CHAPTER 6

ENVIRONMENT AND HEALTH
Prevention in a changing world: the determinants of health and environmental strategies of adaptation

Introduction

The effects of climate variability and change (Figure 6.1) will impact on the quality and availability of natural resources, biodiversity and territorial stability acting also as amplifiers of pre-existing environmental vulnerabilities. These environmental effects will generate risky conditions for the health and wellbeing of the population. An adaptation of the current environmental and health prevention systems is therefore required to cope with these changes. It is indeed necessary to re-think the way in which prevention, surveillance and monitoring activities are planned, organized and implemented as well as the response capacities to emergencies aimed to reduce negative impacts on the exposed population.

The observed effects of climate variabilty and change will impact on the quality and availability of natural resources, biodiversity and territorial stability acting also as amplifiers of pre-existing environmental vulnerabilities.

Increase of average global temperatures:
- Increase of maximum temperatures during hot days
- Increase of minimum temperatures during cold days
- Increase of the annual number of hot days
- Increase of the frequency, duration and intensity of heat waves.

Gradual changes in rainfall:
- Increase of the frequency, duration and intensity of dry periods and droughts
- Variations of the duration, localization and intensity of rainfall and snowfall.

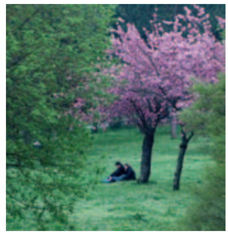
Increase of the frequency and intensity of extreme meteorological events:
- Increase in the annual frequency of very strong winds, torrential rains, anomalous waves and floods often associated to tropical storms and tornadoes.

Major meteorological vulnerability:
- Increased instability of seasonal meteorological schemes
- Variations in the beginning and end of growing seasons.

Sea level rise:
- Flooding of human settlements
- Salinization of coastal ground water.

Figure 6.1: The effects of climate variability and change[1]

[1] Source: FAO data processed by ISPRA

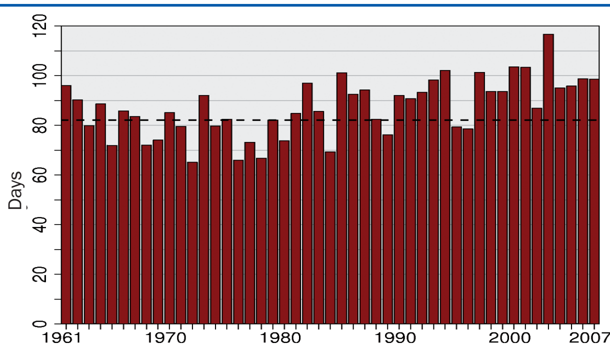


It is well known that health risks from climate change and variability are not only related to mortality or morbidity due to heat waves but they also regard many other potential health effects mediated by environmental changes such as, for example increased risk of infectious diseases transmitted by water, food, vector insects, as well as other unhealthy conditions such bathing water toxicity, chemical food security and changes in distribution and quantity of allergens. A proactive approach in response to a changing environment must therefore identify and define preventive measures in adaptation plans and programmes. These should be integrated with emergency and response systems in order to reduce the adverse consequences of climate change, based on hazard and risk characterization of environment, health and sustainable well being by means of short-term strategies focused on current system vulnerabilities (including the revision of current regulations) and by medium and long term copying measures.

The impacts of climate change call for a proactive response that involves a reorganization of environmental and health prevention systems from a technological, operational and organizational point of view.

The observed data in the last decades show that also Italy is among Countries affected by meteo-climatic change and variability. Time series highlight changes in temperature patterns (Figure 6.2 and 6.3) which will contribute to increase the risk of infectious and allergic diseases as it wil be better discussed further in the text.

In Italy an increase in the number of summer days (T >25°C) has been observed over the last decades.



Note: The dashed line indicates the normal mean value calculated in the period 1961-1990. Data was collected from 49 stations of the AM network

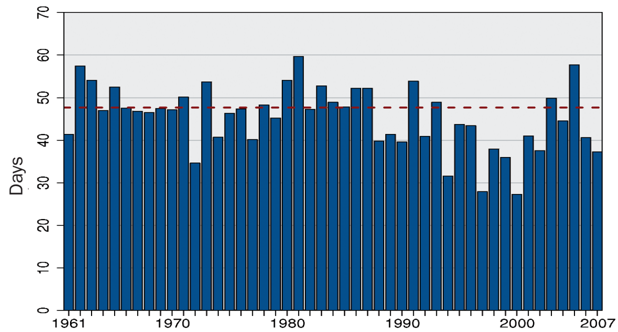
Figure 6.2: Observed data in Italy: average number of summer days[2]

Even the number of rainy days seems to have suffered a statistically significant reduction over the whole national territory, while the

Rainfall patterns are also changed.

[2] Source: ISPRA Environmental Data Yearbook - 2008 Edition

There was also a reduction of about 20% of cold days (T≤0°C) with milder winter and fall seasons.



Note: The dashed line indicates the mean average value calculated in the period 1961-1990. Data was collected from 49 stations of the AM network

Figure 6.3: Observed data in Italy: average number of cold days[3]

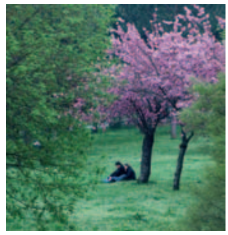
The results of a first national screening of health risks caused by climate change highlight emerging risk conditions.

intensity of rainfall in the Northern and Southern regions has increased at the same time. It is also reasonable to think that Italy will suffer a major increase in temperature in the years to come. An analysis of future scenarios forecasts an increase in the frequency of hot and damp days and, at the same time, a reduction in the number of cold days. The sea temperature is also expected to increase further. These scenarios also forecast a possible reduction in winter rainfall in the Mediterranean region and in Northern Italy as well as an increase in the frequency of intense rainfall patten. A first screening of the meteo-climatic and environmental conditions that will influence related emerging health risk in Italy was conducted by the National Environmental Protection Agency (APAT now ISPRA) in collaboration with the World Health Organization (*APAT–WHO 2007. Cambiamenti Climatici ed Eventi Estremi: Rischi per la salute in Italia"*). On the basis of this National assessment the Environment and Health Task Force of national experts[4]

---

[3] Source: ISPRA Environmental Data Yearbook - 2008 Edition

[4] WG Ambiente e Salute CNCC 2007: Bartolini G. (CIBIC - UNIFi); Bottoni P. (ISS); Braca G. (ISPRA); Bussettini M. (ISPRA); Carere M. (ISS); D'Aponte T. (University of Naples); De Maio F. (ISPRA); De Martino A. (Ministry of Health); Dell'Anno B. (MATTM); Fausto A.M. (University of Tuscia); Funari E. (ISS); Majori G. (ISS); Mancini L. (ISS); Marcheggiani S. (ISS); Martinelli A. (ARPA Umbria); Menne B. (WHO); Miraglia M. (ISS); Morabito M. (CIBIC , UNIFi); Onorari M. (ARPA Tuscany); Orlandini S. (CIBIC, UNIFi); Raineri W. (ARPA Liguria); Rieti S. (ISPRA); Romi R. (ISS); Scala D. (ARPA Tuscany); Sinisi L. (ISPRA); Spizzichino D. (ISPRA); Tuscano J. (ISPRA); Wolf T. (WHO)



established within the framework of the Italian National Conference on Climate Change (CNCC 2007), elaborated specific proposals of measures to support environmental adaptation strategy for the prevention of emerging related health risks. More detailed information can be obtained from the ISPRA publication[5].

Health risks and adaptation of environmental prevention: emerging critical issues and suggested measures

Influence of climate change on vector arthropods and vector borne diseases

In the last few years, meteo-climatic changes have facilitated, not only in developing countries but also in many developed countries an increase in the distribution of many arthropod species potential vectors of diseases. that are very sensitive to environmental and meteo climatic conditions, in particular:

a) Infectious agents and their related vectors are typically sensitive to environmental conditions in terms of survival, reproduction and exponential multiplication of the pathogen;
b) Vectors, being ectothermic organisms (i.e. they cannot regulate their own body temperature), are particularly sensitive to external temperature. Therefore, their biological cycle is strictly regulated by external factors (temperature/humidity).

In addition to meteo-climatic factors, other environmental vulnerabilities can influence the distribution of vectors such as habitat and biodiversity loss, land use, pesticide use and lack of natural predators.

The changes in average temperature and humidity patterns facilitate the distribution of arthropods, potential vectors of viral, bacterial and parasitical diseases.
In addition to meteo-climatic factors, other vulnerabilities can influence the distribution of vectors such as habitat destruction, soil utilization, pesticide utilization and loss of natural predators.

The Tiger Mosquito. Different species of Culicidae[6] permanently live in Italy. Among these *Aedes albopictus*, better known as the tiger mosquito, is a potential carrier of the arbovirus that causes viral diseases (Bluetongue, West Nile, Chikungunya and Dengue).

[5] Cambiamenti Climatici, salute e strategie di adattamento: criticità e proposte operative", ISPRA
[6] *Culex Pipiens* e *Aedes aegypti*. The latter does not currently exist in the Mediterranean basin but could be re-introduced in Southern Europe in the next few years due to meteo-climatic changes in course

The tiger mosquito was introduced in Italy in the early 1990s and by now is well establisehed over national territory. Its health relevance in is that it can potentially become vector for over 20 types of arboviruses.
In its native Countries from Southern China to South East Asia and Africa, the vector is a carrier of dengue (DEN), yellow fever and Japanese encephalitis.

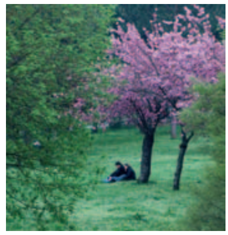
In August 2007 in Emilia Romagna occurred an outbreak of over 200 cases of Chikungunya virus transmitted by the infected tiger mosquito.

In August 2007 in Emilia Romagna, particularly the province of Ravenna, occurred an outbreak of over 200 cases of Chikungunya (a virus from the *Togaviridae* family transmitted by the tiger mosquito) whose endemic area is normally found in different regions of Asia and Africa.
This was the first case in Italy of an outbreak caused by a virus transmitted by the tiger mosquito.
In Italy, the species is already established up to the Alpine regions[7] and its expansion towards the North has reached a peak level.
Up to 2007, the tiger mosquito was observed in many European countries such as Albania, Bosnia Herzegovina, Croatia, Greece, Montenegro, France, Holland, Serbia, Slovenia, Spain and Switzerland[8].
In the last few years the tiger mosquito has also become a “competent vector” carrying other viral diseases such as the West Nile fever (some cases were also recently observed in Italy) and Dengue.
The main meteo-climatic determinants for its settlement are the reduction of average cold temperatures (milder winters and autumns), the reduced quantity and frequency of rainfall and the shorter duration of daylight hours. Figure 6.4 describes the areas for possibile establishment of the tiger mosquito based on 5 different climate scenarios (Source: ECDC).

The Phlebotomus and Leishmaniasis.

Sandfly (Phlebotomus)*.* Leishmaniasis is an infectious disease caused by a protozoan parasite, the *Leishmania infantum.* It is transmitted to humans through the bite of an infected female of

[7] Romi R. (2001a), *Aedes albopictus* in Italy: *an underestimated health problem.* Ann. Ist. Super. Sanità, 37(2): 241-247
[8] *European Center for Disease Prevention and Control (ECDC) Meeting Report* | Paris, 22 October 2007
Consultation on vector-related risk for chikungunya virus transmission in Europe



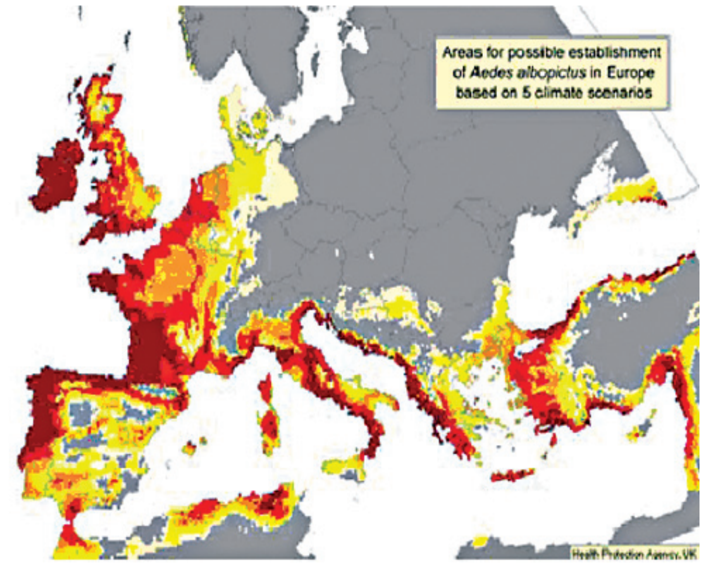


Figure 6.4: Potential Areas of interested by tiger mosquito in Europe based on 5 climate scenarios[9]

The future increase in the distribution of the tiger mosquito in Europe is influenced by meteo-climatic scenarios (temperature and rainfall).

sandfly (Phlebotomus). Both vector's activity and the development of the protozoan parasite in the vector[10] are influenced by temperature.

In Italy, the disease affects humans in two forms: Zoonotic Visceral Leishmaniasis and Sporadic Cutaneous Leishmaniasis. The average increase of temperature could favour the spread of both Zoonotic Visceral Leishmaniasis (ZVL)[11] and its vectors, the Phlebetomus[12],

---

[9] Source: ECDC, 2007
Note: Scenario 1 (light yellow) = 450 mm annual rainfall, -1°C isothermic January; Scenario 2 yellow) = 500 mm - 0°C; Scenario 3 (orange) = 600 mm - 1°C; Scenario 4 (red) = 700 mm - 2°C; Scenario 5 (brown) = 800 mm - 3°C

[10] Bates PA. *Interazione fly Leishmania sabbia: progressi e sfide. Curr Opin Microbiol.* 2008 Jul 11. [Epub ahead of print] PMID: 18625337. Bates PA. *Trasmissione di promastigotes Leishmania metacyclic dalla sabbia phlebotomine mosche.* Int J Parasitol. 2007; 37 (10) :1097-106

[11] The most common reservoir are dogs, while the main vector is the *Phlebotomus perniciosus*

[12] Hematophagous diptera belonging to the Psychodidae family, *Phlebotomus* genus

even in unaffected areas of Northern regions (where only some sporadic cases of dog Leishamiasis had been recorded), as well as an increase of incidence in in already endemic areas . The other form of disease, Sporadic Cutaneous Leishmaniasis (SCL), is caused by dermotrophic species of *Leishmania infantum*.

According to the WHO, the endemic area of Leishmaniasis has expanded since 1993. Currently, it is endemic in 88 countries of the five continents.

According to the WHO, the endemic area of Leishmaniasis has expanded since 1993. Currently, the disease is endemic in 88 countries of the five continents with a total of 12 million diseased and over 350 million people at risk. In the Mediterranean area, during the whole course of the 1990s, there was a alarming increase of Zoonotic Visceral Leishmaniasis human cases . According to the Istituto Superiore di Sanità (National Health Institute), the annual incidence in 2000 was of about 200 cases/year while today we count an average of 500 cases/year.

The Phlebotomus and the arbovirus.

In Italy, Phlebotomus vectors also carry the arbovirus belonging to the *Flebovirus* genus of the *Bunyaviridae*[13] family. Other two fleboviruses were isolated in the 1970s and 1980s. The first is the Toscana virus[14], an agent of central nervous system infectious disease (mainly benign Meningoencephalitis). This virus has been found in at least 3 regions of central Italy (Tuscany, Marche and Abruzzo) and more than 100 species of this virus have been identified in the *Phlebotomus perfiliewi* and *Phlebotomus perniciosus*[15]. The second identified virus is Arbia virus, isolated in same vectors[16] in Tuscany and Marche. It didn't affect any humans so far.

The ticks.

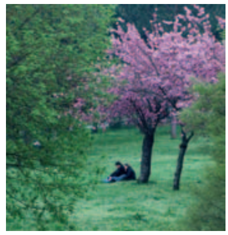
Non-Insect Arthropods (ticks). Many diseases can be also transmitted by non-insect arthropods such as ticks. Among them are the *ixodidae* - or hard ticks - that are vectors of a large variety of

[13] Nicoletti L., Ciufolini M.G., Verani P. (1996) *Sandfly fever viruses in Italy*. Arch. Virol. Suppl., 11: 41-47

[14] Verani P., Lopes M.C., Nicoletti L., Balducci M. (1980), *Studies on Phlebotomus-transmitted viruses in Italy*. I: *Isolation and characterization of a sandfly fever Naples-like virus*. In: Vesenjak-Hirjan J, ed. Arboviruses in the Mediterranean Countries, Zbl Bakt.Suppl 9. Stuttgart: Gustav Fischer Verlag; pp.195–201

[15] Verani P., Ciufolini M.G., Nicoletti L. (1995), *Arbovirus surveillance in Italy*. Parassitologia, 37(2-3): 105-108

[16] Verani P., Ciufolini M.G., Caciolli S., Renzi A., Nicoletti L., Sabatinelli G., Bartolozzi D., Volpi G., Amaducci L., Coluzzi M., Paci P., Balducci M. (1988), *Ecology of viruses isolated from sand flies in Italy and characterized of a new Phlebovirus (Arbia virus)*. Am. J. Trop. Med. Hyg., 38(2):433-439



agents carrying infections that can affect both cattle and humans. From this point of view, there are two kind of ticks of health relevance in Italy: the dog tick, *Rhipicephalus sanguineus*[17], and the forest tick, *Ixodes ricinus*[18], also called sheep tick. The increase of average temperature could have different impact for these two main vectors and on the incidence of the transmitted pathogen. *Tick Borne Encephalitis* (TBE) is caused by an arbovirus of the *Flaviviridae* family and is transmitted by ticks (mainly *Ixodes Ricinus*) that act both as vectors and virus reservoir[19]. In Italy, TBE exists in the region of Friuli Venezia Giulia which has already adopted a vaccination plan for the population at risk. The disease is more widespread in Europe, even if there are fewer cases than Lyme disease. Lyme Borreliosis is caused by an infection from Spirocheta, a bacterium (Borrelia burgdorferi) that is transmitted to humans through the bite of infected ticks of the *Ixodes* genus. The infection, of bacterial origin, mainly affects the skin, joints, nervous system and internal organs. Symptoms can sometimes be serious and persistent and if it is not treated with drugs it will become a chronic diseases. The Italian regions that are mainly affected are Friuli Venezia Giulia, Liguria, Veneto, Emilia Romagna and Trentino Alto Adige (Autonomous Province of Trento). Some sporadical cases have also been identified in the Central and Southern regions and the major Islands.
Milder winter temperatures, caused by climate change, could facilitate the geographical distribution of Lyme Borreliosis in higher altitudes and latitudes. In Europe, Lyme Borreliosis currently records at least 85,000 cases per year and has a growing impact in many countries such as Finland, Germany, Russia, Scotland, Slovenia and Sweden.
Although not all the listed vectors are potentially pathogen carriers (i.e. infected), epidemiological data indicate that the risk is increasing. This represent a public health issue related to the diffusion of certain infectious diseases and must therefore be faced through a systematic environmental preventive

A variation towards milder winter temperatures, caused by climate change, could favour the expansion of Lyme Borreliosis in the higher altitudes and latitudes.

[17] Vector of rickettsial diseases and in particular of *Rickettsia conorii*, the agent of Botonous fever
[18] This is the vector of the TBE virus, which is the agent of the so-called Tick Borne Encephalitis and of the *Borrelia burgdorferi* s.l., which is the agent of Lyme disease or Lyme Borreliosis
[19] Source: EECDC, 2009

Adjustment measures must provide specific environmental action.

activity aimed at controlling the natural populations of vector arthropods.
The spreading out of these populations is caused by very different environmental and social conditions (urban, rural and coastal environments; wetlands; natural protected areas; etc.), which therefore require specific knowledge and approaches. It is evident that any action aiming to the control of these arthropods population should include a detailed assessment of the specific local environmental conditon together with an assessment of the short and long term impacts both on existing species and biodiversity.
The arthropod vector management issue should therefore be included in management, conservation and protection of biodiversity programmes, approaching also local relevant human activities.
The main critical issues for a adequate risk management are:

- Geo-referenced and quantitative knowledge of both species and environmental infected reservoirs;
- Efficiency of eco-compatible biological methods for the vector control.

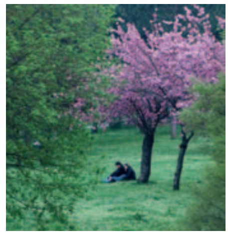
A priority objective in preventing vector-transmitted diseases, not only endemic but also newly introduced, is the assessment of the arthropod diffusion risk.
The achievement of this first objective requires:

- Identifying and locating vector arthropod populations, both autochthonous and allochthonous, involved in the transmission of plasmodes (Anopheline mosquitoes), leishmanias (Phelbotomes), arboviruses (tiger mosquito and ticks), filarials (tiger mosquito), rickettsias and bacteria (ticks);
- Constant monitoring of the dynamics of both vector species populations and possible reservoirs, with respect to the progress of climate events.

Environmental prevention

The identification and location of vector arthropod populations and their monitoring require the following working stages:

- Determination of the distribution and density of foci where arthropods with health relevance in the territory develop. This



is done by catching them with appropriate systems (there are different ones according to the considered vector species);
- Characterization and mapping of the vector species' distribution areals by GIS software, with respect to the epidemiology of the transmitted diseases;
- Identification of the transmission risk of pathogens carried by these arthropods by defining areas with highest risk;
- Assessing environmental, climatic and anthropic parameters that could activate their potential as vectors of pathogenic agents harmful to humans;
- Construction of local health risks maps taking in account the impact of climate change and weather events (floods, water shortage and overheating) on populations of different vector species. Such maps will be realized through statistical associations between data on the distribution and density of foci and environmental and climatic variables.

The mapping of foci where potential vectors of pathogens may develop is therefore a prevention tool both during emergency stages of events and in planning ad hoc measures.

The mapping of foci where potential vectors of pathogenic agents develop is therefore a prevention tool both during the emergency stage, the forecasting of events and in planningand adopting ad hoc measures.

The latter can be classified into short and long term actions.
Siggested short term action are:
- To assess the need of different measures according to different local environmental sites;
- To considere the strategies that need to be implemented, which should take into account risk maps, environmental protection, conservation of biodiversity and social factors;
- To implement focused action aimed to restraint vector populations by techniques based on previous assessment;
- To verify the efficiency of adopted measures;
- To monitor vector populations (by distribution and density) and possible pathogens in areas at risk.

Long term action includes:
- To plan strategies to control vectors within the framework of an integrated environmental management;
- Training environmental operators with adequate skills so that they can be involved in integrated monitoring programmes;
- Implementing an information programme for managers and citizens in order to spread information and processed results to

all relevant local stakeholders. Information programme can be also carried out in schools and training courses can be also organized.

Influence of climate change on water and food quality and availability

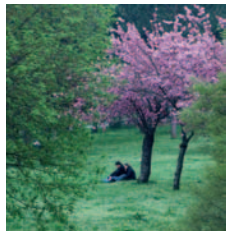
Food security

About the term "*food security*" is applied when all the people, at every time, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences in order to have an active and healthy life[20]. In order to achieve food security, all four components (i.e. availability, stability, accessibility and utilization) need to be satisfied.

The changes in climate conditions can affect food security acting on all components of the food system at global, national and local level.

The most frequent and intense extreme events (such as droughts, increase in sea level and irregular seasonal rainfall patterns) are already showing immediate impacts on food production, food distribution infrastructures, incidence of food emergencies, and food availability for survival and and health lives, both in rural and urban areas (Figure 6.5).

[20] FAO, *Climate Change And Food Security: A Framework Document*. Prepared by the Interdepartmental Working Group (IDWG) on Climate Change of FAO, 2007



Climate change can affect food security acting on all food security system components. More frequent and intense extreme events, such as droughts increase in sea level and irregular seasonal rainfall patterns, are already showing impacts on: food production, food distribution infrastructures; the increase of food emergencies; resource availability for survival and and health lives.

EFFECTS OF CLIMATE CHANGE TAHT ARE IMPORTANT FOR FOOD SECURITY

CO_2 FERTILIZATION EFFECTS
- Increase in availability of atmospheric carbon dioxide for plant growth

INCREASE IN GLOBAL MEAN TEMPERATURES
- Increase in maximum temperature on hot days
- Increase in minimum temperature on cold days
- Increase in annual occurrence of hot days
- Increase in frequency, duration and intensity of heat waves

GRADUAL CHANGES IN PRECIPITATION
- Increase in frequency, duration and intensity of dry spells and droughts
- Changes in timing, location and amounts of rain and snowfall

INCRREASE IN FREQUENCY AND INTENSITY OF EXTREME WEATHER EVENTS
- Increase in annual occurrence of high winds, heavy rains, storm surges and flash floods, often associated with tropical storms and tornados

GREATER WEATHER VARIABILITY
- Greater instability in seasonal weather patterns
- Change in start and end of growing seasons

RISE IN SEA LEVEL
- Inundation of human habitats
- Saltwater intrusions

Figure 6.5: Effects of climate change that are relevant for food security[21]

The impacts of temperature changes will probably include:
- Changes in the suitability of land for crops and livestock;
- Changes in the conditions and productivity of forests;
- Changes in the distribution, productivity and composition of sea resource communities;
- Changes in the incidence of vectors carrying various types of epidemics and diseases;
- Loss of biodiversity and of ecosystemic function of natural habitats;
- Changes in the distribution of good quality water for farming, cattle and fish culture production;
- Loss of arable land due to the increase in aridity and the saline intrusion for groundwater depletion and sea level increase;

[21] Source: FAO, 2007

The causal chain through which weather variability and extreme events influence human nutrition is complex and involves different factors, such as: shortage of water; salinization of agricultural land; destruction of farm products due to floods; interruption of logistics due to disasters; increase in the incidence of plant infections and/or infestation.

- Changes in nurishment options;
- Changes in health risks;
- Internal and international population migration.

Wellbeing systems based on agriculture, which are already vulnerable to the risk induced by climate change, can experience an increase in harvest failures, loss of cattle and fish supplies, major shortage of water and destruction of productive resources. This includes small-scale farming systems rains-depending, systems based on cattle or sheep breeding, communities based on fishing and/or aquaculture (both coastal and inland) and systems based on forest resources.

The rural populations that are mainly at risk are those living along coastal areas, alluvial plains and low river deltas, the mountains and arid or arctic areas. Among these populations there will be probably an increase in the previously existing socio-economic disequalities worsening the nutritional status of women, children, elderly as well as people with chronic diseases and disabilities.

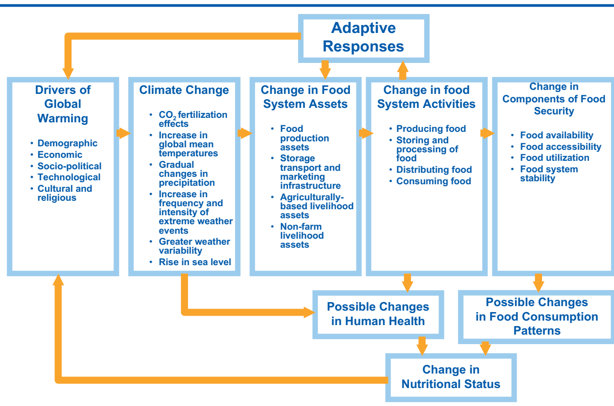
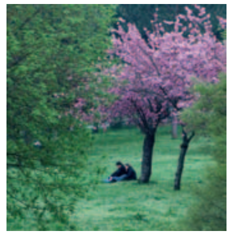


Figure 6.6: Complex interrelations between climate change and food security[22]

In temperate regions, moderate local increases in the mean temperature (from 1 to 3°C), together with the associated increase of CO_2 and changes in precipitation, could have modest beneficial impacts on farming, including wheat, maize and rice. On the

[22] Source: FAO, 2007



other hand, global warming and increase in the frequency of heat waves and droughts in the Mediterranean (which will lead to an increase in semiarid and arid pastures) will cause a reduction in cattle productivity[23].

The causal chain through which weather variability and extreme events influence human nutrition is complex and involves different factors, such as, shortage of water, salinization of agricultural land, destruction of farm products by floods, interruption of logistics caused by disasters, increase in the incidence of plant infections and/or infestations[24]. Adaptation strategies must be focused on each factor and interrelated.

Food safety

Food safety is a scientific discipline describing management, preparation, and storage of food in order to prevent foodborne diseases. These can be caused either by pathogenic agents (viruses, bacteria or prions) that contaminate food, or by environmental toxins.

Climate change together with the way in which food is produced, distributed and consumed, can potentially influence food infections in the next century.

Climate changes together with the way in which food is produced, distributed and consumed, can potentially influence food borne diseases in the next century.

A statistical association between diseases and temperature changes in the short term also suggests that foodborne illnesses shall be influenced by climate change in the long term[25].

Cases of fooborne diseases can be associated to extreme climate events since rain andfloods can favour the spread of pathogens. For example, fresh fruit and vegetables can be contaminated by waterborne pathogens such as the protozoes *Cyclospora* and *Cryptosporidium spp*. Shellfish can also be contaminated by enteric bacteria and viruses that can survive to water treatment plants,

---

[23] APAT - WHO, 2007. *Cambiamenti Climatici ed Eventi Estremi: Rischi per la salute in Italia*

[24] IPCC, 2007: *Climate Change 2007: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change* [Parry, Martin L., Canziani, Osvaldo F., Palutikof, Jean P., van der Linden, Paul J., and Hanson, Clair E. (eds.)]. Cambridge University Press, Cambridge, United Kingdom, 1000 pp

[25] Hall G.V., D'Souza R.M., Kirk M.D. (2002). *Foodborne disease in the new millennium: out of the frying pan and into the fire?* MJA, 177: 614-618

especially if there is a contaminated overflow that occur during floods.
Cases of food poisoning can also be related to meteorological conditions of unexpected heat that can increase bacterial replication. For example, more cases of food poisoning were reported during unusually hot summers both in the UK and in Australia. In general, salmonellosis increase by 5-10% for every 1-degree increase in weekly temperatures, for average temperatures above 5 degrees (Figure 6.7).

Cases of salmonellosis increase by 5-10% for every 1 degree increase in weekly temperatures, for average temperatures above 5 degrees.

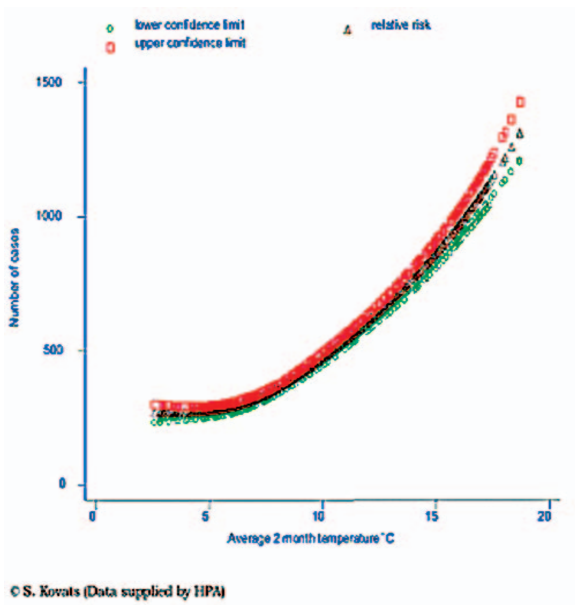
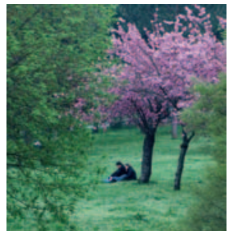


Figure 6.7: Association between cases of salmonellosis and increase in temperature[26]

[26] Source: *Health Effects of Climate Change in UK*, 2008



About one third of salmonellosis transmission cases in England, Wales, Poland, Netherlands, Czech Republic, Switzerland and Spain can be caused by temperature changes. The effect of temperature is more evident one week before the disease, highlighting the importance both of inadequate food preparation and of its storage. Indeed, both the lack of hygiene and the poor control of the temperature during the production, processing, transport, preparation and conservation of food can interact enabling the proliferation of pathogens.

Epidemics caused by waterborne pathogens have been connected to extreme climate events, whose frequency is expected to increase in the decades to come. Furthermore, many cases of gastroenteritis caused by waterborne and foodborne pathogens (especially diseases caused by salmonella and *Campylobacter*) show distinct summer recurrence patterns. Although behaviour patterns could be related to seasons (e.g. preparing barbecues or swimming in the summer) the association between hotter temperatures and diseases highlights that the rate of waterborne and foodborne diseases increases as temperatures rise[27].

In the CASHh report (Climate Change and Adaptation Strategies for Human Health in Europe) epidemiological studies were conducted to describe and quantify the effect that temperature has on foodborne diseases. Data provided by observation laboratories in different European countries confirmed the presence of salmonella (Italy did not participate in the study).

Microscopic filamentous fungi can develop on a large variety of plants and can lead to the production of highly toxic chemical substances, commonly called mycotoxins[28]. The most widespread and studied mycotoxins are metabolites of some types of mould such as *Aspergillus, Penicillium* and *Fusarium*. Contamination caused by fungi can take place during almost all the stages of the food chain (harvesting, storage and transport). Fungi colonization and diffusion are favoured by environmental conditions and

---

[27] Greer A., Ng V., Fisman D. (2008). *Climate chage and infectious diseases in North America: the road ahead. CMJA*, 178(6)

[28] Toxins, originating from fungi and miceti, can produce mycotoxins poisoning by food consumption

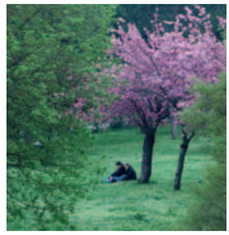
nutritional components, as well as other factors such as infestation by insects or weeds. The biosynthesis of mycotoxins is influenced by quite unique conditions, such as: climate and the geographical location of the cultivated plants,farming practices, storage and types of substratum.

For the moment we can only make forecasts on the basis of acquired knowledge about the key environmental conditions favouring main fungi and/or toxins.

So far we can only make forecasts on the basis of acquired knowledge about key environmental conditions favouring main fungi and/or toxins production. For example, an increase in contamination from *Aspergillus flavus* could be particularly relevant for maize, which is the main crop in Italy affected by these toxins. Indeed, in 2003 there was an unusual peak in maize contamination by aflatoxins due to high temperature and extreme drought. Tons of maize got destroyed due to the presence in food and animal feed of an unacceptable level of these toxins. Fortunately, the impact on human and animal health was minimized thanks to the rapid alert system managed by control authorities. The optimum temperature for the development of toxins a range between 15 and 30 °C. The production of fumonisins has been associated to the dry climate during the grain filling period and the late seasonal rains, so the climate changes that are expected to take place in Italy probably will help the production of toxins.

Climate change can influence insects' capacity to affect plants, altering their ability to tolerate winter, their distribution on farming land and insect varieties.

Climate change can influence insects' capacity to affect plants, altering their ability to survive winter season, as well as their distribution on farming land and insect varieties. We have very little examples of interrelations existing between fungi/mycotoxins and insect attacks on agricultural plants. In almonds and pistachios, high contamination by aflatoxins is associated to damages deriving from larvae of Navel orange worm, while high levels of aflatoxins in maize are almost always associated to damages due to insects, particularly by European corn borer, *Ostrinia nubilalis* (meal moth). Contact between food and infestant species (especially flies, rodents and cockroaches) is temperature sensitive. The activity of flies is mainly influenced by temperature rather than by biotic factors. It is probable that in temperate countries, which have warmer climate conditions and milder winters, the quantity of flies and other infestant species will increase during the summer months, with an early appearance of infestants in spring.
H*armful Algal Blooms* (HABs), which produce toxins, can also



cause human diseases through the consumption of contaminated shellfish. Seawater warming can therefore contribute to the increase of contaminated shellfish or coastal fish, leading to a growth in the distribution of diseases such as ciguatera, an intoxication caused by ciguatoxin (toxin produced especially by *Gambierdiscus toxicus* microalgae).
Vibrio parahaemolyticus and *Vibrio vulnificus* are responsible for no viral infections related to fish consumption in USA, Japan and South East Asia. Their abundance depends on coastal waters salinity and temperature . In 2004, a significant outbreak due to the consumption of oysters contaminated by *V. parahaemolyticus* occurred, which was related to the presence of unusually high temperatures in the coastal waters of Alaska.
The chemical security of waters and food during long periods of drought is also worth it to be considered. A higher concentration of chemical pollutants in waters used for human consumption is forecasted (since a water shortage is followed by a poor dilution effect). Furthermore, increase of plants infestation and temperature lead to both a higher use of pesticides (which degradation is increased by higher temperatures) and a more frequent utilization of new synthesized molecules.

The environmental controls network and the management of biological and chemical contamination

The mitigation of health risk scenarios to prevent contamination of water and food must keep into account new emerging health risks.
The adaptation strategy must on one hand revise environmental control and monitoring protocols and, on the other hand, promote specific action on different determinants such as agricultural practices and the performance of water services (i.e. safer management of water provision, water treatment and sewage services). Their performance is extremely vulnerable during floods, droughts and temperature increases, contributing to increase microbiological and chemical pollutant load in water bodies and soil, also compromising the burdensome water management and protection policies.
The technological and management challenges imposed by climate

The adaptation strategy must on the onehand revise environmental control and monitoring protocols and, on the other hand, promote specific action on different determinants such as agricultural practices and performance of water services, water treatment and sewage services. Technological and

management challenges are: guaranteeing the functioning of existing structures; eliminating management failures of inefficient ones; planning the safe use of new water sources in case of drought; preventing the unavailability of acceptable water quality during flood emergencies.

change: to protect optimal functioning of existing structures; to eliminate management failures of inefficient ones; to plan safe use of new water sources in case of drought or contaminated groundwater; to prevent the unavailability of safe water quality during flood emergencies.

In this regard, ISPRA chairs the international *Task Force on Extreme Weather Events*[29] which, through integrated adaptation measures (involving environmental operators, health services and network managers), has the duty of developing guidelines for the management of the new major environmental risks in order to protect health by improving the performance of water and sewage services during extreme climate events. The draft guidelines[30] are already available on the web site:

http://www.unece.org/env/water/meetings/documents_TFEWE.htm

Climate change, airborne pollens and fungal spores

Climate change has caused an anticipation of the spring pollen season in the Nothern hemisphere. It is therefore reasonable to believe that allergies from pollens (such as allergic rhinitis) have a concomitant seasonal variation.

Climate change has a significant impact on airborne pollens, as reported in the fourth Report of the Intergovernmental Panel on Climate Change (IPCC) WG II.

Climate change has caused an anticipation of spring pollen season in the Nothern hemisphere[31]. It is therefore reasonable believe that allergies from pollens, such as allergic rhinitis, will have a concomitant seasonal variation[32].

While there is a wider presence of some species of pollens, it is still not clear whether even the allergenic content of these pollens has changed, a phenomenon that would surely have important

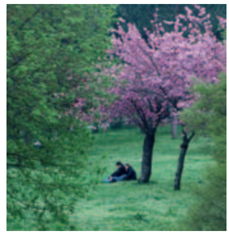
---

[29] The Task Force was inserted in the working programme 2007-2009 of the Water and Health Protocol at the UNO-ECE Convention on Water. Our Ministry for the Environment holds the leadership and ISPRA chairs the Task Force

[30] UNO-ECE Guidelines on Water Supply and Sanitation in Extremes

[31] D'Amato G., Liccardi G., D'Amato M., Cazzola M. (2002).*Outdoor air pollution, climatic changes and allergic bronchial asthma*. Eur. Respir. J., 20: 763-776

[32] Burr M.L., Emberlin J.C., Treu R., Cheng S., Pearce N.E. - ISAAC Phase One Study Group. (2003). *Pollen counts in relation to the prevalence of allergic rhinoconjunctivitis, asthma and atopic eczema in the International Study of Asthma and Allergies in Childhoo*d (ISAAC). Clin. Exp. Allergy, 33(12): 1675-1680



effects on the exposed people[33]. Some studies also show an increase in the exposure to fungi spores and bacteria[34].
Changes in the spatial distribution of natural authoctonous species[35], as well as the introduction of new allergenic species, increase the sensitization of genetically prone individuals. The appearance of new invasive plants (such as Ambrosia) is an important allergy risk for the population living in parts of the world where these plants have raised their distribution[36]. For instance, many laboratory studies show that increase in both CO_2 and the temperature produces a greater quantity of Ambrosia pollen and extends the pollen season, also increasing some plant metabolites that can have a negative impact on health[37].
These changes particularly affect species that bloom in late winter and spring.
Many specific studies have actually highlighted in the last few years a growing anticipation in the blooming period of many allergenic plant species and families, such as Birch[38], *Compositae*[39], *Urticaceae*[40],

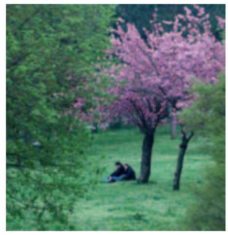
---

[33] Beggs P.J. and Bambrick H.J. (2005), *Is the global rise of asthma an early impact of anthropogenic climate change?* Environ. Health Persp., 113: 915-919
[34] Harrison R.M., Jones A.M., Biggins P.D., Pomeroy N., Cox C.S., Kidd S.P., Hobman J.L., Brown N.L., Beswick A. (2005), *Climate factors influencing bacterial count in background air samples*. Int. J. Biometereol., 49: 167-178
[35] Cecchi. L., Morabito M., Domeneghetti M.P., Crisci A., Onorari M., Orlandini S. (2006), *Long-distance transport of ragweed pollen as potential cause of allergy in central Italy*. Ann. Allergy Asthma Immunol., 96(1); 86-91
[36] Taramarcaz P., Lambelet B., Clot B., Keimer C., Hauser C. (2005), *Ragweed (Ambrosia) progression and its health risks : will Switzerland resist this invasion*? Swiss Med. Wkly., 135: 538-548
[37] Rogers C., Wayne P., Macklin E., et al (2006*), Interaction of the onset of spring and elevated atmospheric CO_2 on ragweed (Ambrosia artemisiifolia L.) pollen production.* Environ. Health Persp.,114:865-869. Mohan J.E., Ziska L.H., Schlesinger W.H., Thomas et al (2006), *Biomass and toxicity responses of poison ivy (Toxicodendron radicans) to elevated atmospheric CO_2*. Proc. Natl. Acad. Sci. USA, 103: 9086-9089
[38] Van Vliet A.J.H., Overeem A., De Groot R.S., Jacobs A.F.G., Spieksma F.T.M., (2002). *The influence of temperature and climatic change on the timing of pollen release in the Netherlands*. Int. J. Climatol., 22: 1757-1767
[39] Stach A., Garcia-Mozo H., Prieto-Baena J.C., Czarnecka-Operacz M., Jenerowicz D., Silny W., Galan C. (2007), *Prevalence of Artemisia species pollinosis in western Poland: impact of climate change on aerobiological trends, 1995-2004*. J. Investig. Allergol. Clin. Immunol., 17(1): 39-47
[40] Frenguelli G., *Interactions between climatic changes and allergenic plants.* Monaldi Arch. Chest. Dis., 2002, 57(2): 141-143

Graminaceae[41], *Juniperus ashei*[42] and *Cryptomeria japonica*[43].
Studies highlighting increases both in the concentration and persistence of fungal spores in the atmosphere are also very interesting[44] (PTCP Ravenna, 2006). Some fungal spores (Alternaria, Epicocco, *Cladosporium, Aspergillus, Penicillum*, etc.) can not only cause allergic manifestations but also be responsible for plant diseases, thus requiring the use of additional chemical treatments that will increase the contamination risk of food and farm products for human consumption. Outdoor fungal spores can also penetrate into indoor environments and (due to the favourable temperature and humidity conditions) can reproduce throughout the whole year.
Climate change can also modify the dispersion of plant pathogen (bacteria, fungi and parasites), making some stressed hosts more prone to attacks from new pathogens.
In terms of impact, airborne pollens of some plants can be responsible for the occurrence of allergic diseases, known as pollinosis[45]. These pathologies generate high social costs, both direct (pharmaceutical expenses, health assistance expenses, loss of working days, etc.) and indirect (loss of the patient's and his family's productivity, loss of school days, etc.). It has been calculated that at least 7-8% of Italian population suffers from clinical manifestations of pollinosis. Pollinosis is more frequent in the second and third decades of life, without significant differences between the two genders. A comorbility between rhinitis and asthma is frequently found (40-80% of patients suffering from asthma have rhinitis and 20-40% of rhinitis sufferers also have asthma). These

---

[41] Burr M.L., Emberlin J.C., Treu R., Cheng S., Pearce N.E. - ISAAC Phase One Study Group. (2003). *Pollen counts in relation to the prevalence of allergic rhinoconjunctivitis, asthma and atopic eczema in the International Study of Asthma and Allergies in Childhood (ISAAC)*. Clin. Exp. Allergy, 33(12): 1675-1680
[42] Levetin E. (2001). *Effects of climate change on airborne pollen*. J. Allergy Clin. Immunol., S107:S172
[43] Teranishi H., Katoh T., Kenda Y., Hayashi S. (2006). *Global warming and the earlier start of the Japanese-cedar (Cryptomeria japonica) pollen season in Toyama*, Japan. Aerobiologia, 22(2): 90-94
[44] Ariano R., Bonifazi F. (2006). *Aerobiologia ed allergeni stagionali*. ECIG
[45] Pollinosis is the most common allergopathy. It includes all clinical manifestations (eye, nose and lung) that occur in people who have become sensitive to pollens of some families of plants or trees



pathologies are supported by a common inflammation process of the respiratory system. Climate change also influences the quality of air, changing its composition (ozone, particulate matter, etc.) and therefore infuencing possible interactions with pollens and/or allergies[46]. Major climate variations produce an increaseof pollens and fungal spores that together with variations in the quality of air (in terms of ozone, other gases and PM), will amplify the negative influences on the functionality of the respiratory and cardio-circulatory system.

It is generally known that air pollution, and the Western life style are responsible for the increase in both allergic respiratory failures and cases of bronchial asthma. Many studies report a higher incidence of allergies in the urban population with respect to the rural one[47].

Experimental studies show that some pollutants interact with allergens inhaled with pollinic microgranules, causing a higher sensitization in allergic individuals and an exacerbation of symptoms[48].

Furthermore, exposure to pollutants seems to reduce mucociliary clearance, increase oxidation stress and stimulate the production of proinflammatory cytokines favouring allergens inhalation[49]. Indeed, in Mediterranean urban areas of the there are not only pollutants, such as (NO_2, PM_{10} and $PM_{2,5}$) but also high concentrations of ozone (O_3), which is a significant irritant for respiratory system. High concentrations of this pollutant are indeed, associated with an increase in asthma attacks, since ozone raises the levels of inflammatory cells and of proinflam-

---

[46] The case of Atlanta is well-known, when during the 17 days of the Olympics in 1996 the traffic blockage caused a significant reduction in the ozone levels and of asthmatic cases in children (Friedman et al., 2001)

[47] D'Amato G. (2000), *Urban air pollution and plant-derived respiratory allergy*. Clin. Exp. Allergy, 30: 628-636 14. Ishizaki T., Koizumi K., Ikemori R., Ishiyama Y., Kushibiki E. (1987) *Studies of prevalence of Japanese cedar pollinosis among residents in a densely cultivated area.* Ann. Allergy, 58: 265-270

[48] Namork E., Johansen B.V., Løvik M. (2006), *Detection of allergens adsorbed to ambient air particles collected in four European cities*. Toxicol. Lett., 165(1): 71-78

[49] D'Amato G., Cecchi L., Bonini S., Nunes C., Annesi-Maesano I., Behrendt H., Liccardi G., Popov T., Van Cauwenberge P. (2007), *Allergenic pollen and pollen allergy in Europe*. Allergy, 62: 976–990

Various epidemiological studies (also conducted in Italy) show that the prevalence of allergic respiratory diseases has considerably increased all over the world in the past decades.

The Italian Study in Young Adults (ISAAC study) found a strong connection between climate and asthma. An increase in the prevalence of asthma is found where temperature range is smaller and where annual mean temperature is higher.

matory mediators in asthmatic patients[50].
Several epidemiological studies[51,52] (also conducted in Italy) show that the prevalence[53] of allergic respiratory diseases has considerably increased all over the world in the past decades. Studies conducted by the American College of Allergy in 2002 show that 15-20% of the population in the United States suffers from allergies and that in most cases the first symptoms appear at schoolgoing ages. Even in Europe, more than 20% of students suffer from allergies and the most common clinical manifestations are atopic dermatitis, rhinitis and hay fever. Asthma must be considered as the main clinical manifestation for its severity , long-term effects and mortality[54].

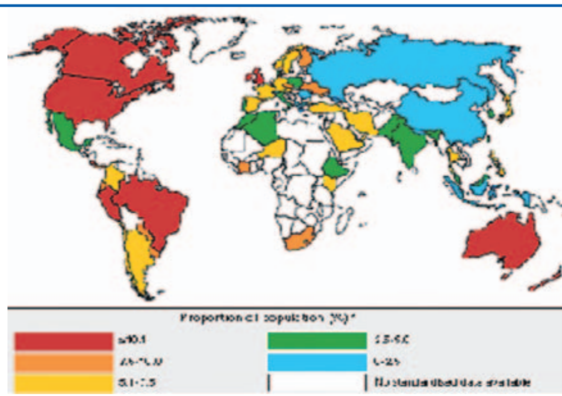


Figure 6.8: Global map of the clinical prevalence of asthma[55]

[50] Bayram H., Sapsford R.J., Abdelaziz M.M., Khair O.A. (2001), *Effect of ozone and nitrogen dioxide on the release of proinfiammatory mediators from bronchial epithelial cells on nonatopic, nonasthmatic subjects and atopic asthmatic patients in vitro.* J. Allergy Clin. Immunol., 107: 287–294

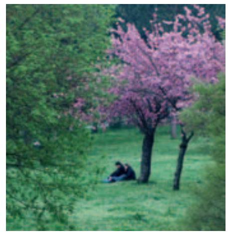
[51] ECRHS (1996), *Variations in the prevalence of respiratory symptoms, self reported asthma attacks and use of asthma medication in the European Community Respiratory Health Survey (ECRHS)*. Eur. Respir. J., 9(4): 687-695

[52] ISAAC (1998), *Worldwide variation in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema*. Lancet, 351: 1225-1232

[53] Prevalence: this measures the number of individuals of a population who, at a given moment, are affected by the disease. This indicator is calculated in relationship to the total number of cases of the disease and the population at risk.

[54] Strachan D., Sibbald B., Weiland Set al (1997), *Worldwide variations in prevalence of symptoms of allergic rhinoconjunctivitis in children: the International Study of Asthma and Allergies in Childhood (ISAAC)*. Pediatr. Allergy Immunol., 8(4): 161-176

[55] Source: Masoli M, Fabian D, Holth S., *Global Burden of Asthma*; GINA



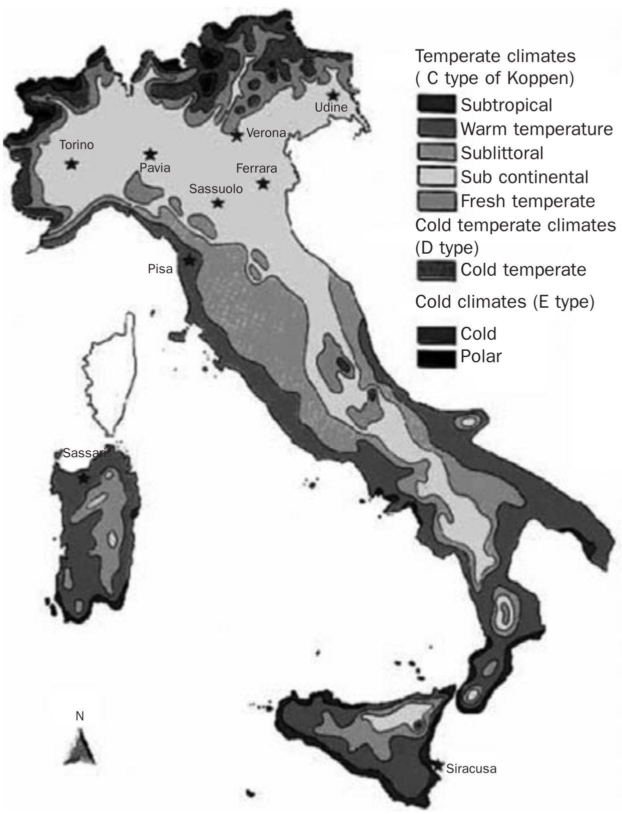


Figure 6.9: Association between climate and asthma[56]

In Italy pollen allergy is estimated to represent about 40% of allergic diseases but it shows an high local variability as summarized in the table below:

[56] Source: Zanolin, E., Pattaro, C., Corsico, A. *et al.*, *The Role of climate on the geographic variability of asthma, allergic rhinitis and respiratory symptoms: results from the Italian study of asthma in young adults.* Allergy, Vol*. 59 (3)*

In Italy pollen allergy is estimated to represent about 40% of allergic diseases but it shows an high local variability as summarized in the tableIn Italy. The different territorial distribution of plants that produce pollens can partially explain the strong sensitization differences in the different regions of Italy.

Table 6.1: Prevalence of pollinosis in Italy[57]

Pollen	North	Centre	South, Islands and Liguria
	% prevalence		
Graminaceae	75	60	40
Urticaceae (Pellitory)	30	40	60
Compositae (Artemisia)	25	15	10
Ambrosia	30	7	2
Chenopodiaceae	1	2	14
Plantaginaceae (Plantago)	4	4	9
Birch	33	13	5
Alder	36	8	7
Hornbeam	34	26	4
Hazel	34	16	4
Cupressaceae	9	28	20
Olea	5	10	25
Fagaceae	7	15	10

The different territorial distribution of plants that produce pollens can partially explain the strong differences in population sensitization in the different regions of Italy. On the basis of these considerations we can state that the expected areal variations of allergenic species can also determine a variation in the prevalence of the various allergies.

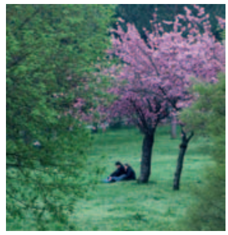
Cases of pollinosis are increasing among the European population.

Cases of pollinosis have increased among the European population too, as emerges from many researches conducted in the last few years [56, 58].

This phenomenon can be explained by various factors, such as a more accurate diagnosis and the introduction of new allergens in the diagnostic panels of routine allergological tests. Even improvement of diagnostic techniques and new scientific evidence are phenomena that may have contributed to identifying a growing number of allergic patients. Some manifestations have only recently been identified as pollinosis. For example, twenty years ago pollen allergy from cypress was considered a “minor pollinosis” while

[57] Source: *Aerobiologia ed allergeni stagionali* Ariano e Bonifazi (2006) data processed by ISPRA
Note: Prevalence is the number of individuals of a population who, at a given moment, are affected by the disease. This indicator is calculated in relationship to the total number of cases of the disease and the population at risk

[58] D’Amato G., Spieksma F.T., Liccardi G., *et al.* (1998), *Pollen-related allergy in Europe*. Allergy, 53(6): 567-578



currently it is the third cause of pollinosis in central Italy.
Even sensitization to fungal spores has a fairly high prevalence in the allergic population, even if this can vary from region to region. An European study highlights an average prevalence of 9.46% of sensitization to Alternaria and Cladosporium, with a variability ranging from the 3% observed in Portugal to the 20% observed in Spain. In an Italian study on Alternaria, instead, while the global prevalence is of 10.5% the observed prevalence ranged from 1.8%, observed in Turin to 29.3% observed in Cagliari[59].
As described above, the importance of pollen allergy is related to the duration and intensity of pollen seasons, the frequency and concentration reached during peaks and the quantity of allergens. On these determinants, temperature variations and rainfall changes could alter the duration and the beginning of the growth season of pollinator plants. the duration of the pollen season in Europe has shown an average increase of 10–11 days in the last 30 years[56].
Many studies show that early blooms are related to the species' behaviour. Indeed, annual species anticipate budding more than perennial ones and those pollinated by insects anticipate it more than those pollinated by wind. In general, early blooming and the peak season of pollens are more pronounced in species that bloom in the early months of the year.
It has been highlighted that climate change can facilitate the dispersion and colonization of species of different plants in new geographical areas[56]. Many international experimental studies show the existence of a relationship between climate change and physiological and biological plant processes. This relationship is sometimes clearly manifested bymigrations of plant species both in altitude and longitude[60]. Infact, in a longer time span, climate change can facilitate the geographical distribution of some plant species in new areas that become climatically suitable. For example, forest species can

As described above, the importance of pollen allergy is related to the duration and intensity of pollen seasons, the frequency and concentration reached during peaks and the quantity of allergens. In this point of view, temperature variations and rainfall changes could alter the duration and the beginning of the growth season of pollinator plants.

[59] Corsico R., Cinti B., Feliziani V., et al (1998) *Prevalence of sensitization to Alternaria in allergic patients in Italy.* Ann. Allergy Asthma Immunol., 80(1): 71-76
[60] APAT – Agenzia per la protezione dell'ambiente e per i servizi tecnici. (2003). Le relazioni tra cambiamenti del clima ed ecosistemi vegetali. Rapporti APAT 32/2003. http://www.apat.gov.it/site/it-IT/APAT/Pubblicazioni/Rapporti/Documento/rapporti_2003_32.html

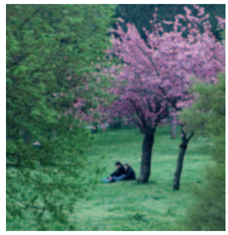
The variation of wind regimes can have important consequences on airborne pollens and therefore on the exposed population. Indeed, wind is responsible for long distance pollen transport, which can be moved also to regions where there aren't plants producing pollens.

move to higher altitudes and/or Northern latitudes. These variations can create new allergies or increase sensitization in population of different geographical areas. For example, the transfer of olive tree cultivation to Northern regions could change the prevalence of olive pollen sensitization in Northern Italy.
Climate change also involves other aspects, such as variation of wind regimes. This could have important consequences on airborne pollens and therefore on the exposed population. Indeed, wind is responsible for long distance pollen transport, which can be moved also to regions where there aren't plants producing pollen. Some researchers believe that the expected variation in wind regimes, related to the current climate change, can have important consequences on these phenomena and ultimately cause the presence of new pollens (and new allergic manifestations) in many Italian regions[61].

The expected increase in extreme events such as storms can have consequences on allergic manifestations. Thunderstorms, when pollens and spores are in the air or even deposited on the ground, have been identified as causes of sudden allergic crisis deriving from the sudden release of large quantities of paucimicronic allergenic particles caused by the breakage of pollens and fungal spores by osmotic shock during the storm. The phenomenon, known as *"thunderstorm asthma"*, was found by several researchers in some Countries such as England[62], Australia[63] and Italy[64].

---

[61] Cecchi. L., Morabito M., Domeneghetti M.P., Crisci A., Onorari M., Orlandini S. (2006), *Long-distance transport of ragweed pollen as potential cause of allergy in central Italy.* Ann. Allergy Asthma Immunol., 96(1); 86-91
Zauli D., Tiberio D., Grassi A., Ballardini G. (2006), *Ragweed pollen travels long distance. Allergy Asthma Immunol.,* 97: 122-123
[62] Davidson A.C., Emberlin J., Cook A.D., Venables K.M. (1996), *A major outbreak of asthma associated with a thunderstorm: experience of accident and emergency departments and patients characteristics.* BMJ, 312: 601-604
[63] Girgis S.T., Marks G.B., Downs S.H., Kolbe A., Car G.N., Paton R. (2000), *Thunderstorm-associated asthma in an inland town in southeastern Australia. Who is at risk?* Eur. Resp. J. 16: 3-8
[64] D'Amato G., Liccardi G., Viegi G., Baldacci S. (2005), Thunderstorm-associated asthma in pollinosis patients. BMJ, http://bmj.bmjjournals.com/cgi/eletters/309/6947/131/c



As explained above, the effects of climate change and, in particular, temperature increase create optimal conditions for the growth and diffusion of fungal spores in the air, which will be released for longer periods in the atmosphere increasing the sensitization risk in the population and/or the occurrence of plant diseases.

Environmental prevention: What do we know? What should we do?

Is is necessary to strengthen local knowledge, implementing aerobiological monitoring of pollens and integrating it with a fungal spore monitoring system. In general, there are two ways of collecting information on pollens and airborne fungal spores in a territory:

- Specific environmental monitoring (aerobiological monitoring);
- Census/mapping of the existing species, including their characterization in terms of significant requirements for health.

It is necessary to strengthen local knowledge, implementing aerobiological monitoring of pollens and integrating it with a fungal spore monitoring system.

In Italy, a project entitled *Rete nazionale di monitoraggio dei pollini e delle spore fungine di interesse allergenico, agronomico e ambientale* (National monitoring network of pollens and fungal spores of allergenic, agronomic and environmental interest - RIMA) is currently running. It is promoted by ISPRA and regional environmental protection Agencies network (ARPA/APPA), in collaboration with the Associazione Italiana di Aerobiologia (Italian Aerobiology Association - AIA), which collects the results of aerobiological monitoring activities carried out in Italy and disseminate information through shared channels. However, monitoring activities do not adequately cover the national territory and there is a poor identification of spores[65]. It is therefore necessary to extend the monitoring network not only by activating pollen and fungal spore sample stations in strategic and priority positions identified according to specific characteristics (plant coverage, territorial utilization, climate zones, etc.), but also using forecast models of airborne biological particles diffusion.
The informations on airborne fungal spores obtained through the network not only prevents their negative effects on health, but are also useful in controlling cryptogamic diseases, preparing

[65] For example, the National Agency's system has at least eight Agencies that map pollens and some species of fungal spores

specific treatments for crops, protecting the environment (air, soil and groundwater) and improving both producers' and consumers' health at the same time.

It would also be useful to define and realize a mapping of urban green able to provide useful information(harmfulness, allergenicity, etc.) on plants existing in public areas such as leasure parks, school garden in order to protect citizens' health.

The awareness of operators working in this sector (such as family doctors, public park employees, etc) and of population should also be increased by means of training courses and information spreading obtained from the integrated management of monitoring networks. This would involve data dissemination during critical seasonal pollinosis periods and the activation of preventive alarm systems identifying the presence of pollens, to be combined with alerts on air pollutants and integrated with aerobiological and local meteorological forecasts.

Conclusions

Health risks and climate change are a well known issue in scientific literature and are widely reported and documented in various national and international government report and assessments.

The management of emerging risks related to new meteo-climatic scenarios can be faced by depicting specific responsibilities to the single sector that influence environmental determinants of health.

But adaptation actions must, in any case, be integrated together, otherwise the adopted measures will be inefficient to control risksand adverse health effects not compatible with a healthy sustainable development.