Cyprus International Institute for the Environment and Public Health

GLOBAL CLIMATE UPDATE COURSE
Research Paper in Public Health related issues

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Research Topic:

How the expected climate change in Cyprus (and nearby Mediterranean region) will affect the water- and food-borne diseases' distribution? Is Cyprus health system prepared for these impacts? What should be done in the future?

Weather is an ancient human health exposure, as told by Hippocrates (Circa 400 B. C) in *"On Airs, Waters and Places"*: "Whoever who wishes to investigate medicine properly, should proceed to this: in the first place to consider the seasons of the year, and what effects each of them produces for they are not at all alike, but differ much from themselves in regard to their changes. Then the winds, the hot and the cold, especially such as are common to all countries, and then such as are peculiar to each locality."

Everyone on the planet talks about the climate change. Human destroys thoughtlessly the environment without thinking the repercussions that may appear not only on himself but also on everybody around him. This destruction has as a result a total climate change. Especially in Cyprus, everyone can see that the climate has changed a lot by the beyond of years. Winters last much shorter than some years ago, the rainfall has been decreased and dams in Cyprus are almost empty. In general, the Mediterranean region will be affected more than any other European area and the forecasts include more droughts, higher temperatures, sea level rise, loss of coastal areas due to floods and erosion, ecosystem's destruction, increase of infectious diseases transmission, etc. The question is: are these projections only hypothetical scenarios? Unfortunately, they aren't.

Nowadays, we face the prospect of an unfamiliar range and scale of hazards to human health from the various global environmental changes that are now emerging (SHOPE 1992). These environmental changes will tend to increase various health problems (whether local malnutrition, the geographic range of vector-borne infections, or the consequences of extreme weather events). Most expected health impacts will be adverse. Expectations are mainly for changes in frequency or severity of familiar health risks. Climate change will increase temperature-related illness and deaths, extreme weather- related health effects; air pollution-related health effects, water and food-borne diseases, vector borne and rodent borne diseases, effects of food and water shortages, and effects of population displacement (Table 1, (Anil Markandya 2009)).

The goal of this research paper is to define the major impacts of climate change in Cyprus and East Mediterranean region to the distribution of water- and food-borne diseases. Contamination of food by viruses, bacteria and pathogens may be induced by increased heat (surface and ocean temperature), because it increases prevalence of food contaminants. Droughts and the resultant decline in water quality are responsible for the increased incidence of water-borne disease. Water contamination of bacteria, viruses, protozoa and parasites, often occurs during drought and flooding.

The burden of disease from water- and food-borne pathogens is substantial. Experts estimate that annually there are more than 210 million cases, 900,000 associated hospitalizations, and 6,000 deaths (CDC 2009). Several water- and food-borne diseases show seasonal patterns, suggesting that they are subject to environmental influences. Specific environmental influences have been documented for several specific pathogens. Environmental changes have effects on pathogen replication, survival, and persistent rates; transmission rates; and disease ranges overall.

Table 1: Health Impacts of Climate Change: Classification.

	Health impacts	
Climate impacts	**Direct**	**Indirect**
Temperature extremes (heat or cold waves).	Heat- and cold- related stresses	- Respiratory and cardio-vascular diseases due to the combined effect of exposure to high temperature and air pollutants
Extreme weather events		
Floods, landslides, storms, cyclones	Deaths and injuries	- Water-borne diseases caused by water contamination and poor sanitation conditions - Psychological morbidity
Droughts	–	- Malnutrition and under-nutrition, due to loss of agricultural production - Water-borne diseases caused by decreased water access and malnutrition - Vector-borne diseases due to changes in vector transmission and stagnation/contamination of small rivers and drainage canals - Respiratory diseases due to increased air-borne particulate matter and increased vulnerability caused by malnutrition and other diseases
Increased temperature	–	- Vector-borne diseases due to higher risk of transmission and changes in the geographical and seasonal distribution - Food-borne diseases due to food contamination

Temperature and precipitation, both of which will increase with climate change, affect the spread of water- and food-borne diseases. In general, increased temperature results in higher pathogen replication, persistence, survival, and transmission for bacterial pathogens, and has mixed effects on viral pathogens but often reduces the overall transmission rate. Higher temperatures seem to produce a greater number of water- and food-borne parasitic infections, as well. Overall, increased precipitation is associated with increased burdens of disease for bacteria, viruses, and parasites, though the causes of these increases differ by pathogen and ecologic setting.

Temperature and precipitation are key climate, or weather variables in the risk of exposure and transmission of water- and food-borne disease (Henry 2002). Extreme weather events and

warmer temperatures change the risk of exposure and are an indirect health effect of global warming. There are three mechanisms in which humans can be exposed to water- and food-borne disease: 1) through ingestion of food contaminated with food-borne pathogens, 2) ingestion of water contaminated with water-borne pathogens, and 3) ingestion of food contaminated by waterborne pathogens or water contaminated with food-borne pathogens. In a warmer climate, exposure and infection to food-borne pathogens, commonly known as food poisoning, is more likely, as these infections exhibit seasonal patterns. Temperature-sensitive infectious diseases, such as food-borne infections (Salmonella sp., and others.) are likely to grow. Recent work shows that the disease burden in Europe could be significant with potentially an extra 20 000 cases per year by the 2030s and 25,000 to 40,000 extra cases per year by the 2080s (Anthony J McMichael 2006). Some of the pathogens that may cause additional risk to human health in a warmer climate are *Salmonella, Clostridium perfringens, Staphylococus aurus, Baccillus spp., Escherichia coli, vibrio parahaemolyticus, Campylobacter jejuni, Listeria monocytogenes, Cryptosporidium parvum, and Giardia lamblia*. Exposure to food-borne pathogens is also a function of food imports. As the integrity of agricultural operations is compromised abroad via a variety of mechanisms, one being climate change, there is expected to be an increase in illness from viral, parasitic and bacterial diseases.

The risk of infection from water-borne pathogens increases with the realization of extreme hydrological events, for example, flash floods, and is an indirect health consequence of climate change (Anthony J McMichael 2006). The impact of climate change on water quality and human health is a function of the location of the extreme hydrological event. For example, in urban areas, intense precipitation may overwhelm sewage treatment plants. Consequently, storm water and raw sewage may combine and be released into drinking water resources. In rural areas, especially those that are home to industrial agricultural operations, intense precipitation carries with it the risk of contaminating drinking water reserves. Exposure and infection from food-borne pathogens are the most ambiguous adverse health effect associated with global warming. The impact of temperature on food-borne disease can occur at many points along the food processing cycle, from livestock operations to domestic preparation and consumption. Thus, the responsibility of controlling food-borne disease outbreaks lies in industry and at home. The prevalence of water-borne pathogens in a warmer climate can be controlled through management and disposal of sewage, bio-solids, animal wastes, and the protection of water sheds and fresh water flows.

More specifically, cCASHh (Climate change and adaptation strategies for human health in Europe) studies on food-borne diseases show that, in general, cases of salmonellosis, increase by 5% to 10% for each one-degree increase in weekly temperature. The effect of temperature is most apparent when the temperature in the week before the onset of the illness is considered, thus indicating that inappropriate food preparation and storage rather than time of consumption is the most important factor. It was estimated that temperature influences the transmission of infection in about 35% of cases of salmonellosis in England and Wales, Poland, the Netherlands, the Czech Republic, Switzerland and Spain. The number of cases of salmonella can be reduced by controlling and monitoring along the food chain. High levels of control measures and more information on food handling and storage would be needed to confront the potential climatic risks.

In addition, the so called botulism (by *Clostridium botulinum*) incidence may increase as ambient temperature increases. *Clostridium botulinum* is ubiquitous in soil water and contaminates food with the botulinium neurotoxin.

Diarrhoeal diseases are one of the most important causes of ill health in Europe in children, from foodborne and waterborne infections (Commission 2009). They are recognized to be highly sensitive to climate, showing strong seasonal variations in numerous sites. The incidence of diarrhoeal disease is strongly related to climate variables. In Lima, Peru, diarrhoea increased 8% for every 10 ^{o} C temperature increase, by annual observations between 1993 and 1998 (Diarmid Campbell-Lendrum 2007). Diarrhoeal pathogens are highly sensitive to variations in climate, and epidemiological studies in many sites have shown strong seasonal patterns of

disease (Drasar et al., 1978). Despite this, few studies have quantified this relationship (Anthony J McMichael 1998). Regression analyses of weather variations and either all-cause diarrhoea, or subsets of overall diarrhoea burdens, have been carried out in a limited number of sites. All studies demonstrate strong climate sensitivity. This is consistent with observations of the direct effects of climate variables on the causative agents. Temperature and relative humidity have a direct influence on the rate of survival and replication of bacterial and protozoan pathogens, and on the survival of enteroviruses and adenoviruses (viruses that cause diarrhoea incidents) in the environment. The relationship between climate variability and diarrhoea is mediated by a range of local factors, the most important being the quality of water and sanitation coverage. This factor affects the incidence of diarrhoea, the relative dominance of different transmission routes (e.g. via water, food, or direct contact), the likelihood that extreme precipitation will lead to contamination of water supplies, and the types of pathogens that cause diarrhoea.

Aside from flooding, a number of other water-related issues are also important (Commission 2009). Reductions in summer water flows may increase the potential for bacterial and chemical contamination. Higher water temperatures may also result in increased occurrence of harmful algal blooms. Increased faecal bacteria contamination is also likely to affect drinking water intakes and areas of water used for recreation. Furthermore the scarcity of suitable water for routine hygiene practices of high significance for health such as proper hand washing might contribute to more infectious diseases outbreaks. Water can act as the habitat and vehicle of the pathogen itself (water-borne diseases), with the infection occurring through direct consumption of the water or through contamination of food. The water-borne diseases include: (i) diarrhoeal diseases caused by a variety of organisms, such as pathogenic *Escherichia coli, Vibrio cholerae,* salmonellae, and viruses, (ii) other viral diseases, such as hepatitis A and poliomyelitis, and (iii) two important parasitic diseases: the cosmopolitan giardiasis and the subtropically confined amoebic dysentery. Giardiasis is an infection caused by *Giardia lamblia,* which is transmitted mainly through contaminated water.

On the other hand, lack of a sufficient quantity of household water invariably leads to poor personal and food hygiene (Commission 2009), which is at the root of another group of diseases ("water-washed diseases," i.e., diseases that could have been avoided by better hand-washing and hygienic food preparation). The two latter types of disease are largely conditioned by poverty, and, hence, poor sanitary conditions, with either direct or indirect faeco-oral transmission. When households have poor access to water, because of a general shortage, because water points are too far away, or for economic reasons, they are likely to use what water is available for drinking and cooking, rather than for washing. Many of the above-mentioned water-borne diseases can also be transmitted by contaminated hands, food, and objects. Typical examples are the El Tor variety of cholera, bacillary dysentery (caused by shigellae), and a number of infections by worms, such as *Ascaris, Trichuris,* and *Oxyuris.* As with the water-borne diseases, water-washed diseases are likely to be much more prevalent in conditions of poor sanitation or lack of sufficient water availability due to droughts.

But, is Europe ready to adapt to the changing climate? Experts surveyed within the cCASHh study ranked income, equality, type of health care system, and quick access to information as most important factors enabling effective response to climate change (WHO 2005). Countries in the WHO European Region vary tremendously in their response capacities (Table 2, WHO 2005).

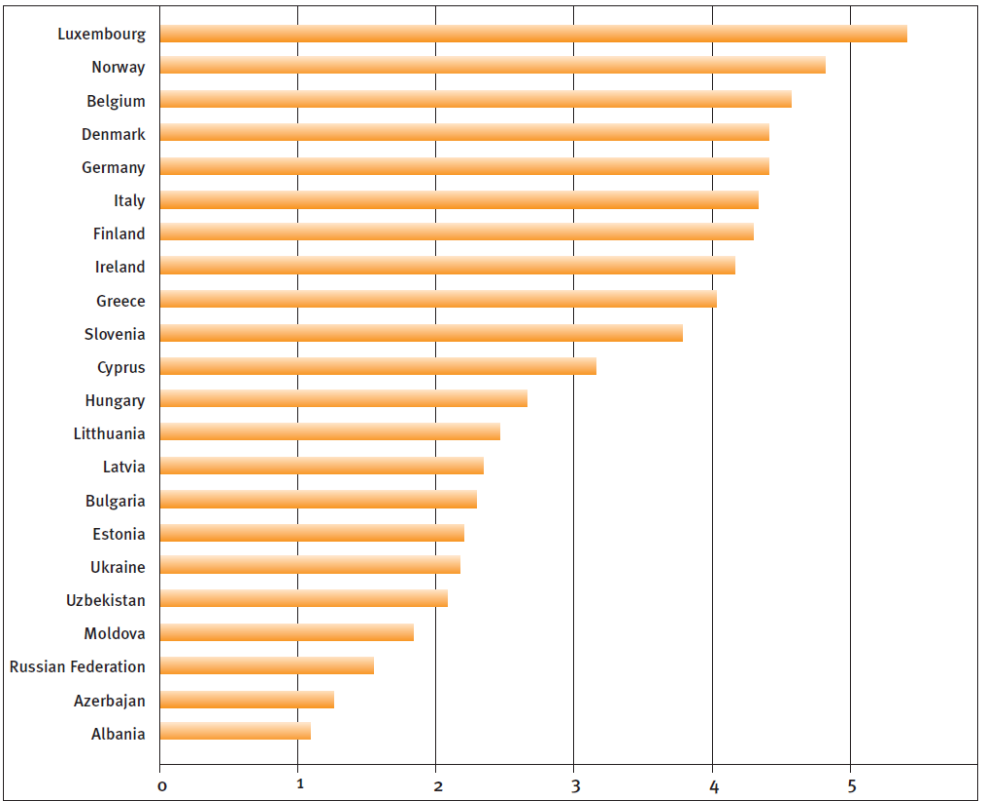
Cyprus has an adaptive capacity index of 3, while Greece has 4 and Luxembourg has the highest, of 5. The highest the adaptive capacity index, the more the country is able to adapt in climate change conditions.

Unfortunately, the Cypriot health care system is not prepared for the impacts of climate change. We are often witnessing that the public and private hospitals are incapable to response in infectious diseases outbreaks. Most of them suffer from endonosocomial infections like MRSA. Recently we had a Legionella outbreak in a private hospital, in the newborn’s room. So, I wonder, if the high risk groups are exposed to diseases inside the hospitals, how can these

hospitals support an infectious disease outbreak? How can infants and elderly be saved from the impacts of climate change, which are expected to be severe?

Management of the health effects of climate change requires inputs from all sectors of government and civil society, collaboration between many academic disciplines, and new ways of international cooperation that have hitherto eluded us (Anthony Costello 2009). Involvement of local communities in monitoring, discussing, advocating, and assisting with the process of adaptation will be crucial. An integrated and multidisciplinary approach to reduce the adverse health effects of climate change requires at least three levels of action. First, policies must be adopted to reduce carbon emissions and to increase carbon bio sequestration, and thereby slow down global warming and eventually stabilise temperatures. Second, action should be taken on the events linking climate change to disease. Third, appropriate public health systems should be put into place to deal with adverse outcomes. Programmes should be funded to explore more the public health dimensions of climate change, either by addressing environmental exposures, urban air pollution or monitoring of ultraviolet exposure, heat waves and infectious disease monitoring. Another tool would be to conduct adaptation assessments and more research on the field. Cooperation is necessary with international organisations and with the priority partner countries at global level as well as at the European and regional levels, and to invite the neighbouring countries to participate in joint actions and encourage them to undertake the necessary work and measures, including the development of national strategies. In every way, health security should be improved, by improving (1) generic preparedness and response for public health emergencies; (2) response to any chemical, biological and radionuclear attacks, and (3) preparedness and response to any infectious disease. In table 3 below, some health adaptation measures that can be applied are given (Anil Markandya 2009).

Table 2: Adaptive capacity index for 22 European and Central Asian countries.



Many Institutions and Government Departments in Cyprus are occupied with collection, analysis and study of Climatological Data, and its possible health effects: the Meteorological Survey Department, the Environment Service, Ministry of Health, academic departments (University of Cyprus, The Cyprus Institute). The Cyprus Institute has arranged an international conference with the subject “Climate change impacts on Public Health”, here in Cyprus in

October 2009. From time to time, national newspapers research this field, due to specific social observations (Pissa 2008). In addition to these organizations, we (as part of the Cyprus International Institute initiative) could work on this subject and assist the implementation of informative campaign, research development and policy strategies enhancement. Moreover, collaboration between health (human and veterinary) and tourism sectors should be developed in order to achieve better surveillance and prevention of the transmission of these diseases.

Human activities have influenced the environment since the first settlements were built and the land cultivated (WHO 1990). At that time, the changes were relatively small and were absorbed by the resilience of the environment. Today, however, it is clear that the effects of the unlimited growth of the human population, and of recent unrestricted technological advances, have had a much greater impact on the environment and may well exceed its capacity to absorb them. The human race is the sole protector of the environment, with the capability to plan wisely, to conserve providently, and to develop prudently. Conversely, it is also capable of polluting or even destroying the environment through greed, ignorance, or indifference.

Table 3: Health Adaptation Measures to Climate Change regarding all health impacts of climate change.

Adaptation measures		**Health impacts**				
		Thermal stresses	**Extreme weather events**	**Vector-borne diseases**	**Water-borne diseases**	**Food-borne diseases**
Legislative and regulatory	Anticipatory	- Building guidelines	- Building guidelines - Economic incentives for building - Urban planning regulation - Forced migration		- Watershed protection laws - Water quality and water supply regulation	- Food sanitation and hygiene regulation
Technical	Anticipatory	- Urban planning (green islands, fountains, green roofs) - Thermal building insulation and air conditioning	- Urban planning (flood-resistant) - Flood protection elevation - Flood protection structures (dams, dykes, walls and raised banks, pump stations) - Reforestation	- Vector control - Vaccination, impregnated bed nets - Surveillance, prevention and control programs - Epidemic forecasting	- Water treatment and distribution - Monitoring water sources - Regulated piped water in houses - Improved sanitation (latrines) - Household sewer connection - Surveillance, prevention and control programs	- Refrigeration - Chlorination of drinking water - Pasteurization of milk - sanitary slaughter and processing o meat, poultry and seafood
	Reactive	- Financial and domiciliary assistance services, "telecare" systems, accompaniment and transport to emergency medical services - Emergency plans (hospital and primary care)	- Pre-disaster recovery plans - First aid and emergency plans - Temporary evacuation	- Hospital and primary care - Outreach doctors	- Hospital and primary care - Outreach doctors	- Food-borne disease surveillance - Hospital and primary care - Outreach doctors
Education and advisory	Anticipatory	- Heat watch warning systems - Educational campaign	- Real-time forecasting - Early warning systems - Educational campaign	- Education campaign	- Health educational campaigns - Boil water alerts	- Food safety education

Cultural and behaviour	Anticipatory	Clothing, drinking, visiting places with air conditioning and green areas	- Use of storm shelters	- Water storage practices	- Washing hands and hygiene - Use of pit latrines	- Avoid high risky food (such as runny eggs and raw shellfish) - Separating cooked and raw food - Wash hands, cutting boards and contaminated surfaces

We must integrate this prospect into our thinking, planning, and preventive policy-making - without allowing it to diminish the importance of dealing with existing public health problems. Indeed, we should note that both existing and future-potential environmental health problems share many of the same underlying causes, relating to poverty, inequality, and social-economic values and practices. The existing insecurity and vulnerability of many of those populations makes more important the need to slow the environmental change processes, while also shoring up the protective and adaptive capacities of populations.

Research into the existence, future likelihood, and magnitude of health consequences of climate change represents an important input to international and national policy debates. Recognition of widespread health risks should widen these debates beyond the already important considerations of economic disruption, risks to infrastructure, loss of amenity, and threatened species. The evidence and anticipation of adverse health effects will indicate priorities for planned adaptive strategies, and crucially, will strengthen the case for pre-emptive policies. It will help us understand better the real meaning of sustainability.

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