories to be prepared for more testing.	Finances Training Pollen sampling to be connected to areas with altitudinal and latitudinal plant migrations Adapt planning to prevent water damaged housing.
Vector-borne diseases	Rodent borne viruses risk for limited spread	Increase Post-exposure rabies vaccination Increase Preventive vaccinations	Clinicians, GPs need to know about possible diseases	Training Regulation of agriculture and forestry Reduce the number of rodent pets Hygienic handling of them if present Wet cleaning of weekend houses
	Bat-transmitted viruses spread for limited amount of viruses	Preventive vaccinations Specific monoclonal antibody treatment	Clinicians, GPs need to know about possible diseases spread by bats	Training Reduce the possibility of bat-human contacts Prevent and prohibit the foods prepared from fruit bats Teach the population to avoid contact with guano
	Tick-borne infections: significant increase of its spread to higher altitudes. Increased risk in certain (northern) regions of Europe of tick-borne encephalitis	Increase use of Hyperimmune gamma globulines Vaccination	Clinicians, GPs need to know about possible diseases; about spread in new habitats (Rodent hosts and ticks have to be altered for increased risk); Vaccination campaign via Public Health Services or other institutes.	Training Application of appropriate clothing of tourists Daily control of the bodies to prevent prolonged feeding of ticks Seasonal chemical reduction of tick density; Protection of forest workers
	Mosquito borne Infections: increase of Dengue, Chikungunya cases/outbreaks West-Nile virus outbreaks	Preventive vaccinations Hyperimmune gamma globulins	Clinicians, GPs need to know about possible diseases, e.g. Chikungunya, Usutu virus (Very	Training Meteorological follow up of precipitation Regular usage of repellents, mosquito nets with impregnation

	Sandfly-borne infections:leishmaniasis geographical (increased) spread		limited risk of European spread), West-Nile virus, leishmaniasis Support by pharmaceutical industry.	Usage of air condition in sleeping rooms Reduction of mosquito density by insecticides Reduction of mosquito density by agricultural and ecological means Early warning system with high density (Italian system)
Food-borne diseases	Seasonal increase of salmonella, campylobacter	Some increase in staff demand for episodes of burden by stressors	No special additional training needed (except for new staff)	Food warning system. Overflow hospital capacity during outbreaks. Heat warning system and hygiene protocols available.
Water-borne diseases	Seasonal increase	Some increase in staff demand for episodes of burden by stressors	Clinicians needed who can recognize occurrence of sentinel cases	Training
Flooding	No trend of increased number of flooding. Injuries 6% of the victims. Diarrhoea will occur in 30% (in flooded house) Mental problems children up to 49% in the first year. 28% of the adults	General practitioner and its staff better prepared; more ad hoc personnel needed. Pharmacy for medication Home health care for home ridden patients or nursery home Public health services: Mental health Health care insurance organisations Clinicians Nursing staff Transport and other supportive staff Medication and equipment	Integration of public and curative health care in aftermath of flooding	Training
Air pollution related diseases	Increase in ozone induced mortalities in Southern-, and Central Europe and slight decrease in Northern-Europe. Compared to baseline period (1961–1990) it might indicate that smaller part of the climate induced ozone increase effects have appeared currently and more of them will happen in the future (until 2021–2050 and 2041–2060) and the decline of	Pharmacy for medication Nursing staff Only seasonal variation in demand Public Health Services in areas with higher burden	Public health sector to increase preventive care	Training

	air quality will in turn affect the public health sector as well. ECHAM4 (A2) gave generally larger health impacts for 2021–2050”.The estimated increase if up to 0.2% in total mortality and respiratory hospitalizations.			

Table 5

Legend
No impact on capacity
Slight impact on capacity
Moderate impact on capacity
Substantial impact on capacity

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