BASE BOTTOM-UP CLIMATE ADAPTATION STRATEGIES TOWARDS A SUSTAINABLE EUROPE

SEVENTH FRAMEWORK PROGRAMME

UNIVERSITY OF EXETER

Subgroup: Health

Case-study: England

(University of Exeter, UK)

September 2014

BASE BOTTOM-UP CLIMATE ADAPTATION STRATEGIES TOWARDS A SUSTAINABLE EUROPE

SEVENTH FRAMEWORK PROGRAMME

Case study developed by:

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Project:

FP7/ Project BASE [2012-2016]

Date of release:

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Purpose of this document:

"The Case Studies Living Document (CSLD) will be the document that each case study leader will use to share the information that (i) characterize and give context to its case study, (ii) the goals within BASE, (iii) the methods used and mainly (iv) a synthesis of the results that that case study is providing to BASE project. This will allow the CS leader to understand how its own case is going (having a good overview), but also (v) will allow the sub-group to which the case study belong to know what is happening and what can be done (mainly on synergies and so on) as well as to (vi) WP4 & 5 coordinators to use that information to report (including each WP task leaders). These living document will also (vii) allow WP6 & 7 partner to know the information."

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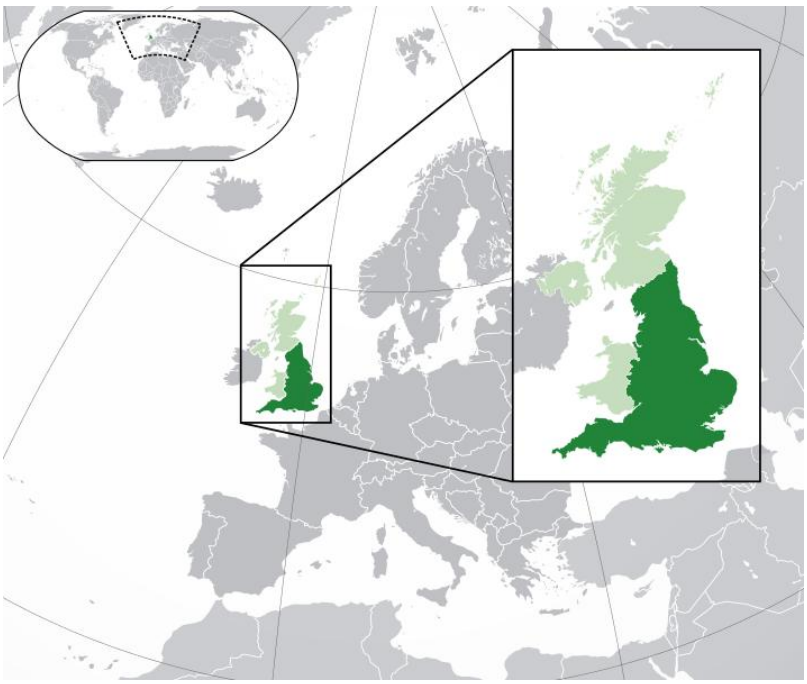
1. General Case Study Description

a) Location

(Please insert the coordinates of the geographical centre of your case study and additionally the area of the entire are under investigation. For a city, for example, use the city centre and the area of the municipality. Illustrate in the map the area in study) procrastination

The country of England is part of the United Kingdom and shares its borders with Scotland to the north and Wales to the west.

GPS: 52°33'42.942"N 1°27'53.474"W



(Source: http://en.wikipedia.org/wiki/England)

b) Case Study Summary

England is part of the United Kingdom and borders Scotland and is characterized by a mild, maritime climate, but has experienced several major extreme events in recent years, notably incidences of flash flooding in Boscastle in 2004 and major coastal flooding due to storm surge in early 2014.

The case study will develop a methodological framework to assess costs and benefits of cross-sectoral adaptation strategies to reduce the impacts of climate change on mental health in England, UK. It will focus first on the identification of climate change impacts on mental health, drawing on a review of the secondary literature and statistical analysis of secondary data, drawing on GIS methods. We will then attempt to identify

potential adaptation options and conduct cost-benefit analysis if possible, or evaluate evidence as to the cost-effectiveness of alternative interventions.

Specifically this case study on adaptation to climate change related health risks in Cornwall, will adapt a "science-first" approach. This impact-based approach evaluates impacts and then uses this as a basis to identify adaptation options (Ranger et al 2010). Therefore the case study will focus on:

1. Review of the literature on climate change and mental health risks
2. Statistical analysis of effects of climatic variability on mental health
3. Valuation of impacts – drawing on existing literature on costing mental health impacts
4. Identification of the potential adaptation strategies to manage these effects
5. Assessment of adaptation options using cost-benefit analysis

c) Context

(Máx 500 words) *If relevant to the understanding of the Case Study, please provide any contextual information of the region, history, etc of the case study*

The recent IPCC report stated that "Up to 2050, climate change will mostly exacerbate existing health problems, and across the 21st century will lead to increases in ill-health, particularly in poorer countries. There could be positive impacts including fewer cold-related deaths, but overall the negative impacts are likely to outweigh the positives". However, very few studies exists that examine the impact of climate change on mental health. A few have attempted to quantify the short and long term impacts of variation in precipitation and temperature on mental health.

Climate change may have significant adverse impacts on human health (IPCC 2007). Consequently, increasing attention is now being given to the issue of adaptation (IPCC 2007; Stern 2007; Costello et al. 2011). The effects of anthropogenic climate change have been discernible for a number of years (WHO 2009a). Most people will have noticed changes to the weather (Kerr 2011) and in the timing of seasonal events such as earlier flowering (Fitter and Fitter 2002). Weather anomalies and extreme events are becoming more frequent globally (e.g. heatwaves and flooding). Over the coming decades, societies will need to adapt to the changing climate (Stern 2007) based on local requirements. Climate change adaptation in terms of minimising or avoiding human health impacts is now taking centre stage (Kurane 2009; Bell 2011). Improvements in the resilience of healthcare systems to meet future climate change will save money long-term and will also assist in coping with natural catastrophes. The World Health Organization (WHO) and the European Commission are both funding research aimed at facilitating health adaptation to climate change (WHO 2009b; European Commission 2012). Because, different geographical regions will be impacted differently by climate change, each country will need to prepare for and adapt to their changing local climatic conditions to protect health.

Climate change results in climatic variability and will have significant consequences for human and natural systems by increasing the frequency of heat stress, drought and flooding (IPCC, 2014). Direct adverse impacts are related to heatwaves, flooding and other extreme weather events (Pall et al. 2011), and these have received the most attention to date (García-Herrera et al. 2010). However, many impacts of climate change on human

health will be indirect, i.e. not linked directly to weather events (Kurane 2009). In the UK the main climate related health threats include: summer heatwaves and droughts; flooding and its associated mental health issues (Paranjothy et al. 2011); interactions between air pollutants, pollen and higher temperatures (Cecchi et al. 2010; Laaidi et al. 2011); deterioration in food and water quality (Lobell et al. 2011); increase in vector borne diseases (Jones et al. 2008). Different UK regions will experience these impacts to different extents will be required to adapt locally to the new conditions.

Cost-benefit analysis of health adaptation measures is rare and this case study will help improve understanding of the issues in implementing such an approach in the health context.

d) Brief General Information on Climate CHANGE and related issues

(Máx 2000 words) *Please state which is the European climate zone of the case study and insert any information regarding the current available information regarding the case-study, namely expected impacts, scenarios.*

Anthropogenic Co2 is a major factor in the continuing rise in global temperature and the increasingly variable weather patterns that occur as a consequence (IPCC, 2014). Research on the health effects of climate change has focused largely on direct physical health impacts, principally death and injury from extreme weather events; impacts of increased temperatures and heat waves; spread of vector-borne disease; air quality and respiratory illness and changes in food and water quality and availability (Fritze, Blashki, Burke, & Wiseman, 2008). Current research into health impacts of climate change all acknowledge the potential risks to mental health (see for example IPCC (2014)) and yet , very little research exists with regard to the short and long term impacts of climate change on mental health disorders (e.g. depression and anxiety) and the associated financial costs.

"There are three key mental health implications of climate change. Firstly, direct impacts of climate change, such as extreme weather events, are likely to have immediate impacts on the prevalence and severity of mental health issues in affected communities as well as significant implications for mental health systems. Secondly, vulnerable communities are beginning to experience disruptions to the social, economic and environmental determinants that promote mental health. Finally, there is an emerging understanding of the ways in which climate change as a global environmental threat may create emotional distress and anxiety about the future." (Fritze et al., 2008).

Below is a broader discussion on the current state of evidence for the UK for key areas of climate change impacts:

TEMPERATURE

Until recently it has been assumed that climate change will decrease winter mortality in temperate countries as winters warm (CCRA 2012). This assumption has been shown to be naïve and two recently published articles have conclusively shown that winter warming will not decrease winter mortality, one in the UK (Staddon et al. 2014) and one in the USA (Ebi and Mills 2013). Furthermore the increase in winter temperature volatility and the possibility of increased cold spells (CCRA 2012), increased severity of temperature drops, occurrence of earlier cold spells, could all lead to increase in winter deaths despite generally warmer winters. This makes the prediction of how climate change will impact winter deaths very uncertain. The ONS (ONS, 2013) reported an estimated 31,100 excess winter deaths occurred in England and Wales in 2012/13, an increase of 29% compared with the previous winter.

Heatwaves, along with flooding, are topics which have received the most attention from an adaptation point of view in Europe (García-Herrera et al. 2010). This is partly because both of these impacts are already occurring with greater frequency and severity, and when they do occur can result in many deaths and / or massive destruction of property and related stress. Point events like these receive saturate media coverage and thus easily enter the public consciousness leading to various responses from politicians. The 2003 European heatwave is a classic example. At a national level, the UK observes 800 heat related deaths a year with a prediction of approximately 2800 deaths per year in the UK by 2050s (Donaldson, Kovats, Keatinge, & McMichael, 2001).

Wild fires do occur in England and area predicted to increase with increasing drought scenarios. However, due to their small size and location costs are currently very minor and injuries are extremely rare (none reported in past 5 years). Even with an increase in occurrence as a result of hotter and drier springs and summers with climate change, it is unlikely that wildfires will be a significant problem in the future and certainly will not be seen on the level of that observed in Southern France or Portugal in recent years.

Temperature and Precipitation

The increased frequency of droughts in England (Helen Louise Berry, Bowen, & Kjellstrom, 2010) will affect agriculture, especially in terms of what crops are planted and the risk of crop losses. This impact on local food production is however unlikely to have any meaningful impact on local food supplies assuming the UK remains in a position to import its food needs. The security of the water supply could be temporarily affected by drought and the risk of flash flooding will increase as a result of dry compacted surface soils. The main health issue resulting from drought relates to mental health issues, especially in the farming sector. Farmers and employees in the farming sector already suffer from a disproportionately high rate of psychological illness and exhibit high suicide rates (Booth et al. 2000; (H. L. Berry, Hogan, Owen, Rickwood, & Fragar, 2011; Obrien, Berry, Coleman, & Hanigan, 2014)). The increased uncertainties arising from climate change and the very likely increased risk of substantial losses in any one year can only further fuel these mental health issues amongst workers in the agricultural sector.

Flooding may become more frequent under a changing climate. The severity of flooding is dependent on a number of additional factors including the time of day, severity of the weather and existing social and economic structures (Reacher et al., 2004). In the immediate and short term, flooding causes a multitude of physical health effects such as drowning, injury, gastrointestinal and respiratory illnesses. Long term effects of flooding are less understood. However, a growing body of evidence suggests that flooding may have long term negative impacts on the psychological health and wellbeing of individuals experiencing a flooding episode (REFS).

England currently suffers from several main types of flooding: coastal flooding, river flooding, groundwater flooding and flash flooding. This is likely to continue to be the case in the future despite the impact of sea level rise and increased risk of storm surges on coastal communities. Many of the villages susceptible to flash flooding are often also at risk of coastal flooding. There are numerous estimates and assessments of the impact of climate change on flood risk in England and the South West of England, e.g. Climate Change Risk Assessment (CCRA 2012), South West Regional Flood Risk Appraisal (SWRFRA 2007), Association of British Insurers (ABI 2009). This case study will assume the view of CCRA, a central view based on the best evidence available. The Boscastle floods in 2004 (Environment Agency 2008) in Cornwall are a key example of flash flooding and the

information on these floods were augmented with other relevant data from England to obtain more robust information of current expected impact.

Storms are intimately linked to flooding, however we will concentrate purely on wind damage and related health risks. Storms will probably be more frequent in the future (CCRA 2012). It is therefore likely that the health impact of severe wind episodes will increase with climate change, but as the current impact on health and wellbeing is relatively low, the future health impact of storms is unlikely to increase to alarming levels. As with flooding, mental health issues arising from experiencing storms and possible financial losses will form a significant component of the impact of storms on health and wellbeing. The UK rarely exhibits large scale storms, hurricanes or tornadoes when viewed from a global perspective - deaths are rare and certainly never run into the 1000s or 10s of thousand as in less developed countries.

e) Existing Information on Case Study's adaptation history

(Máx 2000 words) *Please insert a Short resume of the Case study existing information related to Climate Change Adaptation (major goals, plans, measures and timelines already defined or implemented), important Milestones in its "Adaptation Journey" as well as relevant state-of the art regarding the implementation of Adaptation Strategies and Specific Measure*

The National Adaptation Programme (NAP): Making the country resilient to climate change

The NAP sets out what UK Government, businesses and society are doing to adapt to a changing climate and will be updated every five years with the next assessment due in 2018.

The UK Climate Change Risk Assessment (UK CCRA): t sets out the main priorities for adaptation in the UK under 5 key themes identified in the CCRA 2012 Evidence Report - Agriculture and Forestry; Business, industries and Services; Health and Wellbeing; Natural Environment and Buildings and Infrastructure - and describes the policy context, and action already in place to tackle some of the risks in each area. It highlights the constraints of the CCRA analysis and provides advice on how to take account of the uncertainty within the analysis.

Climate Ready Support Service (lead by the Environment Agency) provides an information service to the public, private and voluntary sectors to help assist in adapting to climate change.

Managing climate risks to well-being and the economy (Adaptation sub-committee progress report 2014): Assess the current state of resilience to weather and climate of the infrastructure, business, health care system and emergency services. It also develops a set of indicatirs that will help the government to track whether or not its actions will increase resilience to future climate change.

Heat wave plan for England 2013: An annual document jointly agreed between NHS England, Public Health England, the Department of Health, the Local Government Association and other stakeholders that aims to prepare for, alert people to, and prevent, the major avoidable effects on health during periods of severe heat in England. It recommends a series of steps to reduce the risks to health from prolonged exposure to severe heat

for: the NHS, local authorities, social care, and other public agencies, professionals working with people at risk, individuals, local communities and voluntary groups. To support the plan, the MET office produces heat health alerts Heat-Health Watch Alerts

To support the Plan, the Met Office issues Heatwave Alerts from 1 June to 15 September each year. There are five levels: Level 0 (long term planning, all year), Level 1 (heatwave and summer preparedness programme, 1 June to 15 September), Level 2 (heatwave is forecast – alert and readiness), Level 3 (heatwave action), Level 4 (major incident – emergency response, declared by central government).

Health and Care System Adaptation Report 2015: The Sustainable Development Unit are currently developing a report on how the health and care system is adapting to climate change has been requested by government under the Adaptation Reporting Power (ARP) component of the Climate Change Act (2008). The report is due for submission in May 2015. A cross system working group (DH, NHS England and Public Health England) has been established to assess how climate change risks are assessed, whether adaptation plans are in place and how the impacts of adaptation plans are evaluated in the following parts of the system: Overarching system level, National Bodies, Providers (NHS), Ambulance Trusts, Clinical Commissioning Groups, Community/The Public's Health (Health and Wellbeing Boards).

Adaptation to Climate Change: Planning guidance for health and social care organisations 2014 (NHS England and PHE):
This guidance forms part of the formal Emergency Preparedness, Resilience and Response (EPRR) guidance for NHS, public health and social care organizations.

f) Connection with other research projects:

(Please list and shortly describe previous or ongoing research projects directly related with the Case Study) Please write the name and summary of the project, relevant partner institutions, year of beginning and end of project)

None

g) Case ID, Typologies and Dimensions

Having in mind the following BASE Objectives; Categories of Case Studies, please fill in the following table.

BASE OBJECTIVES
1. Compile and analyze data and information on adaptation measures, their effectiveness. (…)

2. Improve current, develop new and integrate methods and tools to assess climate impacts, vulnerability, risks and adaptation policies (…).

3. Identify conflicts and synergies of adaptation policies at different levels of policy making with other policies (including climate mitigation) within and between sectors. (…)

4. Assess the effectiveness and full costs and benefits of adaptation strategies to be undertaken at local, regional, and national scales using innovative approaches (mainly by integrating bottom-up knowledge/assessment and top-down dynamics/processes) with particular attention on sectors of high social and economic importance.

5. Bridge the gap between specific assessments of adaptation measures and top-down implementation of comprehensive and integrated strategies.

6. Use and develop novel participatory and deliberative tools to enhance the effective use of local contextualized knowledge in adaptation strategies to assess perceptions of adaptation pathways and their co-design by citizens and stakeholders.

7. Disseminate findings by sharing the results of the project with policy-makers, practitioners and other stakeholders. (…)

CASE STUDIES CATEGORIES

A. Public administration (municipality, regional, national, european)
B. Research and education Centres (universities, research centres, projects and groups, schools)
C. Public companies
D. Companies (farms, SMEs, big businesses)
E. Social enterprises (cooperatives, non profit companies, woofing farms, etc)
F. Consortiums (partnerships, campaigns),
G. NGOs (environmental NGO, local development NGO, charities, etc)
H. Transition Initiative
I. Ecovillage
J. Informal groups, Movements

Case ID			Typologies and characterization				
Country & Name of CS	BASE Objectives to be answered by the CS	Category of case study	Territorial zones	Scale	Process Direction	Temporal Definition	Timescale[1]
UK, Cornwall Health	[x] Objective 1 [x] Objective 2 [ ] Objective 3 [ ] Objective 4 [ ] Objective 5 [ ] Objective 6 [x] Objective 7	Example: [ ] Companies	[x] Rural [x] Urban [x] Coastal [ ] River Basin	[ ] Local [ ] Regional [x] National [ ] Transnational [ ] European /Global	[x] Bottom-Up [x] Top-Down	[ ] Retrospective [x] Prospective	ongoing

[1] Please insert year of start and year of end of case study.

h) Impacts, Sectors and Implementation

Please tick the relevant boxes for impacts and implementation and insert the number 1 for primary sector and the number 2 for secondary sector.

Impacts		Sectors		Implementation	
Primary CC Impacts (Climate-Adapt)	Primary CC Impacts (BASE)	Primary and Secondary Sector (Climate Adapt)	Primary and secondary Sector (BASE)	Implemented[2]	Phase of Implementation[2]
[1] Extreme Temperatures [ ] Water Scarcity [1] Flooding [ ] Sea level Rise [2] Droughts [ ] Storms [ ] Ice and Snow	[1] Extreme temperatures [ ] Water scarcity [1] Flooding [ ] Coastal Erosion [2] Droughts [ ] Soil Erosion [2] Vector Borne Diseases [ ] Damages from extreme weather related events (storms, ice and snow)	[ ] Agriculture and forest [ ] Biodiversity [ ] Coastal Areas [ ] Disaster risk reduction [ ] Financial [ ] Health [ ] Infrastructure [ ] Marine and Fisheries [ ] Water Management [ ] Urban	[ ] Agriculture [ ] Biodiversity & Ecosystems [ ] Coastal and Marine systems [ ] Energy [x] Health and Social Policies [ ] Transport [ ] Production Systems and Physical Infrastructures [ ] Water resources [ ] Tourism	[ ] Yes [x] Ongoing [ ] No	[1] Assessment [ ] Planning [ ] Implementation [ ] Monitoring [ ] Evaluation

i) Importance and Relevance of Adaptation

Please tick the relevant box for the case study.

[ ] Case developed and implemented as a climate change adaptation measure

[ ] Case developed and implemented and partially funded as a climate change adaptation measure

[x] Case mainly developed and implemented because of other policy objectives, but with significant consideration on climate change adaptation aspects

2. Case study research Methodology

a) Research Goals

(Máx 500 words) *Please insert which are the General Goals for the case study as well as how will the case study contribute for BASE projects and BASE key research questions.*

[2] When the case study consists of a public administration with a top down approach, implementation can be an approved legislation or regulation. When the case study is about practical adaptation measures like a sand dune, for example, implementation should be considered finished when the dune is built in situ.

This case study aims to develop a methodological framework to assess the costs and benefits of cross-sectoral adaptation strategies to reduce the impacts of climate change on mental health in England, UK. The case study will focus on major likely climate change induced mental health risk. Specifically, it will examine climate variability and impacts on depression and anxiety. To establish the likely mental health risks, we will first review the existing literature on climate change and mental health risks in the UK. We plan to exploit secondary data on mental health in England to estimate the potential impact of climate change, by examining data relating to prescriptions and hospital admissions. We only include England in the nationwide case study due to lack of data availability in Scotland and Wales. We will also examine the spatial variation and the impact of climatic variation. The mental health impacts of background climate change and the adaptation options will be valued where possible and assessed using cost-benefit analysis.

This case study contributes to the BASE project by investigating the application of cost benefit analysis to decision making in the health context.

Principal research questions for this cases study are:

1. Review of the literature on climate change and mental health risks
2. Statistical analysis of effects of climatic variability on mental health – drawing on secondary data on prescriptions, hospital admissions and climate.
3. Valuation of impacts – drawing on existing literature on costing mental health impacts
4. Identification of the potential adaptation strategies either in place or planned to manage these effects
5. Assessment of adaptation options using cost-benefit and multi-criteria analysis

b) Stakeholders involved

(Máx 2000 words) *Please insert any information about the stakeholders involved in the adaptation process with which you will relate to, namely their nature, involvement in the process, etc. If possible highlight the decision-making process as well as the leadership process for Climate Adaptation Strategies. Do Mention if there exists any kind of public engagement and participation within the Adaptation process.*

Building on a number of existing relationships with partner organisations the UK, we will work with key stakeholders to identify climate change adaptation strategies in order to conduct economic valuation.

Key stakeholders to be engaged in this case study are:

- **Public Health England** protects and improve the nation's health and wellbeing, and reduce health inequalities.
- **NHS** is responsible for health care provision in the UK
    - **Health and Wellbeing Boards** are a key part of broader plans to modernise the NHS to: ensure stronger democratic legitimacy and involvement; strengthen working relationships between health

and social care, and, encourage the development of more integrated commissioning of services. The boards will help give communities a greater say in understanding and addressing their local health and social care needs.

- **University of Exeter Medical School** has as major teaching and research hub located in Cornwall.
- To a lesser extent we will engage with **General Practitioners** and national patient groups and the **Environment Agency**.

c) Methodology

(Máx 2000 words) *Please insert what will be your research approach regarding this case study, how did you define it (did it include participatory sessions or not) and how you will implement it during the BASE Project period.*

This case study adopts a "science-first" approach, i.e. impacts are first identified using available analysis (either based on analysis of secondary data or existing studies). In this national case study, statistical analysis of the impact of background climate variation (excluding extreme events) will be conducted using GIS analytical methods. We will first, attempt to identify the associations between climatic variation and mental health, before identifying possible adaptation options.

Cost - benefit analysis will be carried out and where appropriate, multi-criteria analysis will also be applied if relevant. Stakeholder engagement is important in the uptake of results for policy, and a number of key stakeholders have been identified.

The steps taken are:

1. Review of literature on climate change effects on climate variability and impacts on mental health risks;
    a. Databases searched: Web of Science, Medline, EBSCO
    b. Search terms included for example:
        i. Climate change AND health AND mental health
        ii. Climate variability OR variation AND health AND mental health AND mental illness AND anxiety AND depress* AND wind AND precipitation AND rainfall AND temperature
2. Secondary data analysis of effects of climatic variability (wind, precipitation, temperature, UV flux) on mental health disorders (specifically depression and anxiety, evidenced through prescriptions for anti-depressants)
3. Valuation of mental health impacts (prescription costs for anti-depressant drugs)
4. Identification of adaptation options, based on the literature and discussion with key stakeholders;
5. Assessment of adaptation options using cost-benefit analysis (and multi-criteria analysis if appropriate).

We have conducted a review of the literature on the potential health impacts of climate change, drawing on relevant bibliographic databases and existing studies by the UK government, IPCC, World Health Organisation and others. In order to capture emerging threats that are identified in the literature, but which not yet be mainstream additional Web of Science searches were made using terms described above.

Data sources and analysis

Metal health prevalence and prescribing data

Monthly health and GP data were derived from the Quality and Outcomes Framework (QOF) for June 2010 – December 2012 (NHS, 2011). Available data utilised include depression prevalence (number of new diagnoses of depression per month (patients 18 and over with a new diagnosis of depression in the preceding 1 April to 31 march who have had a bio-psychosocial assessment by the point of diagnosis), for each General Practice (GP) in England for the specified time period. It also includes data about the number of prescriptions for depression (identified through British National Formulary codes) and the associated costs of for dispensation of medication for depression. This analysis excludes more severe mental health illnesses such as schizophrenia and associated medication prescriptions. Data relating to GP practice locations and the associated registered list/population was also obtained.

Climate data

Projected monthly climate data were obtained from BASE partners at the National Institute of Geophysics and Volcanology in Italy (CORDEX). We used climate scenario projections of Representative Concentration Pathways (RCPs) 4.5 and 8.5 which represent an approximate 1- 3^{o}C temperature increase up to 2050. We selected climate variables based those that could have most likely impacts on mental health, as identified by existing evidence (e.g. Molin et al, 1996; Huibers et al., 2010; Hartig 2007). These parameters included the mean monthly values of: surface air temperature (K), precipitation (cm per day) , cloud cover (% total cloud fraction) and ultraviolet irradiance (W m-2). All climate data were provided in 15km grid squares.

Socioeconomic data

Health and mental health specifically are closely related to socioeconomic status (REF) and geographical location (i.e. urban/rural). Given these associations, we included a GP-weighted Index of Multiple Deprivation (IMD) and an urban rural measure from the Office of National Statistics (2010). IMD is shown to be incredibly stable over time and we therefore included the GP-weighted IMD from 2010 in our analysis to control for effects of socioeconomic status.

Population growth data estimates were calculated based on IIASA SSP1 and SSP% which are both associated with rcp4.5 and rcp8.5 respectively.

Data cleaning

Climate data were converted from the standard rotated polar grid coordinate system to the UK standardised latitudes and longitudes in order to map both climate variables and prescription data to GP locations (identified through postcodes). Through an iterative process, the final dataset contained climate data, number of items prescribed, the total cost of prescribing per month, GP list size and allocated urban/rural and IMD scores for each month (start June 2006 – end December 2050) for each GP practice in England (~8000).

From these data we calculated a 'cost per person' (total cost of prescribed items per GP practice per month/GP list size for that month) to use as our dependent variable. This was to give us an indication of the change in costs of prescribing over time, attributable to climate change, accounting for socioeconomic and geographical influence.

We first used a panel analysis (month within practice) to look for associations between prescribing data and climate data for the period of 2010 – 2012. We then applied coefficients from the model to our projected climate variables to give an estimated forecast of costs of depression resulting from climatic variability.

Table 1: Approaches to integrate climate change into decision making

Method	Description	Implications for design of policy
Impact based approaches	Evaluate impacts and then use as basis to identify adaptation options. Has a science first basis.	"Science-first" approach
Adaptation and vulnerability based approaches	Starts from the processes of enhancing adaptive capacity, independent of assessment of climate risk. Approaches identified enhance robustness to climate changes or shocks.	"Policy-first" approach
Risk management approaches	Focuses on decision making and offers framework for incorporating all approaches – and explicitly considers uncertainty.	"Policy-first" approach

(Adapted from Ranger et al 2010)

An attempt to place monetary values on health endpoints, where possible, will be made, drawing on existing studies that use cost-of-illness methods or stated or revealed preferences. Presenting both the quantities and the monetary values is appropriate to allow for comparison across impacts. In the literature addressing willingness to pay to avoid health risks the emerging debate on the differential values attributable to voluntary

health risks taken by individuals, compared to involuntary risks shows that mortality risks are valued differently depending on the nature of the risk. Hence lives lost estimates are usefully supplemented by valuation data that reflects the different types of risk. We will estimate most of the costs for mortality based on the value of a prevented fatality.

The initial plan was to conduct cost-benefit analysis of different adaptation options for mental health. This had to be modified due to the findings, which showed that climate change is likely to lead to improved mental health. This meant that instead of cost-benefit analysis, to estimate the full economic benefit of climate change we needed to consider benefits beyond reduced spending on prescriptions of improved mental health. These include:

- Reduced pain and suffering;
- Reductions in levels of lost earnings; and
- Reductions in premature mortality due to suicide.

Note: Partners/Case Studies using PRIMATE tool will be using CBA (to prioritize) and/or MCA (with stochastic PROMETHE II) and the Monte Carlo Uncertainty Analysis, so please check these boxes.

METHODS to be used in Case Studies[3]	YES // NO
A) Methods for prioritizing adaptation options	
Cost-Benefit Analysis (CBA)	Yes
Cost-Effectiveness Analysis (CEA)	No
Multi-criteria Analysis (MCA)	No
Analytic Hierarchy Process (AHP)	No
B) Quantification of impacts and relationships between factors affecting adaptation	
Causal Diagrams	No
Influence Diagrams	No
Process-based Modelling	Yes
Welfare variation analysis under restrictions	Yes

[3] For descriptions and references of the Methods please refer to Milestone 8. For data requests from specific Work Packages please refer to Deliverable 4.1

C) Uncertainty and sensitivity analysis	
Probabilistic multi model Ensemble	No
Monte Carlo simulations (PRIMATE uses this method)	No
Real option analysis	No
Climate risk management process	No
D) Participatory Methods	
Scenario Workshop	No
Participatory Cost Benefit Analysis (PCBA)	No
Participatory add-ons to CBA	No
Participatory add-ons to Multi Criteria Decision Analysis	No
Participatory add-ons to Adaptation Pathways	No
Other (add extra lines if necessary):	

(Máx 500 words) *Please highlight if you have any special need or focus regarding any of these methods and their use on your case study.*

Case study Timeline

(Please insert and image/graph of the Timeline of your Research Approach, highlighting important milestones and deliverables.)

January – April 2014	Developing approach to the research, identifying stakeholders and partner organisations
May – September	Literature searches and method development
November – May 2015	Climate-health data analysis,
May - June 2015	Economic analysis
June – August 2015	Drafting/updating of CSLD

d) Collaboration with other Partners and Case studies

Collaboration with BASE case studies (see list in EMDESK):

Case: _____Madrid_____; Person: ____ Aline Chiabai_____

Case: _____; Person: _____

Case: _____; Person: _____

Case: _____; Person: _____

Case: _____; Person: _____

Case: _____; Person: _____

Collaboration within BASE partners/researchers (EX: for a specific competence):

Name: _Aline Chiabai__; Partner: __BC3_

Name: _____; Partner: _____

Name: _____; Partner: _____

Name: _____; Partner: _____

Name: _____; Partner: _____

Name: _____; Partner: _____

Name: _____; Partner: _____

Research Outputs

1. Scientific Publications

- Interim reports + final case study report for D5.5 (Month 30)

- Scientific papers:

1) "Psychological health and wellbeing, weather and climate change: estimating potential UK futures" To be submitted to: *American Journal of Preventative Medicine* or *Climatic Change*

2) "Climate-health modelling to address the links between climate variability and mental health impacts" To be submitted to: *Nature Climatie Change*

(add more papers in case you need)

2. Other Publications

- Books/Books Chapters: # 1

Provisional Title: _____

_____; Month/Year: ___/_____

3. Other

- Title "Assessing the health impacts of climate change, adaptation and mitigation, Stakes and methods

  Conference: Workshop – Saint Maurice

  Date: 8-9 June 2015

  Held by The French ministry of health and the French Institute for Public Health Surveillance in preparation for COP21

- Title "The impact of weather and climate change on the environment in the South West"

  Conference: PPHN / CIEH Environment Conference

  Date: 27 May 2015

- Title "Mental health and climate change: Costing impacts and assessing adaptation options in England, UK"

  Conference: European Climate Change Adaptation Conference 2015

  Date: 12-14 May 2015

3. Invited seminars, presentations at local events, etc…Participation in Climate Change Adaptation

j) Process overview

(Please describe the use of Participatory Methodologies within your case study, namely its integration in the overall Research Methodology explained earlier in the CSLD, the rational behind it and key expected outcomes – Máx 1000 words)

Currently no specific adaptation process or strategy specifically for mental health. No participatory methods used within this case study. Interactions with key stakeholders (NHS, Public Health) were held informally in order to determine if any potential mental health adaptation plan(s) were in progress or planned. Possible actors include: Public Health, NHS, Health & Wellbeing Boards, Cornwall Council - despite being included in significant climate change adaptation reports (i.e. CCRA, CCAP, IPCC), no decisions regarding mental health have been made to date.

k) Participation in the Process Phases

(Please uncover the role of all participants in the process of implementing adaptation measures. The adaptation implementation has been divided into four phases for purposes of ease: 1) Initiative/decision to act, 2) Development of potential adaptation options, 3) Decision-making, and 4) Implementation. The process phases are to be filled out with information corresponding to each participant. I.e. if experts were not consulted in the 'decision-making' phase, then describe why they were not included. It is also important that a wide array of participants is described, including those that were excluded from parts of the process.)

Make a bullet point for each of the five participant categories below (and distinguish between for example different stakeholder or expert groups) and be as descriptive as possible how, <u>why/why not were they involved</u>.

Process phases:

1. *Initiative/decision to act*

Stakeholders - Due to no adaptation strategy, mental health charities could be key stakeholders in the development of any future adaptation strategy

Citizens - none

Experts - No direct initiative to act specifically, broadly referred to in CCRA, IPCC, CCAP

Politicians – None specifically relating to mental health

Officials/legislators – Potentially Public Health England

2. *Development of potential adaptation options*

Stakeholders: No specific adaptation options in development - unknown why, possibly due to lack of evidence.

Citizens - No specific adaptation options in development - unknown why, possibly due to lack of evidence. Citizens unlikely to be involved at this point.

Experts - No specific adaptation options in development - unknown why, possibly due to lack of evidence.

Politicians - No specific adaptation options in development - unknown why, possibly due to lack of evidence.

Officials/legislators - No specific adaptation options in development - unknown why, possibly due to lack of evidence.

3. *Decision-making*

Stakeholders - No specific decisions regarding development of potential adaptation strategies for mental health have been made - unknown why, possibly due to lack of evidence.

Citizens - None

Experts - Academic institutions (inc. UoE, ECEHH)

Politicians - No direct involvement of politicians. More broadly indicated a need to consider impacts of mental health in a changing climate in CCRA, CCAP, IPCC.

Officials/legislators - None

4. Implementation – None, unknown why
Stakeholders

Citizens

Experts

Politicians

Officials/legislators

I) Participation Experience

(Please report with regards to your case study and the implementation of Participatory Methodologies using a traditional SWOT analysis – Strengths; Weaknesses; Opportunities and Threats)

Strengths	**Weaknesses**

Opportunities	Threats

m)Learning through Participation

In order to capture how participation could improve the climate change adaptation process, please report with regards to your case study:

a) Your view whether and how participation influenced the strategies and measures decided in your case?

b) How you think the participatory process in your case could be/have been improved?

c) Any novel (use of) participatory methods observed in the case studies

4. Climate Change Adaptation Measures and Strategies

a) Adaptation Measures under analysis in your case study

(Please identify your Adaptation Measures considered in this case-study and provide a short description of each)

The UK Climate Change Risk Assessment (2012), the IPCC report (2014) and the National Adaptation Programme (2013) all suggest that climate change is likely to have a significant impact on mental health, but this is largely attributable to extreme events such as flooding and drought. Despite the issue being highlighted in these high profile reports, there is currently no specific mental health and climate change adaptation plan available or in development to date. Therefore this case study will examine costs of anti-depressant prescribing and how this may/may not increase in the future as a consequence of climate change (excluding effects of extreme events). Treatment is itself a form of adaptation. In the absence of treatment, the outcomes of mental health related illness and associated economic costs would be more severe. The initial plan was to assess the costs and benefits of treatment and other forms of adaptation, however this was not possible as climate change was shown to have a positive impact on mental health in the UK.

b) Adaptation Measures selection and data availability prior to BASE

(Please describe how and why where these specific measures selected for further research and analysis under BASE and what is the baseline data already available for each specific adaptation measure. Máx 500 words)

There is extensive extant secondary data available through the Health and Social Care Information Centre. The data utilised in this case study is on GP locations, GP list size, prescription identity (i.e. name of drug group), number of items prescribed and total cost of prescribed items (for depression, as identified by previously based on BNF drug groupings). Understanding how the cost of prescribing varies over time when controlling for socioeconomic factors can start to build an evidence base of the impacts of (background) climate change on mental health. Socio economic data are available from the 2011 census (ONS 2012).

We also utilised available climate projections obtained from CORDEX for two climate scenarios (rcp 4.5; rcp 8.5). However, analysis was only conducted on rcp4.5 and associated SSP1 as there was little difference between the two scenarios and the health outcome.

c) Full description of Adaptation Measures

(Please provide a full description on each of the Adaptation Measures regarding this 21 leading questions under. If more than one Adaptation Measure please copy paste the structure provided.)

<u>Process</u>

I. Would, or at which part would, institutions and private stakeholders implement the measure autonomously to adapt to climate change (Adaptive capacity)?

In this case, a benefit was found. Mental health in the UK will likely improve with climate change, due largely to the effect of temperature which has a strong positive impact. (Note that this would not necessarily be the same in less temperate regions – so care should be taken in transferring these results beyond regions with climates similar to the UK). The taking of treatment is in itself an adaptive response – so too is reduced treatment. This we assume to be largely autonomous – patient led demand for anti-depressants being the basis of the analysis.

II. Does the measure initiate further activities for adaptation to climate change?

Potentially, his analysis suggests that mental health is positively impacted by climate and specifically temperature. This may have implications for location of new developments and spatial planning and for resourcing needs of the National Health Service – i.e. with reduced future mild to moderate depression resources could be targeted to other activities.

III. Does adaptation aim for flexibility and reflexivity (i.e. the ability to change as CC and other factors develop)?

Yes. This is a largely autonomous and flexible process.

IV. Is the measure effective under different climate scenarios and different socio-economic scenarios?

Yes. The response is stronger under some scenarios than others, but the findings are robust to variation in the scenarios.

V. Is the adaptation measure iterative?

Yes. It can be adjusted.

VI. Does the measure contribute to overall sustainable development, alleviate already existing problems and bring benefits for other social, environmental or economic objectives than adaptation (no regret measures)?

Yes

a. Please describe briefly how

Reduced pressure on resourcing of the National Health Service is one outcome, but as the outcome is dependent on climate this is not a no-regret measure. Other "treatments" including so called "green prescriptions" may yield health benefits beyond the mental health outcomes, but these are not the subject of this research.

VII. Can adjustments be made later if conditions change again or if changes are different from those expected today?

Yes

The process is based on autonomous adaptation to a certain extent, so treatment regimes may vary in the future. One key will be to ensure that future treatments include this flexibility.

Outcome

Relevance and effectiveness of adaptation measures

VIII. How important is the climate change threat addressed by the measure? What economic values, ecosystem functions and socio-cultural values are at stake, and to what extent are they affected by climate change impacts? Is there an indication of overriding public interest, e.g. critical infrastructures, public health ?

The adaptation is fundamentally linked to public health and health infrastructures. There are significant other economic benefits associated with improved mental health outcomes.

IX. What portion of the targeted potential damages can be avoided by implementing the measure? (0-100%)

This is based around prescriptions behaviour, if prescribing behaves as at the current time 100% of the benefit can be realised.

Efficiency

X. How high are the benefits of the measure relative to the costs? Are the costs justified by the benefits
(Please refer to results of economic evaluation in chapter 5)

The overall findings are that the mental health benefits of climate change in the UK are significant. The overall benefits are £12.7 million in terms of reduced spending on prescriptions, £1.47 billion for lost earnings, £1.39 billion for pain and suffering and £551 million for reduced mortality.

XI. What are the costs of the administrative implementation of the measure? Are there potential funding under the umbrella of other European policies (eg. CAP/Cohesion policy ? N/A

None – autonomous adaptation assumed.

XII. Does the measure give an incentive for innovation to different actors (e.g. SMEs) / can it deliver a competitive advantage for the local economy? (Y/N)

No

XIII. Does the measure have effects on employment? (Y/N)

Yes – in terms of reducing sickness leave

XIV. How long is the time-lag between implementation of the adaptation measure and the effect of the measure?

None

XV. What is the timeframe during which the measure will have an effect?

Unknown

XVI. Does the measure create synergies with mitigation (i.e. reduce GHG emissions or enhance GHG sequestration)? (Y/N)

Yes – drug production is one of the largest parts of emissions of greenhouse gases from the National Health Service in the UK and as such reduced prescriptions will lead to potential reductions in greenhouse gases. However, it depends on how the freed resources are spent – if on other drugs then the relative energy intensity and associated emissions of the lifecycle of the drug may have to be assessed.

XVII. Does the measure alleviate or exacerbate other environmental pressures? (Explain briefly)

It likely will reduce pressure on the environment from antidepressants – emerging evidence suggests that pharmaceuticals in the environment may lead to environmental damage. For example, climate change related environmental change Climate-related environmental changes are associated with a rise in the incidence of chronic diseases (e.g. cardiovascular disease and mental illness) resulting in a higher rate of prescribing to treat such conditions. Biological inputs into the natural environment and disposal of excess or overprescribed items into the natural environment may potential have huge impacts on biological systems (Redshaw et al. 2013).

Equity

XVIII. What are the impacts on different social or economic groups, are there expected impacts on particularly vulnerable groups? (distributional impact)

Our analysis showed a greater impact of climate variability on those groups who were most deprived. In constructing the statistical model, we included a broad measure of socioeconomic status (IMD) that is used as a standard measure in many health related studies.

XIX. Does the measure enhance well-being and quality of life (e.g. in the urban environment)? (Y/N)

Difficult to determine if background climate variability has a protective effect on depression and anxiety – further analysis would be required to begin to elucidate this effects.

5. Impacts, Costs and Benefits of Adaptation measures

(This section of the CSLD follows the Economic Assessment Steps put forward by UFZ and thoroughly described in D4.1, chapter 4. Please check D4.1 for any doubts or questions. In case of duplication of information with previous sections of the CSLD feel free to copy paste.) For more detailed guidance (incl. two examples) please see the above mentioned chapter 4 of D4.1. Please do not hesitate to contact volker.meyer@ufz.de, oliver.gebhardt@ufz or Filipe Alves if you have questions about how to fill out this section.

a. Step 1 – Preliminary Risk Assessment and identification of adaptation tipping points (max 1500 words)

(some of these questions might be already answered in section 1 – if so, just copy&paste)

What is the climate change related problem/risk you would like to reduce by adaptation?

- Which problems already exist, what is/are the current risk/s?
- Which assets and sectors are at risk under current climate variability?
- Which adaptation or protection measures are already in place? (refer to typology of measures in D6.1, table 2)
- How do these risks presumably change due to climate and socio-economic change?

- What are the main drivers, impacts and affected sectors (refer to BASE impact and sector categories, see also Table 1 of D6.1)
- Which climate and socio-economic scenarios are used?

Climate change may have significant adverse impacts on human health (IPCC 2007). Consequently, increasing attention is now being given to the issue of adaptation (IPCC 2007; Stern 2007; Costello et al. 2011). The effects of anthropogenic climate change have been discernible for a number of years (WHO 2009a). Most people will have noticed changes to the weather (Kerr 2011) and in the timing of seasonal events such as earlier flowering (Fitter and Fitter 2002). Weather anomalies and extreme events are becoming more frequent globally (e.g. heatwaves and flooding). Over the coming decades, societies will need to adapt to the changing climate (Stern 2007) based on local requirements.

England, UK has a maritime climate and will experience significant changes in weather patterns over the coming decades and it is predicted that by 2050-2080 the local climate will be 2 to 3 °C warmer than now, both in winter and summer (IPCC 2007). England will also experience longer periods of warm/hot and dry weather in spring and summer (CCRA 2012). Overall levels of precipitation will be similar to now, but more concentrated in the winter months (CCRA 2012). In addition it is predicted that extreme weather events will become more frequent, including heatwaves, storms, heavy rainfall, and cold spells (IPCC 2012). These changes will occur over the medium term, and are within the time frame of planning and development.

Direct adverse impacts are related to heatwaves, flooding and other extreme weather events (Pall et al. 2011), and these have received the most attention to date (García-Herrera et al. 2010). However, many impacts of climate change on human health will be indirect, i.e. not linked directly to weather events (Kurane 2009). In the UK the main climate related health threats include: summer heatwaves and droughts; flooding and its associated mental health issues (Paranjothy et al. 2011); interactions between air pollutants, pollen and higher temperatures (Cecchi et al. 2010; Laaidi et al. 2011); deterioration in food and water quality (Lobell et al. 2011); increase in vector borne diseases (Jones et al. 2008). Different UK regions will experience these impacts to different extents will be required to adapt locally to the new conditions.

Climate change adaptation in terms of minimising or avoiding human health impacts is now taking centre stage (Kurane 2009; Bell 2011). Improvements in the resilience of healthcare systems to meet future climate change will save money long-term and will also assist in coping with natural catastrophes. The World Health Organization (WHO) and the European Commission are both funding research aimed at facilitating health adaptation to climate change (WHO 2009b; European Commission 2012). Because, different geographical regions will be impacted differently by climate change, each country will need to prepare for and adapt to their changing local climatic conditions to protect health. However, given the overwhelming recognition that climate change is likely to impact significantly on mental health, either via exacerbating existing conditions or through new depression diagnosis, there remains no explicit mental health and climate change adaptation plan. Given the immense pressure already faced by the National Health Service, adapting to changing mental health treatment demands and understanding possible climate-related triggers (e.g. temperature, rainfall), may become increasingly important under current climate change scenarios.

This case study utilises the rcp 4.5 climate scenario with associated Shared Socioeconomic Pathways (SSP) 1 to calculate changes in GP list size to 2050. We have also used a GP-weighted Index of Multiple Deprivation (IMD), modified to include an estimate of a weighted average of the IMD scores for each LSOA (Lower Super Output Area)

in which a given practice has registrations. The weights are the % of the practice's registrations in each LSOA (HSIC 2011).

We were specifically interested in whether there was an association between mental health (depression and anxiety) and climate variability. Panel analysis (random effects , table 1) of these data suggested that, as might be expected, cost of prescribing increases as precipitation, cloud cover and UV increase, but decreases with rising temperatures.

Table 1. Panel data analysis (month within practice)

RCP4.5 - Cost per person	B	p	95% CI	
% Cloud cover	0.007076	<0.001	0.0066	0.0076
Cloud ^2	-0.000048	<0.001	-5E-05	-4E-05
Precipitation (cm/day)	0.000090	<0.001	8E-05	1E-04
Precip ^2	0.000000	<0.001	-3E-08	-2E-08
Mean temp (K)	-0.282623	<0.001	-0.291	-0.2746
Temp ^2	0.000493	<0.001	0.0005	0.0005
UV (J/m2/s)	0.000788	<0.001	0.0008	0.0008
UV ^2	-0.000002	<0.001	-2E-06	-2E-06
Urban	ref			
Town/fringe	0.045956	<0.001	0.0369	0.0551
Rural	0.06356	<0.001	0.0492	0.0779
IMD - Quintile 1 (least deprived)	ref			
Q2	0.025882	<0.001	0.017	0.0347
Q3	0.027652	<0.001	0.0186	0.0367
Q4	0.028639	<0.001	0.0195	0.0378
Q5	0.01475	0.002	0.0055	0.024
ICC	0.76			

Which adaptation tipping points can be identified?

- Can adaptation tipping points, critical levels for adaptation, be defined for this current strategy? (=when objectives are not met anymore due to changes)
  Refer to otherwise expand on Table 3 of D6.1
- When (roughly) will these critical levels be reached due to climate change or socio-economic change
- Give appropriate period (2015-2030, 2030-2050, after 2050) for each considered combination of climate and socio-economic scenario.

In this case the adaptation being considered is largely autonomous – so when temperature increases demand for prescriptions and mental health services will likely reduce in terms of mild to moderate depression.

b. Step 2 – Identification of Adaptation Measure and Adaptation Pathways (max 1500 words)

(some of these questions might be already answered in section 4 – if so, just copy&paste)

What are the alternative adaptation measures?

- What are the primary and secondary objectives of adaptation?
- What are potential measures to meet these objectives?
- (refer to typology of measures in D6.1, table 2)
- What is your baseline option (the "business-as-usual"-option)?
    - What is the ambition level of this baseline strategy?: Maintaining current risk levels or current protection levels (implying with CC risks may increase)?
    - Is current backlog of investments for adaptation measures included or excluded?
    - Does it include only planned adaptation or also autonomous, non-planned adaptation?
- Are there complementary measures? Is it appropriate to bundle these measures?

What are alternative adaptation pathways?

- What is the "sell-by"-date of the measures or bundles of measures? I.e. when will they – under conditions of climate change – not any longer be able to meet the defined objectives?
- What would be alternative measures or bundles of measures at these "tipping points"?

In terms of the timing of adaptation for health impacts, it may be possible to adapt and apply the "adaptation pathways" model of Haasnoot (2012, 2013). This model identifies "tipping points" for adaptation, and in the health context major tipping points can be seen as being linked to the timing of damages:

- Primary interventions – before damage occurs to minimise exposure (e.g. a number of public health interventions)
- Secondary interventions – aim to prevent disease before it becomes manifest (e.g. screening tests)
- Tertiary interventions – applied once impacts occur

Table 2 gives an overview of these interventions for different health impacts of climate change.

The development of new drugs or treatment regimes may also lead to the potential for a tipping point – e.g. the development of a new vaccine against a particular climate related condition. Factors that change the cost-effectiveness of given interventions may also be important – for instance through changes in the costs of raw materials or in the costs of production. Such factors may have a lagged impact – as they may take significant time to pass through government decision making (e.g. review by NICE, the National Institute for Clinical Excellence, in the UK). Thus, the emergence of new anti-depressants may influence the findings here.

In the recent past, extreme weather events have increased awareness of climatic risks and assisted in driving policy in terms of the installation of heat warning systems.

Table 2: Primary, Secondary and Tertiary Adaptation

Health impacts	Primary	Secondary	Tertiary
Heat stresses	Building and technical solutions. Urban planning (green roofs, etc). Heat health warning systems (preventive). Educational campaign.		Heat health warning systems (reactive). Emergency plans and medical services.
Extreme weather events related deaths, injuries, mental health effects	Structural measures to reduce flooding (dykes, walls) Land-use and urban planning (flood-resistant). Early warning systems and real-time forecasting.	Disease surveillance and monitoring	Emergency and evacuation plans. Diagnosis and treatment
Water-borne diseases	Water and sanitation systems. Information and health education.	Disease surveillance and monitoring.	Diagnosis and treatment (early detection).

Source: D4.1

c) Step 3 - Evaluation Criteria and Method (max 2000 words)

a. Step 3a Selection of evaluation criteria

Which evaluation criteria should be used?

- What are the relevant positive and negative properties of the measures (costs and benefits) to be considered in the evaluation process (economic, ecological and social effects)?
- (see D4.1, chapter 4 for examples)
- What is the appropriate unit to measure each of these criteria? Is the performance of the adaptation options measured in qualitative, monetary or other quantitative terms?

b. Step 3b Selection of evaluation method(s)

What is the appropriate evaluation method?

- Is it possible to express all relevant cost and benefit criteria in monetary terms?
  (→ cost-benefit analysis)
- Is it possible to express the positive effect (objective) by a single non-monetary indicator?
  (→ cost-effectiveness analysis)
- Are there several relevant criteria which cannot or cannot easily be expressed in monetary terms?
  (→ multi-criteria analysis, PCBA)
-

We are able to assess the benefits in terms of improved mental health, with reduced cases of mild to moderate depression, in terms of:

- Reduced prescription costs;
- Reduced losses of earnings;
- Reduced pain and suffering; and
- Reduced mortality risk due to suicide.

We are not able to quantify the impact on the environment – nor the impacts of diverting resources to other demands in the National Health Service.

c. Step 3c Weighting of evaluation criteria (applicable only to multi-criteria analysis)

What are the preferences of stakeholders regarding the different evaluation criteria?

- Are there different stakeholder groups with varying preferences regarding the evaluation criteria?
- Which weight do stakeholders and/or decision makers attach to a substantial change in the performance of the adaptation options regarding each evaluation criterion?
  (see D4.1, chapter 4.10.2 for guidance for the Swing-Weight method)

N/A

d. Step 4 - Data collection (max 2000 words)

What are the costs and what are the benefits of the alternative adaptation options?

- What potential data sources are available, including damage & impact assessment methods or existing CBA studies on adaptation measures?
- If no relevant data sources are available and modelling cannot be undertaken: Which experts can estimate proxies for assessing the performance of measures regarding the respective criterion?
- How do the adaptation options perform with regard to each of the cost and benefit criteria selected in step 3a

Examples of previous literature that have valued depression include Hames and Vardoulakis (2012) who estimated the costs of a case of depression at £970 2010 prices based on Bower et al (2010). In this study they also assumed that 10% of those flooded developed depression.

The costs of depression were assessed by Thomas and Morris for the year 2000 in England . They estimated NHS treatment costs for depression at £369,865,000 (2000 prices) and that there were just under 2.7 million cases of depression – implying an average cost of £138.97 per case (2000 prices). These were adjusted to bring to 2013 prices. Thomas and Morris also examined morbidity costs in terms of incapacity benefit and loss of earnings and the costs associated with mortality. The former is identified directly for the case of Ménière's, and to count also the cost of depression would be to risk double counting. In terms of mortality, Thomas and Morris report 2615 deaths associated with depression, and use measures based around lost earnings to place a monetary value. Such a method to value premature mortality is controversial, and does not account for a number of other values. The UK government uses a "value of a prevented fatality" of £1.145 million (HMT, Green Book) based on measures of willingness to pay for mortality risk reduction and estimates of other costs including lost output. This compares to the £214,913 per fatality estimated by Thomas and Morris.

There are difficulties in applying valuation methods to QALY gains. For example, Van Houtven et al (2006) used meta-regression analysis of morbidity valuation studies and examines whether there is a relationship between willingness to pay and health status measures. They analyse 230 WTP estimates from 17 studies and find that QALY based estimates of illness severity are significant in explaining variation in willingness to pay, but they reject the assumption of a constant WTP per QALY gain. Gyrd-Hansen (2005) explores the theoretical and methodological issues relating to the identification of willingness to pay for a QALY, suggesting from a theoretical perspective one unique willingness to pay estimate cannot be found. Issues faced include diminishing marginal utility of health and differences in values of incremental health in different populations.

The initial stage of the analysis showed a growth in total cost of prescribing that was primarily driven by a) projected climate change and b) projected population growth (fig 1). We calculated the growth in prescribing costs due to population change alone by multiplying the baseline average cost per person by the projected monthly populations (i.e. what would the total cost be if cost per person stayed constant, but population grows?) We subtracted this from the results of the first set of projections to get the estimated monthly total cost due to climate changes alone, and this indicates that the average monthly difference was around -£750k (total) – i.e. projected prescribing costs were more if climate stayed the same as 2010, than if it changes as predicted (fig 2).

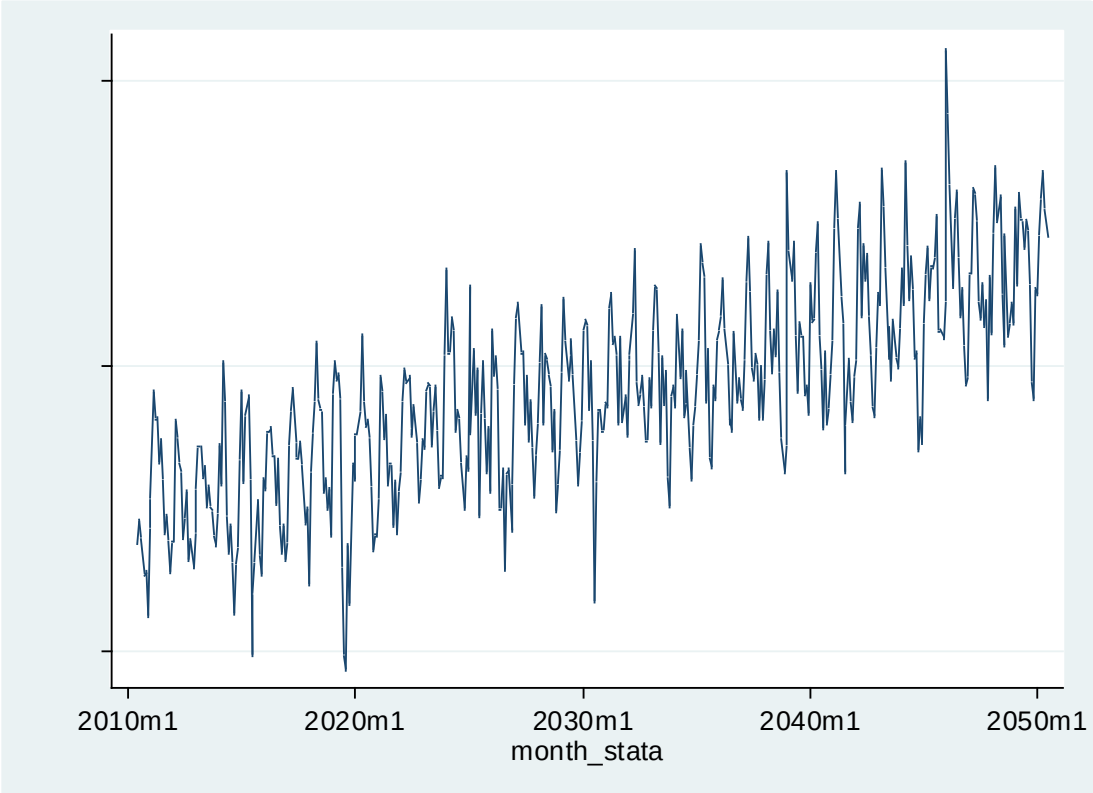


Fig 1. Forecast costs of depression to 2050. The model gives us the regression coefficients for antidepressant prescribing cost per person predicted by weather, IMD and urban/rural for months 2010-2012. These coefficients were then applied to monthly weather data to 2050 (and assume that the geography of deprivation and urbanisation remains constant until 2050) to give us a projected monthly cost per person. The national SSP population growth rate forecasts were applied to practice populations in 2010 to estimate monthly practice population to 2050. Projected cost per person was then multiplied by projected practice population for each month to give total cost of prescribing per practice per month. These were summed across all practices to give an estimate of total (England) monthly prescribing cost per month.

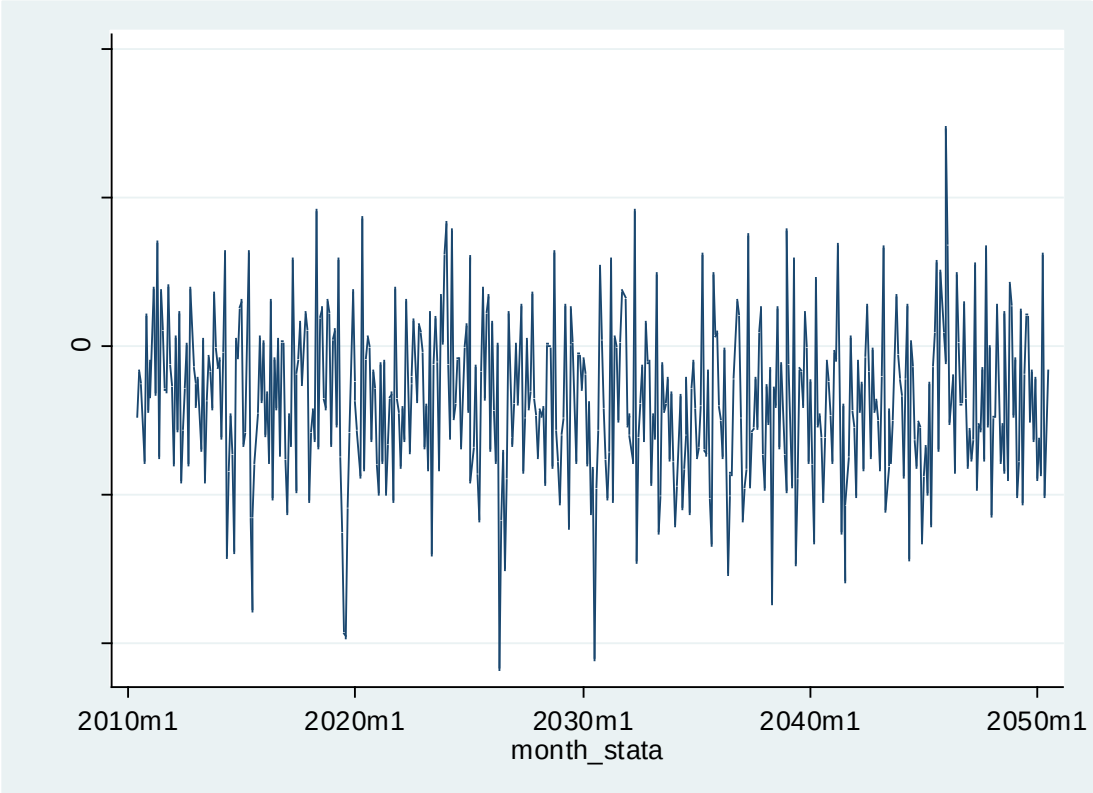


Fig2. Forecast costs of prescribing to 2050 (RCP4.5 versus no change in climate).

Shioroiwa et al (2010) use a double bounded dichotomous choice with bidding game to estimate willingness to pay for one additional quality adjusted life year gained in seven countries. They used an internet survey and found willingness to pay in the UK of £23,000, compared to $63,000 in the United States, AU$64,000 in Australia, JPY 5 million in Japan, KWN 68 million in Korea and NT$2.1 million for Taiwan. Bobinac et al (2010) also used contingent valuation to assess QALY gains in the Netherlands. They found mean WTP per QALY was €12,900 based on VAS (Visual Analog Scale) valuations and €24,500 based on the Dutch EuroQol tariffs. Income was a significant determinant of WTP, with those on high incomes willing to pay €75,400 and those on low incomes just €5,000. Pinto-Prades, Loomes and Brey (2009) examined the values of different health states in Spain using standard gambles to elicit utilities for two different health states, one representing moderate problems on some health dimensions of the EQ-5D instrument and the other representing moderate problems on most dimensions and severe on anxiety and depression. Willingness to pay was elicited using cards – with respondents identifying amounts they were willing to pay, those they were not willing to pay and others that they were uncertain about. They found thay there was serious doubt over whether a reliable all-purpose monetary value of a QALY could be derived from a survey on quality of life, risk and duration. Problems included insufficient sensitivity to the duration of health states and size of quality of life improvements, as well as order effects, payment period effects and “chaining” effects.

Donaldson et al (2011) compared results for the WTP per QALY based on modelling results drawing on the Value of a Prevented Fatality and the results of a survey using discrete choice experiments. This study was largely focussed on the development of the methodology – and so a representative sample of the population was not used. The

modelling results yielded a value of £10,000 to £70,000 per QALY, whereas the survey results suggested values of between £18,000 to £40,000 per QALY – though some results were implausibly high.

Table 3: Selected studies on willingness to pay per QALY

Study	Location	Treatment type (group in brackets)	Elicitation method	WTP per QALY estimate
Cunningham and Hunt (2000)	UK	Orthognatic treatment (patients)	Standard gamble for health status and payment scale for WTP	£506
Blumenschein and Johannesson (1998)	USA	Asthma (patients)	Rating scale, time trade-off and standard gamble for health status and dichotomous choice + bidding games for WTP	$7,000 to $46,000
Zethraeus (1998)	Sweden	Hormone Replacement Therapy (patients)	Rating scale and time trade-off for health status, dichotomous choice for WTP	118,400 SEK to 156,100 SEK
Bala et al (1998)	USA	Shingles (general population)	Standard gamble for health status and dichotomous choice for WTP	$15,588 to $49,133 depending on treatment
Olsen and Donaldson (1998)	Norway	Three health care programmes (general public)	Author estimates for QALY gains based on descriptions, payment card for WTP	0.2 NOK to 6.7 NOK
Shioroiwa et al (2010)	Various: UK, USA, Australia, Japan, Korea and Taiwan	Generic serious illness (general public)	Dichotomous choice with bidding game	UK £23,000, USA $63,000 Australia AU$64,000 Japan JPY 5 million Korea KWN 68 million Taiwan NT$2.1 million
Bobinac et al (2010)	Netherlands	Two different health states (general public)	Visual analog scale and Euroqol for health status, contingent valuation for WTP based on payment scale + open ended	€12,900 to €24,500

Donaldson et al (2011)	UK	Range of health states (unrepresentative sample of general public)	Standard gamble/person trade-off for health states ; Discrete choice experiment for valuation	£18,000-£40,000 (eliminating "implausibly high values")
Gyrd-Hansen (2003)	Denmark	Range of health states (general public)	Health states based on EQ-5D, Discrete choice experiment for valuation	DKK88,000
Gyrd-Hansen and Kjaer (2012)	Denmark	Chronic inferior health state	Health states using EQ-5D and time trade off, WTP using dichotomous choice and payment card	DKK2,404 to DKK 241,963
King et al (2005)	USA	Hypothetical treatment raising to full health	Health states using standard gamble, time trade-off and visual analog scale; WTP using iterative closed ended bidding	$12,500 to $32,200
Byrne, O'Malley and Suarez-Almazor (2005)	USA	Osteoarthritis (general public)	Health states using visual analog, time tradeoff and standard gamble, WTP based on open-ended	$1,221 to $5,690

Given the above, we value costs per QALY using the NICE threshold of £30,000 per QALY. The average weight attributable to mild to moderate depression is 0.125 – so multiplying through this gives a value of £3750 per patient year for reduced symptoms of mild to moderate depression. Taking these factors into consideration, we have calculated the additional, wider economic benefits of background climate change on mental health, given the apparent protective effects of climate change (driven by temperature) on mental health. These benefits associated with reduced symptoms of mental health conditions include: Productivity gains, reduced pain and suffering, reduced mortality (reduction in suicides). To do this, an estimated value is calculated e by transforming the output from a cost measure to 'patient year equivalent'. Estimates of costs of drugs per patient per year, estimates of the number of 'patient years' gained and multiply by cost per patient /year (table 4).

Table 4. Economic value of mental health benefits of changes in average climate in England: 2040-2045 (RCP4.5, SSP1) (£mn, current prices, no discounting).

Cost type	Value (£mn)
Treatment costs	12.65
Lost earnings	1,473.38
Pain and suffering	1,391.30
Mortality	551.44

What is the evaluation time frame?

- What is the lifespan of the measure with the longest lifetime?

The adaptation here is autonomous – admittedly it is subject to variation due to changes in prescribing behaviour. Recent trends towards other treatment types are noted, but demand for these type of therapies will also likely decline with climate change.

Which discount rate should be applied?

- Which discount rate is recommended by national guidelines for climate change adaptation measures (or public investments)?
- Is it a linear discount rate or any other type (i.e. declining, hyperbolic, etc.)
- (In addition, for testing the sensitivity of the results with regard to the discount rate(s) used, also apply a low and high discount rate (1% and 5%)).)

The UK government recommends a declining discount rate for climate change relevant projects. Here we do not have a project to assess, so no discounting is needed.

How to deal with data uncertainty?

- Can uncertainties related to the performance of the measures regarding certain evaluation criteria be described by a range (min-max), a triangular distribution (min, most likely, max) or any other kind of probability distribution?

Uncertainties exist in a range of areas. The values will be sensitive to assumptions on the values of health, notably the value of a Quality Adjusted Life Year and the Value of a Preventable Fatality. Reducing the value of a QALY to the lowest value of Donaldson et al (2011) changes the value of pain and suffering from £1.4 billion to £835 million.

e. Step 5 – Evaluation and Priorization (max 1500 words)

What is the ranking order of alternative adaptation options (measures, bundles of measures or pathways)?

- For cost-benefit analysis:
  What is the net-present value (discounted benefits – discounted costs) of the alternative options?
  What is the benefit-cost ratio?

- For cost effectiveness analysis:
  Which alternative achieves a defined objective at lowest costs?
  What is the cost-effectiveness ratio?
- For multi-criteria analysis:
  Which adaptation option performs best?
  (e.g. for PROMETHEE approach: which option has the highest net flow?)
- What are the uncertainties associated with the performance of the different options?
- Is there and, if so, to what extent uncertainty in the ranking of options?
- Is it possible to determine which option most likely performs best or is it necessary to gather further information to reduce uncertainty (go back to step 4)?

The adaptation here is largely autonomous, and we have shown that the benefits of mental health reductions are significant. There are a number of caveats with this analysis, however, including:

- The analysis relies on a rather limited data set;
- The assumption that "patient equivalent years" can be estimated from drug consumption; and
- The values attributable to health outcomes are subject to some uncertainty.

The results here would be robust to the climate scenarios under the BASE project, given the strong temperature signal.

6. Implementation Analysis – Understanding, Leadership and Governance of the implementation of adaptation measures

(Please describe the process of implementation of adaptation measures in real world contexts, namely key barriers and opportunities, governance dynamics and the concrete use of scientific knowledge and economic analysis in political decision-making. Please address Policy Questions from WP2&7 on the CSLD_Support doc)

To be determined through the completion of the case study

7. Development of new tools for adaptation planning and implementation

(Please describe the development and use of new tools for climate change adaptation planning and implementation which you have used under BASE research project and report on their SWOT analysis and overall feedback. Máx 2000 words)

New tool(s) developed and used during BASE:

1) _____
2) _____
3) _____
4) _____

Description for each New tool (Máx 50 words/each):

Swot Analysis:

Strenghts	**Weaknesses**

Opportunities	Threats

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