EU funding to promote climate change adaptation and risk prevention and management in Portugal: potential effects on mitigating health hazards

Eduardo José Rocha Medeiros

Instituto Universitário de Lisboa (ISCTE-IUL), DINÂMIA'CET - IUL, Lisboa, Portugal - Avenida das Forças Armadas, Edifício Sedas Nunes, Sala 2W4-d, 1649 – 026 Lisboa, Portugal - Eduardo.Medeiros@iscte-iul.pt;

Abstract:

Following the publication of the most recent (2018) National Spatial Policy Programme (Programa Nacional da Política de Ordenamento do Território – PNPOT), several critical development risks were identified for the Portuguese territory over the next few decades. These include expected rises in average temperatures and overall reduction of precipitation levels. This novel climate panorama can negatively impact human and environmental health, for instance via increasing numbers and intensity of forest fires, biologic desertification processes, and heatwaves. These predicted climate changes can also lead to high peaks of intensive rain, leading to catastrophic river floods which, associated with rising sea levels, in a coastal country like Portugal, can lead to increasing health hazards of all sorts in Portuguese territory over the coming decades. In this context, this article analyses the EU funding on promoting climate change adaptation and risk prevention and management in Portugal (2014–2020) via the Operational Programme for Sustainability and Efficient Use of Resources (POSEUR), and its potential effects on mitigating health hazards in the Portuguese territory. In parallel, it analyses existing Portuguese environmental development strategies to unveil the extent to which policy actions to mitigate health hazards are being considered.

Keywords: Health Hazards, PO SEUR, Climate Change, EU Cohesion Policy, PNPOT.

1. Introduction

Living a healthy life is considered by the United Nations (UN) as a critical capability for human development. Hence a 'health-related indicator' has been used as part of the UN Human Development Index (HDI) since its inception (UN 2020). This chapter discusses the potential negative impacts of climate change on human health, through its direct and indirect effects of increasing average temperatures. It also examines whether and how the Portugal 2020 (the partnership agreement undertaken between Portugal and the European Commission (EC), which brings together the five European structural and investment funds – ERDF, Cohesion Fund, ESF, EAFRD and EMFF – setting the programming principles which enshrine the economic, social and territorial development policy to be advanced in Portugal in the programming period between 2014 and 2020) and its environmental sustainability related Operational Programme (PO SEUR), has contributed to mitigating health hazards related to climate change in Portugal.

Critically, climate change is considered as s small-moving global crisis, entailing complex operative policy solutions in response to human-induced actions at the base of a global warming trend observed in past decades (Sachs 2015). Being aware of such policy challenges, the UN 2030 Agenda identified a specific strategic development goal (SDG 3), dedicated to ensuring healthy lives for all. In the end, with the implementation of related measures, the UN expects mortality rates to be significantly reduced by 2030, especially in less developed countries, and that universal health coverage should be a reality in all countries by 2030. As important are the SDG 3 sub-goals 3.3 (by 2030, end the epidemics of AIDS, tuberculosis, malaria and neglected tropical diseases and combat

hepatitis, water-borne diseases, and other communicable diseases) and 3.d (strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks), which are directly related to climate change-related effects (UN 2016).

In this context, this chapter draws on current literature on health hazards and climate change, and in particular on the effects of climate change on health hazards in Portugal in past years and over the coming decades. Mostly based on desk research, from a methodological standpoint, it sheds particular light on analysis of the approved projects database of the PO SEUR which directly and indirectly relate to mitigating the effects of health hazards. As regards the literature review, there are a limited number of analysis on the impacts of the PO SEUR on health impacts. The same goes for similar analysis for the Portuguese regions. In essence, this chapter addresses the potential positive effects of the PO SEUR on mitigating these hazards in Portugal. The remainder of the chapter is structured as follows. It begins by setting out a literature review on health hazards and climate change, to identify the main analytical dimensions or components which can guide analysis of the PO SEUR project database. The following section debates the potential climate change effects in health hazards in Portugal. The empirical analysis of the case study (Portugal) is provided in the next section and policy implications are discussed in the conclusion.

2. Health hazards and climate change: a literature review

The fundamental idea behind the scientific and political alerts to global climate change in past decades (Sachs 2015) is mainly linked with mounting evidence showing global warming trends (Shao 2017). These, in turn, are recognized by the scientific community as potentially having direct and indirect negative effects on human health from, for instance, heatwaves, droughts, and floods (Johansen 2017). Directly contributing to these global warming trends, the burning of fossil fuels like oil and coal creates the conditions for health problems, including lung and heart diseases (including cancer), allergies, chronic bronchitis, asthma, chronic obstructive pulmonary disease, stroke, and chronic respiratory diseases (Epstein and Ferber 2011). Furthermore, rising temperatures can bring about a series of heat-induced diseases, including "dehydration, heat rash, heat cramps, heat exhaustion, heat fatigue, heat syncope/fainting, and heatstroke" (Schulte and Chun, 2009: 544).

Indirectly, rising temperatures create optimal conditions for disease-spreading vectors like insects, with particular attention to mosquitoes, strongly associated with the spread of crippling and often fatal diseases like malaria, dengue, and Zika (National Geographic 2016). Indeed, “according to the Intergovernmental Panel on Climate Change’s projections for human health, a rise in global average temperatures of 3 to 5°C by 2100 could lead to 50 million to 80 million additional annual cases of malaria worldwide, primarily in tropical, subtropical, and poorly protected temperate-zone populations” (Johansen 2017: 40). Besides the aggravation of health symptoms resulting from the spread of mosquito-related diseases (headache, rash, joint pain, fever, encephalitis, meningitis, fatigue, paralysis, severe neurological problems, etc.) (Rivera-Amarillo & Camargo 2020), global warming trends also affect the escalation in numbers of termites, cockroaches, rats, spiders, and scorpions (Johansen 2017; Loko 2016).

The rise of allergies and asthma can also result from global warming trends since this favour the growth of plants that release allergy and asthma-causing pollens (Singer 2013) and tend to increase with the rise of forest fires (Fearnside 2017). More worrying still is the expected rise in the number of deaths attributable to rapid global warming trends (at least 150,000 per year), which is expected to double by 2035 (Johansen 2017). Reflecting a long anthropologic legacy of global pollution, the spread of suspended particulate matter from outdoor urban exposures can increase their harmful health effects in rising temperatures (Cifuentes et al. 2001). On the other hand, many of these gas emissions which result from burning fossil fuels are also pollutants (Johnsson et al. 2019).

From another viewpoint, climate change has the potential to affect the health of humans by influencing the indoor environment, depending on the characteristics of the buildings. Here, the levels of poverty are a crucial "indicator of individual vulnerability to climate change and are related to marginalization and lack of resources" (IOM 2011: 52). Most influential in this regard are also natural hazards which can become ever more dangerous as a result of rising global temperatures like tropical storms, which may lead to increasing outdoor and indoor health hazards (Theodore and Dupont 2012). Among the potential impacts on health from direct and indirect consequences of climate change influencing the indoor environment are (IOM 2011):

- Increased mortality and decreased productivity;
- Exposure to chemical emissions from damaged materials;
- Water and vector-based diseases;
- Respiratory distress and illness;
- Allergen-mediated distress and illness;
- Exposure to excessive heat and cold;
- Exposure to CO_2 from backup electrical generators;
- Increasing numbers of insects and rodents (pesticide exposure).

In all, according to the Intergovernmental Panel on Climate Change (IPCC), there is mounting evidence of "human health effects directly affected by climate change (e.g., heat stress, death, or injury in floods and storms) and indirectly through changes in the ranges of disease vectors (e.g., mosquitoes), waterborne pathogens, water quality, air quality, and food availability and quality" Schulte & Chun 2009: 542). Moreover, the same entity concludes that "health impacts will be largely influenced by local environmental conditions and socioeconomic circumstances and by the range of social, institutional, technological, and behavioural adaptations taken to reduce the full range of threats to health" (Schulte & Chun 2009: 542). It is also worth noting that numerous factors can influence the degree of health hazards provoked by climate change: (i) age; (ii) obesity; (iii) pre-existing disease; (iv) body size; (v) socio-economic condition; (vi) pregnancy; (vii) immunologic status; (viii) type of work clothing; and (ix) genetic characteristics (Schulte & Chun 2009).

In much the same way, Patz & Hatch (2013) conclude that climate change presents a significant challenge to global health. Similarly, they identify a myriad of areas in which health impacts can be observed as a result of increasing average temperatures, natural hazards, and air pollution. In turn, these trends can lead to increased illnesses and deaths, related to allergic and infectious diseases and malnutrition. But most importantly, these authors highlight the fact that, over the next decade, a disproportional impact on health hazards is expected due to climate change across the world with the "populations that are often least responsible for climate change that experience the greatest adverse impacts" (Patz & Hatch 2013: 1). This raises ethical and moral issues which need to be addressed globally when dealing with concrete global policy actions aiming at mitigating climate change (Graham 2015; Gudynas 2016; Lukasiewicz 2017) in the many policy areas covered by climate change-related health hazards (Fig. 1).

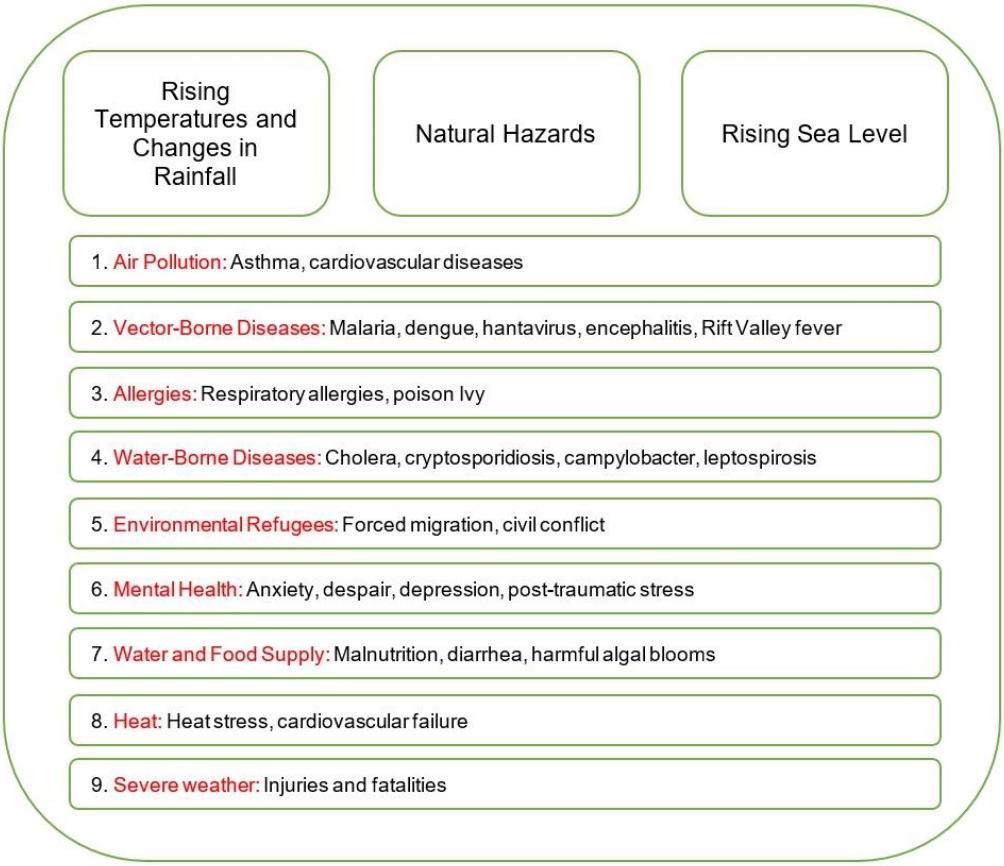

Figure 1. Climate Change and Health hazards main analytical dimensions and components. Own elaboration based in - https://www.jkgeography.com/impacts-of-climate-change-on-people-and-places.html

3. Potential climate change effects in health hazards in Portugal

The most recent version of the Portuguese National Spatial Planning Programme (Programa Nacional da Política do Ordenamento do Território – PNPOT) manifests several challenges faced by Portuguese territories from potential climate change effects. These are especially concerning regarding the risks associated with the rise of the average temperatures, the reduction of rainfall, the rise of the average sea level (Fig. 2), and associated natural risks: increasing droughts, coastal and river floods, and forest fires (DGT 2018a; DGT 2018b; DGT 2018c). When contemplating the expected impacts of climate change in Portugal, the same document sets the stage for increasing extreme meteorological events with different territorial levels, since the Portuguese weather conditions vary significantly from north to south and from east to west. Inspired by several international studies which predict potential climate trends in Europe, the PNPOT warns that, by the end of the 21st century, the average maximum temperature in the summer will increase between 0.5ºC along the coast and 2ºC in the inland territory on the mainland. In turn, respectively for the Madeira and Azores archipelagos, there is an expected rise of temperatures between 2ºC and 3ºC, and 2.5ºC and 3ºC.

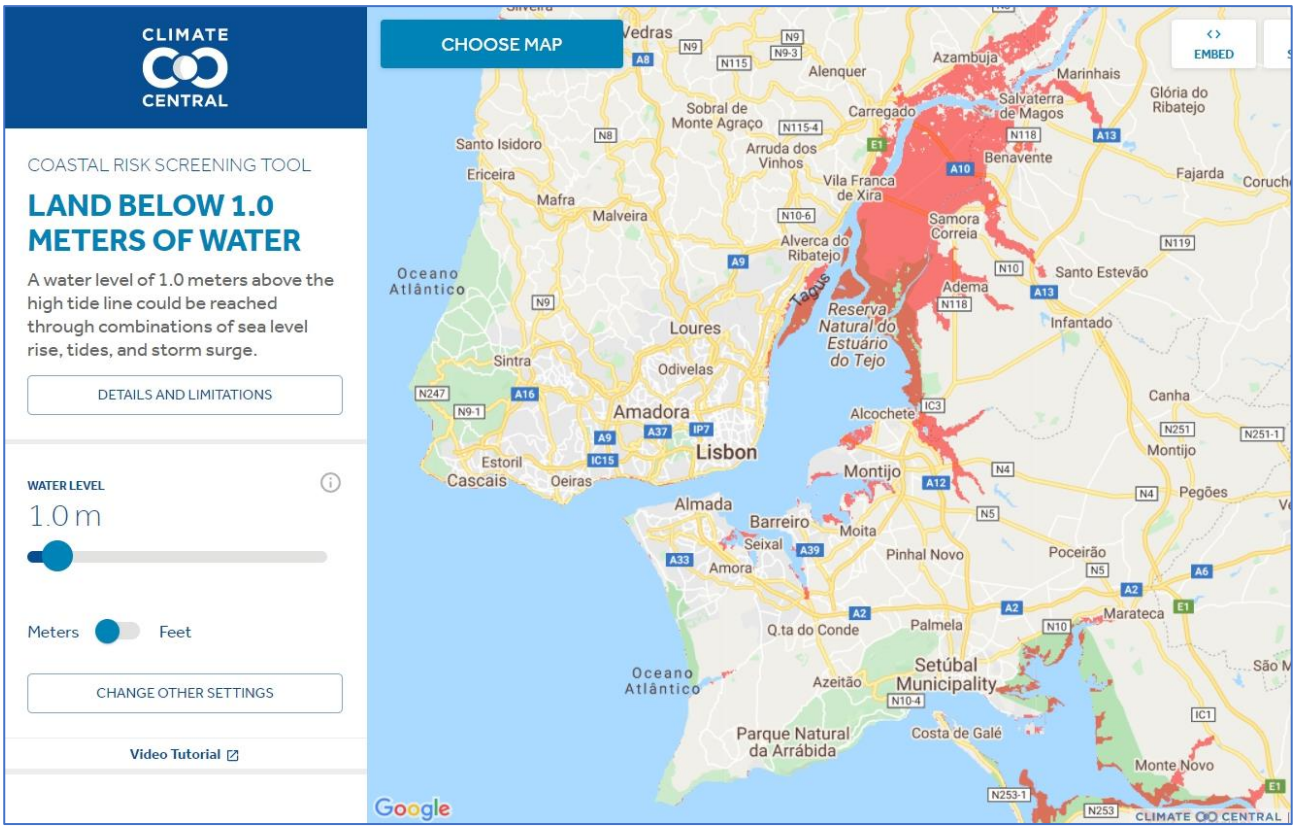

Figure 2. Areas affected by mean sea level rise of 1 m in Lisbon Metropolitan Area. Source https://coastal.climatecentral.org/

In tune with several international scientific reports, the PNPOT predicts a reduction of the levels of rainfall for the end of this century in Portugal. In more detail, a significant reduction (between 20% and 40%) of the total annual rainfall is expected occurs in the mainland area of Portugal. Worst still, drought periods are expected be more recurrent and intense. Likewise, for the Madeira archipelago, a reduction of rainfall of around 30% is estimated by the end of the century. Conversely, for the Azores archipelago, a slight increase in rainfall levels of around 10% is expected during the winter, and a reduction during the summer (DGT 2018a).

Finally, based on concrete measurements of the mean sea level made in the Portuguese city of Cascais for more than a century, the PNPOT draws attention to the fact that an increasing rise of the mean sea level can be observed in recent years in Portugal, when compared with past decades. In more detail, between 1992 and 2004 the sea rose on average 2.1 mm/year. Between 2005 and 2016 it rose 4.0 mm/year, which fits within the global trends, in which most estimates of global mean rise in the sea level this century will fall below 2 m (Kulp and Strauss 2019). For the Azores archipelago, this rise in the average sea level is expected to read 1 m by the end of this century. In all cases, this scenario poses great concerns in a country like Portugal, which has a vast coastline where more than 70% of the population lives, with particular concerns for several areas of the Lisbon Metropolitan Area (Fig. 2).

Crucially, based on the findings of the previous section, the predicted climate changes in Portugal can contribute to increasing the risks of various health hazards, including the spread of several diseases provoked by mosquitos and other animal pests, and other diseases associated with increasing temperatures and heatwaves. Furthermore, the reduction of available potable water and food production poses an alarming challenge to the country, with potential negative effects on the health of the Portuguese population. The same goes for the expected rise in extreme weather events, including floods and river and sea inundations, heatwaves and the occurrence of fires, with a serious impact on forested territories. Needless to say, Portuguese urban areas are particularly vulnerable to

several of these climate change-related natural risks, and hence to related health hazards, thus requiring an adaptation of social and health infrastructure to respond to increasing heatwaves and potential mortality rates. In the end, the PNPOT identifies five main potential socio-economic impacts resulting from predicted climate trends in Portugal: (i) increasing financial effort due to emergencies; (ii) new needs to respond to social and health services; (iii) rising costs in infrastructure adaptation; (iv) rise of energy costs; and (v) a need to change economic models towards an efficient low-carbon economy (DGT 2018a).

Curiously, the Portuguese National Strategy for Climate Adaptation (Estratégia Nacional de Adaptação às Alterações Climáticas – ENAAC in Portuguese) is even more drastic in its climate change predictions for Portugal until the end of the century, as it predicts an average rise in summer temperatures between 3ºC in the littoral areas and 7ºC in the interior of the Portuguese continental territory. It is also interesting to note that the ENAAC expects the elimination of days with frost in most parts of the Portuguese territory. Hence, as previously seen, this scenario can provoke a rise in animal plagues (e.g. mosquitos), and a consequent rise in health hazards in Portugal (APA 2013). This report proposes a plethora of measures in several sectors to mitigate the predicted climate change-related impacts in Portugal. Only two were advanced for the health sector: (i) a Contingency Plan for Adverse Extreme Temperatures – Heat Module, and (ii) a National Programme for the Surveillance of Culicidae Vectors.

In a section dedicated to potential health hazards resulting from climate change in Portugal, the ENAAC highlights the potential introduction of novel risk factors to human health, especially related to the distribution of infectious and respiratory diseases transmitted via vectors like mosquitos and increasing pollution. Similarly, natural disasters like floods and heatwaves can have a direct and indirect physical and psychological impact on human health, for instance via injuries and the destruction of homes. By now, for instance, the Madeira archipelago is already dealing with a rise of dengue fever, due to rising average temperatures. On the other hand, the impacts on food production and the availability of potable water can contribute to increased risk of diseases associated with malnutrition and water contamination (APA 2013).

Added to that, there is a well-known association between intense precipitation phenomena and outbreaks of cryptosporidiosis. On the other hand, lower water flows in rivers and reservoirs, associated with higher temperatures, could increase human exposure to cyanotoxins produced by cyanobacteria, which could have serious consequences for human health. In the case of food-borne illnesses, the increase in air temperature is associated with a rise in cases of salmonellosis in different locations. Outbreaks caused by norovirus were also associated with cases of heavy rainfall and flooding that caused the overflow of wastewater. In sum, climate change and the expected effects on the distribution and prevalence of diseases in Portugal could lead to the emergence of new demands on health systems, requiring adaptation work that must be carried out as soon as possible to prevent and reduce the extension of the effects on the population (APA 2013).

Recent research has also provided a word of caution that should highlight the potential negative health effects of the rising sea level on the water and food supply. Indeed, on the Portuguese mainland, hundreds of thousands of inhabitants dwell near the Atlantic coast, which is also populated by key development infrastructure and economic activities. Hence, an extreme flood hazard scenario could provoke high levels of coastal erosion and rising coastal flooding risks (Antunes et al, 2019).

On the main expected impacts of heatwaves on the health of the Portuguese population, Dias et al. (2012) note the need to embrace measures with can effectively mitigate verified increased death rates from respiratory diseases in Portugal. Also noteworthy are the scientific studies which have demonstrated increased mortality rates in Portugal due to exposure to rising temperatures (Alcoforado et al. 2015; Almeida et al. 2010) causing severe respiratory diseases (Monteiro et al. 2013). It is expected that extreme heat events will have a negative profound effect, mostly in the Portuguese large metropolitan areas, and in Lisbon in particular (Cardoso et al, 2019). According to Forzieri et al. (2017) an increasing percentage of around 3000% of deaths is expected in Western Europe under a

global warming scenario of a rise in average temperature of 2.8°C by 2100. Here, the south of Europe and, in Portugal particular, is highly likely to see significant rises in the mortality rates from heat extremes (Naumann et al, 2020; Casimiro et al, 2006). Moreover, increasing ambient air levels of aeroallergens are expected to rise in the Portuguese territory in coming years (Schleussner 2019), while an expected increase in forest fires in a warmer climate will tend to increase cardiovascular and respiratory-related illnesses (Vitolo et al, 2019). In tandem, vector-borne diseases such as leishmaniasis, Lyme disease, and Mediterranean spotted fever, are expected to rise in Portugal, as a consequence of the rising temperatures (Casimiro et al, 2006).

4. Contribution of the PO SEUR to mitigate health hazards in Portugal: 2014–2020

As one of the 16 programmes created to implement the Portugal 2020 Strategy (Medeiros 2020), the PO SEUR (Programa Operacional Sustentabilidade e Eficiência no Uso de Recursos – Operational Programme for Sustainability and Efficient Use of Resources) is focused on supporting policy actions towards green and sustainable growth invoked in the Europe 2020 Strategy: promoting a sustainable development model based on a low-carbon economy and in adapting to climate change, and preventing risks, as well as supporting environmental protection and resource efficiency. The European Union (EU) Cohesion Policy is committed to financially supporting the Europe 2020 Strategy in the 2014–2020 programming period, which includes in its five main targets the core domain of the PO SEUR of combating climate change and supporting energy efficiency and sustainability. It was this EU context, favourable to the support of green policies towards sustainable growth, which culminated in the recent approval of the 'European Green Deal' (EC 2019) as a global plan to support the development of a green and sustainable economy in the European context, and in which the PO SEUR strategy was outlined.

On a national scale, the main objectives of the PO SEUR are aligned with various national development plans and strategies that support processes of growth and sustainable development (see Medeiros 2022), like the national Commitment to Green Growth. These, in turn, cover several areas of sustainable development, such as the support to: (i) the green economy (GDP, exports, employment, productivity, circular economy); (ii) more sustainable territories (urban rehabilitation, energy efficiency, public transport, water efficiency); (iii) a green energy transition (energy efficiency, renewable energies); (iv) combating natural risks, pollution and climate change (CO_2 emissions, air quality); and (v) the protection of nature (water bodies, biodiversity).

Specifically, the PO SEUR intends to contribute to the national sustainable growth and development priority, via the financial support to projects which address a low-carbon economy. It is fundamentally based on more efficient use of resources and wider promotion of greater resilience to climate-related natural risks and catastrophes. On the other hand, the PO SEUR acts as a policy-funding vehicle to materialise the national government goals of seeking a sustainable development trajectory, supported by a more competitive and resilient model of development. This entails lower consumption of fossil fuels and a simultaneous generation of new opportunities of employment and wealth generation in the green economy sector. This is particularly important in a country like Portugal which is still highly dependent on a tax of fossil fuels.

Therefore, the PO SEUR follows the EU guidelines to anticipate and adapt to expected global changes in the field of energy, climate change and more efficient use of resources, alongside a dynamic perspective that links competitiveness to sustainability. Indeed, Portugal is deeply committed to the structural transformation of its model of development, thus trying to create conditions for greater cohesion and convergence within the European context (Miguel 2018). This national commitment towards a green economic structural transformation as a central model of development follows a remarkable positive change in fostering environmental sustainability policies in Portugal over the last 30 years (Cravo and Guerreiro 2019).

In concrete terms, the PO SEUR acts as the key financial package for supporting environmental sustainability policies in Portugal at all territorial levels, as complement to other main dimensions of territorial development and cohesion (see Medeiros 2016; 2019), such as economic competitiveness and social cohesion (Table 1). In detail, the PO SEUR is supported by three main intervention axes or strategic pillars: (i) support the transition to a low-carbon economy in all sectors; (ii) promoting climate change adaptation and risk prevention and management; and (iii) protecting the environment and promoting efficient use of resources. As seen, none is directly associated with the mitigation of health hazards. However, as discussed previously, it is possible to infer that many financed PO SEUR interventions are due to indirectly and directly contributing to mitigating the potential negative impacts of climate change in health hazards in Portugal.

Table 1. Portugal 2020 main thematic domains.

Main policy goal	Central Thematic Goal
Competitiveness and Internationalisation	1. Strengthening research, technological development, and innovation; 2. Enhancing access to, and use quality of, information and communication technologies 3. Enhancing the competitiveness of small and medium-sized enterprises 7. Promoting sustainable transport and removing bottlenecks in network infrastructures 11. Enhancing institutional capacity of public administration efficiency
Social inclusion and employment	8. Promoting employment quality and sustainability and supporting labour mobility 9. Promoting social inclusion and combating poverty and discrimination
Human capital	10. Investing in education, training and professional training to acquire skills and in lifelong learning
	4. Supporting the shift towards a low-carbon economy in all sectors 5. Promoting climate change adaptation, risk prevention and management 6. Preserving and protecting the environment and promoting resource use efficiency

Source: Own elaboration based on https://poseur.portugal2020.pt/en/po-seur/about-the-programme/

The predicted financial provisions of the PORTUGAL 2020 earmarked for environmental sustainability-related policies were around 25% of the its total budget. By the end of 2021, however, the implemented projects in the field of environmental sustainability had only absorbed around 16% of the Portugal 2020 investments, in stark contrast with the 45% targeted at the domain of 'economic competitiveness'. Within the PO SEUR, the bulk of the investment was aimed at finance water-related projects (mostly infrastructure) due to the need of many Portuguese localities to guarantee a clean water supply and to treat waste water (Fig. 3). As such, the PO SEUR policy interventions in the climate change domain only absorbed around 21% of its total budget (Fig. 4). Indeed, a cursory glance over the PO SEUR project database only reveals a few projects directly aiming at supporting public health issues or health infrastructure (Table 2).

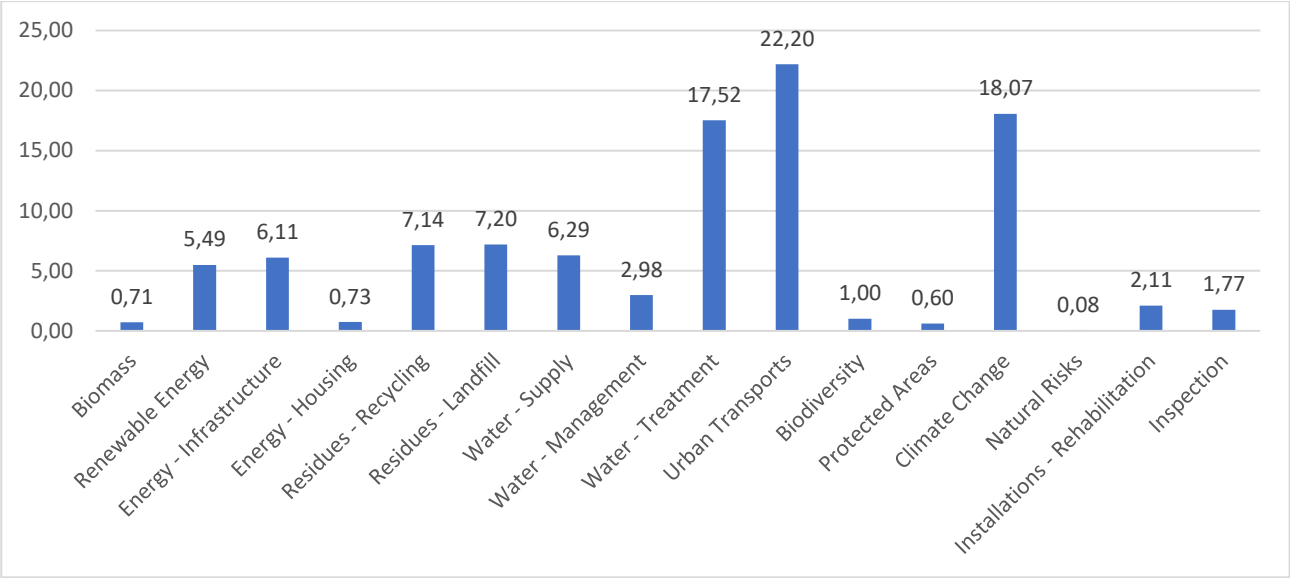

Figure 3. PO SEUR investment (%) per main policy area of environmental sustainability. Source: Own elaboration based on Portugal 2020 database.

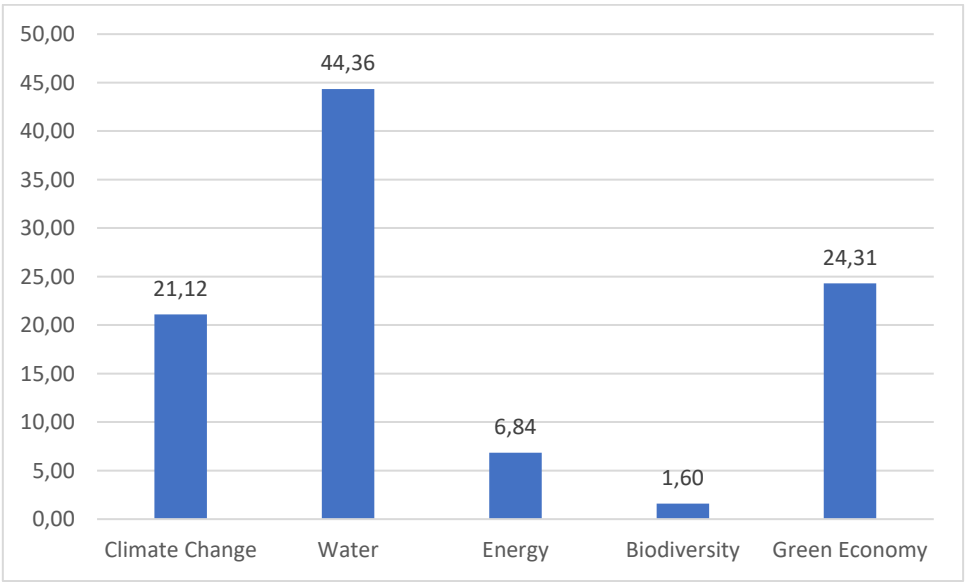

Figure 4. PO SEUR investment (%) per main priorities. Source: Own elaboration based on Portugal 2020 database.

Table 2. Examples of PO SEUR projects directly related Health Issues.

Entity	Project	Health Goal	€
Unidade Local de Saúde do Alto Minho, E.P.E.	Energy efficiency in Viana do Castelo Hospital	Reconvert the energy system for improving efficiency	3,444,162
Instituto Nacional de Saúde Ricardo Jorge, I.P.	Measures to increase energy efficiently via the use of renewable sources of energy	Implement measures to increase energy efficiency via the replacement of existing systems, changing interior and exterior illumination,	2,332,202

		promoting renewable sources of energy.	
Associação Humanitária dos Bombeiros Voluntários de Mondim de Basto	Amplification and requalification of the Mondim de Basto Fireman Edifice	Allow for a separation between the health parking space and the fireman parking spaces.	479,993
Instituto Politécnico de Viana do Castelo	Energy efficient in the Health Superior School	Respond to climate change trends and environmental concerns	510,271
Instituto Politécnico de Viseu	Energy efficiency in the Superior Health School of Viseu	Optimize energy performance: guarantee indoor air quality, promote healthy spaces, increase thermal comfort, reduce consumption in Central Administration buildings, rationalize energy consumption and reduce greenhouse gases.	235,330
Instituto Politécnico de Santarém	Improve energy efficiency in the Superior Health School	Using LED lights, replacement of ventilation systems, and installation of Installation of a photovoltaic solar system, application of thermal insulation in the pipe network to be reused in the hot water production system. Awareness Actions to promote the rational use of energy.	213,856
Municipality of Espinho	New Urban Expansions of Basic Sanitation – Completion of the Water Supply Networks in the Municipality of Espinho	Minimizing the risks to public health associated with the consumption of water not coming from the public network.	481,448
Grândola Municipality	Water supply of Brejinho de Água	Provide the populations of Brejinho de Água	216,318

		with quality water supply, in quantity and with continuity, minimizing the risks to public health associated with the consumption of water not coming from the public network.	
Mirandela Municipality	Resolution of supply water quality problems with impact on human health	Carry out interventions at the level of Iron, Manganese and Arsenic removal filters	41,236
Funchal Municipality	Replacement of Water Distribution Networks - Western Sector of Funchal	The renovation of these networks aims to reduce the high losses that affect the network, increase the available flow to improve the quantity and quality of water distributed, thus rationalizing the consumption of drinking water, and replacing the material of the old ducts with another that complies with the regulations related to the risk to human health, also improving the hydraulic operation of the networks.	1,487,595
Municipality of Viseu' Services	Closing of the Carvalhal Wastewater Sanitation Subsystem	Guarantee to the villages of Lamaçais, Santo Amaro and the Baixa de Figueiredo area of the Parish of S. Pedro de France a public service of quality wastewater sanitation, essential for the functioning of the social and economic fabric, as well as the protection and improvement	106 470

		public health and the environment.	
Local Health Unit of the Alto Minho E.P.E.	Energy efficiency in the Viana do Castelo Hospital	Reconvert energy systems to obtain significant savings in terms of energy consumption, while maintaining and improving service outputs and security of supply.	3,444,162

Source: Own elaboration based on Portugal 2020 database.

Even so, the reading of the PO SEUR project database allows us to conclude that, directly or indirectly, many of its financed projects are providing a positive contribution, to mitigating climate change-related effects in Portugal, albeit with different levels of intensity. Indeed, there are several ongoing interventions aiming to: (i) correct coastal erosion due to the rise in sea level, for instance by depositing sediments and controlling floods; (ii) reduce air pollution, for instance by fomenting the use of renewable sources of energy, energy efficiency and the use of sustainable transports. These measures have also an indirect positive effect in mitigating rising temperatures and thus limit the spread of vector-based diseases and allergies, at least at the local level; (iii) treat residual waters, for instance by the construction of water treatment plants, with positive consequences for mitigating water-borne diseases; (iv) assure water and food supply, for instance by investing in water-related infrastructure; and (v) protect the territory from severe natural disasters, for instance by artificially supplying sand to existing dunes along the coast.

Within this panorama, it is possible to conclude that the PO SEUR has had a positive impact in reducing the potential negative health hazard effects in several Portuguese regions and policy domains which are affected by climate change. How far these impacts can contribute to significantly reduce health hazards in Portugal resulting from climate change is hard to quantify and would require a more detailed ex-ante impact assessment exercise, demanding que collection and treatment of a vast pool of data which is out of the scope of this analysis. One thing is certain: the PO SEUR does not act in isolation. Indeed, other Portugal 2020 investments, for instance in improving health systems and educational training programmes on the need to follow more sustainable development paths, can also contribute to responding to the predicted rise of health hazards due to climate change in Portugal in the coming decades. One good example is the EU Integrated Sustainable Urban Development Strategies, financed by EU Cohesion Policy since 2014–20 (Medeiros and van der Zwet 2020a, 2020b), which target European cities (108 in Portugal), as a concrete policy response to support green development in urban areas, which are known carbon footprint hubs (UN 2020).

5. Conclusion

Increasing temperatures and increasing humidity associated with climate change are expected to impact negatively on many policy domains, including health-related hazards. Among many other negative impacts on human health, climate change is expected to raise human mortality in many parts of the world, for instance via increasing exposure to water and air and vector-based diseases, the direct exposure to excessive heat and cold waves, increasing air pollution, and increasing natural hazards, with a potential rise in human injuries and fatalities.

As it is located in the south of Europe, all available studies demonstrate that Portugal is one of the European countries that is expected to have higher negative impacts of current global climate change trends, in particular a relatively high increase in average temperatures and reduced rainfall in

the non-littoral areas. More detailed national studies, both on the mainland and in the two archipelagos (Madeira and Azores), are clear in pointing towards expected rise of temperatures between 3ºC and 7ºC (ENAAC), in a worst-case scenario. The consequences of such climatic dramatic trends on increasing negative health hazards effects are evident, with potential negative impacts in all the domains of the presented analytic dimensions of climate change-related health hazards.

At the very least, several national reports conclude that, by 2050, Portugal is expected to experience a significant rise in the average sea level, with negative consequences on the economic activities and the health security of thousands of inhabitants who reside near the sea, in a country like Portugal with a long coastal area. Running parallel to this, it is difficult to dispute that the expected rise in temperatures, especially high in non-littoral areas, will inevitably lead to increased vulnerability to vector and water-borne diseases like malaria and cholera, as well as respiratory/pulmonary diseases. The high possibility of increasing heatwaves could lead to increased cardiovascular failures and mental health-related symptoms (anxiety, depression, etc.), and also to rural migration towards the cooler littoral areas, in a country in which the bulk of the population already resides in these areas. The problem is that the large metropolitan area in Portugal (Lisbon) is expected to be largely and negatively affected by these increasing heatwaves, and may also suffer from reduced food production and clean water provision from other parts of the country due to climate change trends, which could ultimately contribute to health-related issues such as malnutrition.

In almost every way, the picture painted for the expected climate change trends in Portugal for the next decades is quite dark. Worse still, its potentially negative consequences for the health of the Portuguese population is not rosy at all. On the contrary, a wealth of negative health hazard-related effects is expected to occur in Portugal in the near future. So, it is important to know if and how the investments of the analysed PO SEUR are contributing to mitigating such negative trends. By detailed analysis of its 2022 approved projects until the end of 2021, it was possible to conclude that the PO SEUR has had a relatively positive impact on mitigating climate change trends in some policy areas, although it must be realised that climate change has a global character and, as such, each country can only do so much to invert current global climate change trends.

Despite the difficulty of convincingly relating the PO SEUR approved projects' funding to mitigating health hazards in Portugal, an in-depth project analysis allowed us to find that the projects directly associated with mitigating 'climate change' trends only received a little more than 20% of the total PO budget, so far. By itself, this number does not reveal the full scope of the potentially positive role of the PO SEUR in mitigating health hazards in Portugal. Indeed, in addition to financing projects which directly deal with the consequences of rising temperatures in Portugal, like the protection of the coast, the PO SEUR has also been contributing to adapting the Portuguese economy and its regions to a more sustainable development path by, for instance, financing projects in the area of production of renewable sources of energy and sustainable public transportation. Furthermore, the PO SEUR has placed great emphasis on improving water management and supply in all Portuguese regions, which can have a very positive impact on mitigating the potential negative impacts of climate change on food production and availability of clean water. In this stance, one can conclude that the PO SEUR has had indirect and direct positive effects on mitigating health hazards by financing projects which have contributed to: (i) reducing air and water pollution; (ii) lessening the vulnerability of the coastal areas to the rise of the average sea level; (iii) lowering the need to use of fossil fuels to produce energy and to urban mobility; and (iv) modernising some health-related infrastructure.

It goes without saying that combating climate change-related challenges requires a strong global response. In a global panorama, Portugal is just a relatively small piece of land in the west of a European peninsula. Hence, Portuguese-financed policies to combat climate change can only do so much to mitigate related health hazards. Even so, within the current global panorama, each country needs to deliver its pro-active policy measures to combat climate change. In the case of Portugal, it can be seen that there are several national strategies which predict, with detailed precision, the potential negative impacts of climate change to several health hazards for the coming decades. In this

context, one would expect that the Portugal 2030 Climate Action and Sustainability Programme (2021–27) can dedicate a specific line of investment to directly mitigate the health hazards resulting from predicted climate change trends in all Portuguese regions. Only time will tell, however, how far the EU funds have positively contributed to preparing the Portuguese territory to cope with climate change-related health hazards.

References:

Alcoforado, M, Marques D, Garcia R, Canário P, Nunes M, Nogueira H, Cravosa A (2015) Weather and climate versus mortality in Lisbon (Portugal) since the 19th century. Applied Geography 57(2015):133–141

Almeida S, Casimiro E, Calheiros J (2010) Effects of apparent temperature on daily mortality in Lisbon and Oporto, Portugal. Environmental Health 9(12):1–7

Antunes C, Rocha C, Catita C (2019) Coastal Flood Assessment due to Sea Level Rise and Extreme Storm Events: A Case Study of the Atlantic Coast of Portugal's Mainland. Geosciences 9(5):239

APA (2013) Relatório de Progresso Estratégia Nacional de Adaptação às Alterações Climáticas [Progress Report National Climate Change Adaptation Strategy]. Agência Portuguesa do Ambiente, Amadora.

Cardoso R, Soares P, Lima D, Miranda P (2019) Mean and extreme temperatures in a warming climate: EURO CORDEX and WRF regional climate high resolution projections for Portugal. Climate Dynamics 52(2019):129–157

Casimiro E, Calheiros J, Santos F, Kovats S (2006) National assessment of human health effects of climate change in Portugal: Approach and key findings. Environmental Health Perspetives 114(12):1950–1956

Cifuentes L, et al. (2001) Hidden Health Benefits of Greenhouse Gas Mitigation. Science 293(5533):1257–1259

Cravo R, Guerreiro, J (2019) Environmental Sustainability: A 30-Year Progress Assessment in Portugal. Journal of Environmental Protection 10(2019):1507-1535

DGT (2018a) PNPOT Alteração, Diagnóstico [National Spatial Planning Programme - Change, Diagnosis]. DG Território, Lisboa.

DGT (2018b) PNPOT Alteração, Estratégia e Modelo Territorial [National Spatial Planning Programme - Change, Strategy and Territorial Model]. DG Território, Lisboa.

DGT (2018c) PNPOT Alteração, Agenda para o Território [National Spatial Planning Programme - Change, Agenda for the Territory]. DG Território, Lisboa.

Dias D, Tchepel O, Carvalho A, Miranda A, Borrego C (2012) Particulate matter and health risk under a changing climate: Assessment for Portugal. The Scientific World Journal 2012. 409546 - 10.1100/2012/409546.

EC (2019) The European Green Deal. European Commission, Brussels.

Epstein P, Ferber D (2011) Changing Planet, Changing Health: How the Climate Crisis Threatens Our Health and What We Can Do about It. University of California Pres, Berkeley.

Fearnside P (2012) Brazil's Amazon forest in mitigating global warming: unresolved controversies. Climate Policy 12(1):70-81.

Forzieri G, Cescatti A, Silva F, Feyen L (2017) Increasing risk over time of weatherrelated hazards to the European population: a data-driven prognostic study. The Lancet Planetary Health 1(2017):200–208

Graham S (2015) Climate Change, Ethics and Human Security. Ethics, Policy & Environment 18(1):112-115

Gudynas E (2016) Climate Change, the Quadrilemma of Globalization, and Other Politically Incorrect Reactions. Globalizations 13(6): 938-942

IOM (Institute of Medicine) (2011) Climate Change, the Indoor Environment, and Health. The National Academies Press, Washington, DC
Johansen B (eds.) (2017) Climate change: an encyclopedia of science, society, and solutions, Vol. III, ABC-CLIO, Santa Barbara
Johnsson F, Kjärstad J, Rootzén J (2019) The threat to climate change mitigation posed by the abundance of fossil fuels. Climate Policy 19(2):258-274
Kulp S, Strauss B (2019) New elevation data triple estimates of global vulnerability to sea-level rise and coastal flooding. Nat Commun 10(4844):1-12
Loko Y, Agre P, Orobiyi A, Dossou-Aminon I, Roisin Y, Tamo M, Dansi A (2016) Farmers' knowledge and perceptions of termites as pests of yam (Dioscorea spp.) in Central Benin. International Journal of Pest Management 62(1):75-84
Lukasiewicz A (2017) Ethics, environmental justice and climate change. Australasian Journal of Environmental Management 24(3):332-333
Medeiros E (2016) Territorial Cohesion: An EU Concept, European Journal of Spatial Development. 60 – http://www.nordregio.org/publications/territorial-cohesion-an-eu-concept
Medeiros E (2019) Spatial Planning, Territorial Development and Territorial Impact Assessment. Journal of Planning Literature 34(2):171-182
Medeiros E (2020) Portugal 2020. An effective policy platform to promote Sustainable Territorial Development? Sustainability 12(3):1126
Medeiros E (2022) The territorialisation of the UN Agenda 2030 and cross-cutting issues in energy, environment and health: the case of Portugal. In Leal Filho et al. (Eds) (2021) Sustainable Policies and Practices in Energy, Environment and Health Research. Springer, Cham, 393-411.
Medeiros E, van der Zwet A (2020) Sustainable and Integrated Urban Planning and Governance in metropolitan and medium-sized cities? Sustainability 12(15): 5976
Medeiros E, van der Zwet A. (2020) Evaluating integrated sustainable urban development strategies: a methodological framework applied in Portugal, European Planning Studies 28(3):563-582
Miguel C, Mendes A, Madeira L (2018) An Overview of the Portuguese Energy Sector and Perspectives for Power-to-Gas Implementation. Energies 11(12):3259
Monteiro A, Sá E, Fernandes A, Gama C, Sorte S, Borrego C, Lopes M (2016) Air quality over Portugal: now and in 2050. Sustainable Development and Planning, VIII(1):621–630
National Geographic (2016) Human Health, National Geographic, Washington DC
Naumann G, Russo S, Formetta G, Ibarreta D, Forzieri G, Girardello M, Feyen L (2020) Global warming and human impacts of heat and cold extremes in the EU. Publications Office of the European Union, Luxembourg
Patz J, Hatch M (2013) Public Health and Global Climate Disruption, Public Health Rev 35(12):1-23
Rivera-Amarillo C, Camargo A (2020) Zika assemblages: women, populationism, and the geographies of epidemiological surveillance. Gender, Place & Culture 27(3):412-428
Sachs F (2015) The age of sustainable development, Columbia University Press, New York
Schleussner C, Menke I, Theokritoff E, van Maanen N, Lanson A (2019) Climate Impacts in Portugal. Climate Analytics, Berlin
Schulte P, Chun H (2009) Climate Change and Occupational Safety and Health: Establishing a Preliminary Framework. Journal of Occupational and Environmental Hygiene 6(9):542-554
Shao W (2017) Weather, climate, politics, or God? Determinants of American public opinions toward global warming. Environmental Politics 26(1):71-96
Singer S (2013) Respiratory health and ecosyndemics in a time of global warming. Health Sociology Review 22(1):98-111
Theodore L, Dupont R (2012) Environmental Health and Hazard Risk Assessment Principles and Calculations. CRC Press, New York

UN (2016) Transforming our world: the 2030 Agenda for Sustainable Development. United Nations, New York

UN (2020) Human Development Report 2020. United Nations, New York

Vitolo C, Di Napoli, C, Di Giuseppe F, Cloke H., Pappenberger F, (2019) Mapping combined wildfire and heat stress hazards to improve evidence-based decision making. Environment International 127(June 2019):21-34