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CRITICAL ANALYSIS OF HEAT PLANS AND INTERVIEWS

DELIVERABLE 2.4

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Critical analysis of heat plans and interviews

Deliverable 2.4

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Preface

This report presents the work that has been performed by SCORCH partners to create insights in the functioning of European heatwave plans, and to aid in the development and evaluation of heatwave plans.

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1. Introduction

Background & objectives of SCORCH

Extreme temperatures, including heat and cold waves, are climatological hazards. Both in the EU as in EU-Neighbourhood countries, research has shown that heatwaves cause a rise in morbidity and mortality. Since heatwaves are not restricted to country borders, a cross-border approach is required to ensure collective preparedness and response to mitigate the impacts on communities and limit the financial and health costs.

The overall objective of SCORCH is to reduce the impact of heatwaves on vulnerable, urban populations through improved risk communication strategies based on existing EU plans and guidelines. In addition, we will measure risk perception and behaviour in communities in EU-neighbourhood countries through surveys and foster a cross-country culture of prevention and cooperation.

Why a critical analysis?

The SCORCH project aims to make use of existing knowledge and strategies for preparing and responding to heatwaves. Therefore, over the past year, we analysed existing heatwave plans and strategies (D2.1), reviewed scientific literature on the effectiveness of these plans (D2.2) and conducted key stakeholder interviews to capture their experiences and insights (D2.3). In this report, we synthesise our findings from these previous analyses and provide recommendations on key components of a heatwave plan. As such, we aim to provide support for developing new or evaluating existing heatwave plans.

2. Methodology

This report provides a synthesis and critical analysis of the work that was done for the previous deliverables in WP2, specifically the overview of national plans (D2.1), the literature review (D2.2) and the key informant interviews (D.3). Specifically, we revisited the collected data and the conducted analyses in order to compare the three data sources with the aim of identifying key components of a heatwave plan.

The report follows the same structure as previous deliverables, which is based on the core elements identified by WHO (see annex 1). Through this critical analysis, we aim to further complement these elements (Bittner et al. 2013). We start by looking at topics included in current heatwave plans, which we then supplement with lessons learned and new knowledge gained from the literature review and key informant interviews. In doing so, we aim to aid and foster the development of new heatwave plans as well as the evaluation of existing heatwave plans.

In order to effectively compare the three data sources, we only include information for which we have at least two data sources (e.g. a national plan and literature). The table below provides an overview of the countries included in each of the previous deliverables. In this report, we focus on results from Belgium (BE), France (FR), Germany (DE), Italy (IT), Republic of North Macedonia (MK), the Netherlands (NL), Portugal (PT), Spain (ES), Switzerland (CH) and the United Kingdom (UK). Not included here, are results from Austria (AT), Finland (FI), Latvia (LT), Luxembourg (LU) and Sweden (SE).

Table 1 – Overview of countries included in the reports

	AT	BE	FI	FR	DE	IT	LT	LU	MK	NL	PT	ES	SE	CH	UK
D2.1															
D2.2															
D2.3															
D2.4															

2.1. Analysis

The previously conducted analyses of the national plans, literature review and key informant interviews (see respectively deliverables no 2.1, 2.2 and 2.3 for more detailed information on the used methodologies) were all performed using the same codebook in NVivo, a software program for conducting qualitative analyses. The critical analysis described in this report focuses on codes relating to the WHO core elements. For each topic (chapters 3.3-3.9), we review and synthesise information from the three data sources. This can be viewed as data triangulation: for the same topic, we review three types of data. The synthesis then highlights similarities and/or differences between data sources.

The syntheses per topic stay close to the results described in previous deliverables, which are then used as a stepping stone to identify best practices and lessons learned.

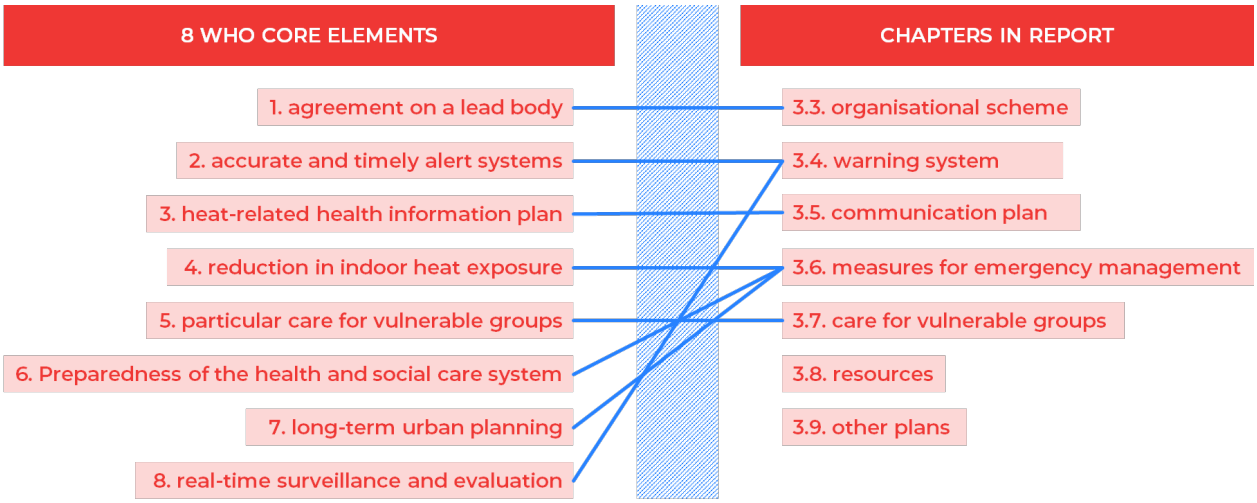
These include aspects or processes that are fundamental to a heatwave plan and/or represent the most effective way of reaching heatwave plan objectives.

Together, all defined recommendations constitute a list of key components of a heatwave plan (chapter 4), which can be used as a guidance during the development or evaluation of national heatwave plans. Note that there is no "one" heatwave plan. Our findings our based on the analysis of 10 national heatwave plans from European countries, which all have their own advantages and disadvantages and are in their own way adapted to a specific national context.

2.2. Report

Similar to previous deliverables in WP2, the structure of this report is based on the eight core elements which have been identified by WHO as important to the successful implementation of heat-health action plans (Bittner et al. 2013; WHO Regional Office for Europe 2008). Two chapters are not directly linked to the core elements, resources and other plans, but provide valuable information on national heatwave planning.

Figure 1 – link between WHO core elements and chapters in report



For each topic, we first synthesise our findings from the three data sources (overview national plans, literature review, key stakeholder interviews), which is then followed by the definition of recommendations, components of a national heatwave plan, based on insights gained from this synthesis.

3. Critical analysis of collected information

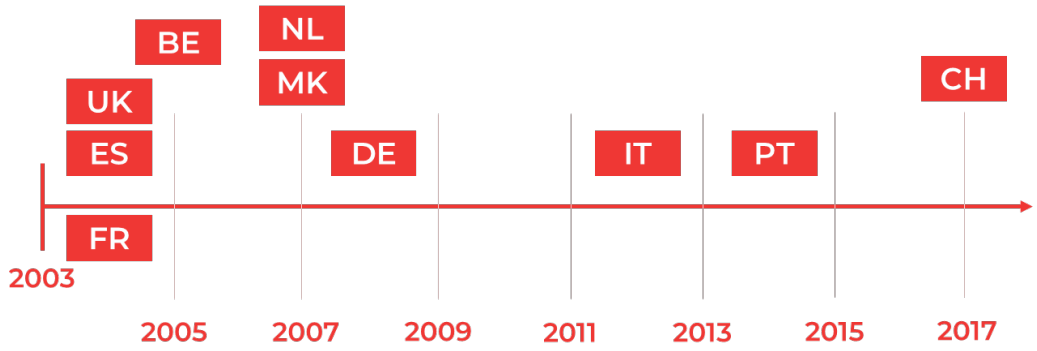
3.1. Introduction

The analyses of the national heatwave plans, the literature review and the key stakeholder interviews provide insights into international differences in heatwave planning in Europe. Overall, we find that heatwave plans are recognised as an important public health initiative, especially by ministries and national public health agencies. Heatwave plans can have several objectives (D2.1):

- **to prevent negative health effects of heat**, in particular in populations considered at risk or vulnerable;
- **to raise awareness on the health impact of heat** in the general public, vulnerable populations and their caretakers, and involved authorities and organisations;
- **to coordinate actions** among authorities and organisations; and
- **to forecast heat and other adverse weather** conditions in a timely manner.

In Europe, the development of heatwave plans took off in the aftermath of the 2003 heatwave, which caused high numbers of heat-related illnesses and deaths. The figure below shows that indeed most of the selected plans were developed in the first years after the 2003 heatwave.

Figure 1 – timeline heatwave plans (first version) (based on D2.1)



3.2. Overview of international similarities and differences

Table 2 provides a general description of the similarities and differences in heatwave plans in Europe. The table discusses 6 criteria: organisational scheme, warning system, communication plan, measures and recommendations, care for vulnerable groups and resources. These criteria are based on the 8 WHO criteria (Bittner et al. 2013) but adapted on insights from previous SCORCH deliverables (D2.1, D2.2 and D2.3). The information in the table is elicited from the national plans and completed with information from the interviews.

Similar to Bittner et al. (2013), we identify several sub-elements for each criterion. Together, the criteria and their sub-elements can be read as a recipe for writing a national heatwave plan. Some of the sub-elements we identify are similar to those identified by Bittner et al. (2013), whereas others are new. In this regard, this part of the report can be read as complementary to their work, as it is both a testing of their framework against actual practices and an addition to the framework based on our findings.

In the following paragraphs we describe our main findings, which includes reflections on international differences and similarities. In chapter 4, the findings are summarized in a presentation of the key components of a heatwave plan according to our analyses.

Table 2 – International comparison of heatwave plans

Country	Organisational scheme	Warning system	Communication plan	Measures and recommendations	Care for vulnerable groups	Resources
BE	Definition and assignment of roles in relation to alert levels Roles on national level	5 alert levels Parameters: meteorological, health, indoor temperature	Internal: procedure, roles External: procedure, roles, recommendations, tools	Mitigation Preparedness Response Evaluation	Identified groups: age, environmental, medical, social Care: adapt care	Data Legal resources
FR	Definition and assignment of roles in relation to alert levels, overall communication and evaluation Roles on national and departmental levels	5 alert levels Parameters: meteorological, environmental, health, medical capacity	Internal: Procedure, roles, tools External: procedure, roles, tools	Preparedness Response Evaluation	Identified groups: age, medical, social Care: identify, monitor, adapt care	Data Human resources Financial resources Legal resources
DE	General description of required roles	3 alert levels Parameters: meteorological, health, indoor temperature, medical capacity	External: recommendations, tools	Mitigation Preparedness Response Evaluation	Identified groups: age, medical, social Care: identify, adapt care	Data Legal resources
IT	No information on the definition and assignment of roles	4 alert levels Parameters: health, medical capacity	External: tools	Preparedness Response Evaluation	No definition of vulnerable groups or specific care measures	Data
MK	Definition and assignment of roles in relation to alert levels, implementation of the plan and overall communication	5 alert levels Parameters: meteorological, environmental, health, indoor temperature	Internal: procedure, roles, measures, tools External: procedure, roles, recommendations, tools	Mitigation Preparedness Response Evaluation	Identified groups: age, medical, social Care: adapt care	Data Human resources Legal resources
NL	Definition and assignment of roles	3 alert levels Parameters: meteorological, health	Internal: procedure, roles External: procedure, recommendations, tools	Preparedness Response Evaluation	Identified groups: age, environmental, medical, social Care: adapt care	Data
PT	Definition and assignment of roles in relation to alert levels, monitoring and overall communication Roles on national and regional levels	3 alert levels Parameters: meteorological, environmental, fires, health, medical capacity	Internal: procedure, roles, tools External: procedure, roles, recommendations, tools	Mitigation Preparedness Response Evaluation	Identified groups: age, medical, social Care: identify, adapt care	Data Financial resources Legal resources
ES	Definition and assignment of roles in relation to alert levels, monitoring and overall communication	4 alert levels Parameters: meteorological, health	Internal: procedure, roles, tools External: procedure, roles, tools	Preparedness Response Evaluation	Identified groups: age, environmental, medical, social Care: identify, monitor, adapt care	Data Human resources Legal resources

Country	Organisational scheme	Warning system	Communication plan	Measures and recommendations	Care for vulnerable groups	Resources
	Roles on national and regional levels					
CH	General description of required roles with examples of possible stakeholders to include	4 alert levels Parameters: meteorological, health	Internal: procedure, tools External: procedure, recommendations, tools	Mitigation Preparedness Response	Identified groups: age, medical, social Care: monitor	Data Financial resources
UK	Definition and assignment of roles in relation to alert levels Roles on national and local levels	5 alert levels Parameters: meteorological, health, indoor temperature, medical capacity	Internal: procedure, roles, recommendations, tools External: procedure, roles, recommendations, tools	Mitigation Preparedness Response Evaluation	Identified groups: age, medical, social Care: identify, adapt care	Data Human resources Legal resources

3.3. Organisational scheme

The first criterion (see chapter 4) we discuss is the organisational scheme. In the context of a national heatwave plan, the organisational scheme should include the following elements:

A. identification of the different stakeholders who should be involved;
B. defining and assigning roles and responsibilities;
C. structures that facilitate collaboration among stakeholders;

3.3.1. Identification of stakeholders

Although the identification of relevant stakeholders was not explicitly discussed in the previous deliverables, it is nonetheless a crucial element of a heatwave plan and a first step in its design.

National plans. The identification of stakeholders is often part of the process prior to the development of a plan, so the process is generally not described in heatwave plans. Only the German and Swiss plans (resp. Straff and Mücke 2017; and Ragettli and Röösli 2017), which are recommendations rather than actual plans, provide a description of the identification process. Both plans contain examples of actors that can be included and possible roles they can fulfil, which they largely base on the WHO recommendations[1].

Literature. The literature review (D2.2) does not include any article in which the identification process is described. However, one article (Abeling 2015) points out that heatwave plans should not be limited to the health sector, because heatwave vulnerability also includes environmental, social and technical dimensions. Hence, we deduct that the identification and involvement of stakeholders should consider all relevant sectors. Further, stakeholders should be involved in the development of the plan to improve engagement and uptake.

Interviews. The identification process is also not addressed in the interviews (D2.3), but respondents (BE, DE, MK, NL, PT, ES) point out that it is important to include stakeholders from other sectors besides health. Specific examples include social institutions, schools, trade unions, sports clubs and event organisers. One respondent from Germany points out that it is not always easy to identify and, especially, to engage stakeholders from other sectors as there is often no pre-existing relation or no foreknowledge of relevant stakeholders in other sectors.

Based on these findings, we define a first sub-element for the criterion "organisational scheme" (see also chapter 4):

- **identify and involve stakeholders from various sectors**

[1] The WHO recommendations include the "involvement of >1 agencies" (Bittner et al. 2013), and the "participation of agencies other than the one issuing the warning" (WHO and WMO 2015).

The identification of stakeholders is especially relevant during the development of the plan. Therefore, this task will most likely be performed by the author(s) of the national heatwave plan. Since we know from the interviews, that identifying and involving stakeholders beyond one's own sector or network can be difficult, we recommend a cross-sector approach to this issue. For instance, the identification process can be carried out collaboratively by stakeholders from different sectors, or by a stakeholder with a cross-sector network.

3.3.2. Roles and responsibilities

a. The process of defining and assigning roles and responsibilities

In order for involved stakeholders to know what is expected of them within the heatwave plan, it is important that roles and responsibilities are clearly described and assigned. Furthermore, all stakeholders should be aware of and accept their role in the plan, and should know who the main other stakeholders (e.g. coordinator) are (Alexander 2005; Bittner et al. 2013). This allows for timely and coordinated actions and helps to avoid confusion and duplicate efforts.

National plans. The analysis of the national heatwave plans shows that all nine countries define roles and responsibilities, though they do so in varying degrees of detail. Most plans (BE, FR, MK, NL, PT, ES, UK) include a clear definition of roles and responsibilities and assign these to specific stakeholders. These roles are related to the specific alert levels that are distinguished in the respective plans. This means that for each alert level, the plan sets out the procedure, including a definition of roles, role division and sometimes also descriptions of specific tasks. Some plans (FR, MK, PT, ES) also define and assign roles that are not related to a specific alert level, but are instead overarching. For instance, roles relating to the implementation of the plan, communication or evaluation. This can be helpful as there are some tasks that are overarching. Moreover, we believe that by defining roles and responsibilities only in relation to alert levels there is a tendency to focus only on response, implying there is less attention for mitigation, preparedness and evaluation. A few plans (DE, CH) provide a more general description of roles without assigning these to specific stakeholders (though possible stakeholders are listed in the Swiss plan) and alert levels. This may hinder the implementation of the plan as relevant stakeholders might not feel they are responsible to perform these roles. In order to ensure that assigned roles and responsibilities result in actions, some heatwave plans enforce certain responsibilities by law (FR, PT, ES, UK).

Literature. The literature review uncovers that there is room for improvement in stakeholder awareness about the heatwave plan and their role in it (Abrahamson and Raine 2009; Boyson, Taylor, and Page 2014; van Loenhout, Rodriguez-Llanes, and Guha-Sapir 2016). When a plan does not clearly define and assign roles to stakeholders, there might be confusion and disagreement about who should take responsibility (Abrahamson and Raine 2009). In addition, a heatwave plan should contain sufficient and clear guidelines that enable stakeholders to implement and coordinate interventions adequately. Without such guidelines, stakeholders are left by themselves

to figure out how to realise and implement certain actions (Abrahamson and Raine 2009).

Interviews. Based on the interviews we conclude that most respondents believe their roles and responsibilities are clearly defined in the plan, though some issues are pointed out, namely: a lack of detailed information on how to perform roles, role performance is hindered by a lack of autonomy to change organisational tasks, need for or lack of good coordination. Furthermore, we find that the role descriptions given by respondents can deviate from definitions in the plan (see also annex 1). In some cases, stakeholders take up more roles than described in the plan, and in other cases they take on completely different roles. For some stakeholders no comparison can be made as they only appear in either the national plans or participated in the interviews.

Summary. By comparing the information given about roles and responsibilities in the national plans and interviews, we learn that there are discrepancies between plan and practice. These discrepancies take two forms: the actual roles can diverge from those described in the plan, and for some types of stakeholders there are no roles defined in the plan. Further, both the literature review and analysis of the interviews reveal that, from the perspective of involved stakeholders, national heatwave plans generally do not describe roles and responsibilities in sufficient detail. By clearly defining and assigning roles and responsibilities in sufficient detail, transparency and the engagement of stakeholders could be enhanced.

Therefore, we define a second sub-element for the criterion “organisational scheme” (see also chapter 4):

- **Clearly define and assign roles and responsibilities**

b. Specific roles

In deliverable 2.1 and 2.3, we have distinguished seven roles stakeholders can perform within the context of a heatwave plan: author; activator, coordinator, informer, monitor, implementor and evaluator. Below, we discuss our main findings for each role based on the overview of national plans (D2.1), the literature review (D2.2) and the key-stakeholder interviews (D2.3). The literature review does not always hold information on specific roles, so it is not included for all roles. Annexes 2 and 3 provide more detailed insights of the stakeholders who perform these roles and their specific responsibilities. This overview reveals differences between plans and practice of the stakeholders that perform the roles and their specific responsibilities.

Author : stakeholder responsible for developing and writing the plan

National plans. Within the national plans, there is no information on the process of how the plan was developed and written. The only look-in we get is through the author list. National heatwave plans are often authored by multiple stakeholders collaboratively with one stakeholder carrying the lead or commissioning the development of the plan.

Literature review. The literature shows involving relevant stakeholders in the development of a plan leads to a more effective uptake and helps to avoid confusion about roles and responsibilities (van Loenhout et al. 2016). This makes sense as it helps stakeholders to define and assign roles according to actual expertise and abilities and allows them to weigh in on the development of realistic measures.

Interviews. The interviews confirm that the development and writing process of a national heatwave plan is a collaborative effort of multiple stakeholders, with more stakeholders added over time (BE, DE, MK, PT, ES, CH, UK). Stakeholders are involved from various sectors to contribute their expertise. This may mean that some only contribute to a small but specific part of the plan (e.g. defining parameter thresholds), whereas others make a larger contribution. Further, the interviews reveal that the development of a national plan, can be an iterative and continuous process. Therefore, some heatwave plans (BE, UK) are actualised regularly, based on experiences and lessons learned. This is why often the roles of author and evaluator (see below) are closely intertwined. Finally, some respondents (NL) point out that it is not always easy to start the development of a national heatwave plan as stakeholders might not be convinced of its relevance or don't consider heat to be a priority.

Based on these insights we define the following sub-elements for the criterion "organisational scheme" (see also chapter 4):

- **involve relevant stakeholders when developing the plan**
- **develop and write the plan in a continuous process**

Activator : stakeholder responsible for activating the plan and/or warning system

National plans. The whole response phase, and therefore also other roles (e.g. coordinator, implementer), are dependent on the activator activating the plan. A clear

definition of the role and responsibilities and an assignment of the role to a specific stakeholder are thus vital. Most national heatwave plans (BE, FR, MK, NL, PT; ES, UK) include information on the activator's role and identity within the description of the warning system and alert levels. The role is usually performed by a national or regional authority or government agency, as they are suited to carry such responsibility. It is possible that different stakeholders are assigned the role of activator for different levels. For instance, higher alert levels usually involve scaling up required measures and resources, which lower-level activators might not be authorized to do. Besides deciding on plan activation, the main responsibility of the activator is to communicate this activation to internal and external stakeholders and the public. Often, the activator role also involves communication before activation (e.g. information exchange) and after de-activation (e.g. evaluation). Usually the activation is communicated one or more days before the occurrence or aggravation of the heat event. Another key responsibility of the activator is to activate plan implementation, by themselves and by other stakeholders (e.g. implementation of measures, activation of crisis cell).

Interviews. The interviews confirm these tasks for activators: deciding whether or not a higher alert is triggered, communicating this activation and activating plan implementation. The interviews further stress the importance of communication and information exchange in the short period before and during the activation. Often, the activation is the result of close collaboration among the activator, monitor and coordinators. Finally, although this role is often detailed the most within the plans, the respondents identify two issues for activators: to reach all external stakeholders and everyone in the public (especially those further down the communication line or those who are more isolated), and to ensure the activation of plan implementation (especially during a prolonged period of activation). Both issues can be mitigated by assigning sectoral or local activators, whether or not in the context of a localised heatwave plan.

Based on this summary, we define two sub-elements for the criterion "organisational scheme" (see also chapter 4):

- **assign ≥1 activator(s) to activate the plan and/or alert levels**
- **an activator must have the required authority and communication lines**
- **plan activation includes decision making, communicating the activation and activating implementation**

Coordinator : stakeholder responsible for coordinating implementation and cooperation

National plans. Most national plans (DE, FR, MK, PT, ES, UK) recognize the importance of inter-organisational coordination of efforts by all stakeholders. In fact, coordination is often an explicit objective of national heatwave plans and most plans assign one or more coordinators. This role is often fragmented across levels (national, regional, local), sectors (e.g. health) and/or tasks (e.g. communication), indicating a need for multiple coordinators. However, one coordinator usually takes precedence over the others or has a more encompassing role. Overall, the role of coordinator is best assigned to a stakeholder who is well connected to other stakeholders and who has the required

authority and skills. Yet, these requirements as well as the tasks of the coordinator are usually not described within the national plans.

Literature review. The literature review confirms that coordination occurs on different levels, but that especially at the national level, a coordinator can help to avoid heterogeneity in the type and quality of plan implementation (de'Donato et al. 2018; van Loenhout et al. 2016).

Interviews. Based on the interviews, we can further confirm that coordination takes place on different levels. Coordinators are appointed to coordinate efforts within and among organisations, which each may require a different type of stakeholder. For instance, the Red Cross national headquarters might be best situated to coordinate the implementation of measures in the field by their different departments, whereas a local authority might be better suited to coordinate the cooperation among different implementers such as the Red Cross. The lack of good coordination is explicitly mentioned as an issue in multiple countries (DE, MK, NL, PT) as it hinders timely implementation and decision making. This lack can stem from no coordinator being appointed, lack of coordinating skills or insufficient resources to perform the role adequately.

Following these insights, we define two sub-elements for the criterion "organisational scheme" (see also chapter 4):

- **assign ≥1 coordinator(s) for inter-organisational coordination at all levels**
- **a coordinator must have the right network and the required authority, skills and resources**

Evaluator : stakeholder responsible for evaluating the national heatwave plan

National plans. The role of heatwave plan evaluator can be assigned to the same stakeholder(s) who author(s) the plan (BE, MK, NL, PT, UK), to a cross-government body (FR, MK, ES) and/or to experts (e.g. meteorological agency evaluates parameters) (BE, FR, UK). Usually, the evaluator evaluates the national heatwave plan before and/or after the summer. The tasks of the evaluator are to evaluate the effectiveness and relevance of implemented measures, to assess the accuracy and impact of parameters and threshold values, to identify difficulties and lessons learned, and to update the national heatwave plan. In addition, heatwave plans can assign a second type of evaluator to evaluate the situation during the occurrence of a heatwave (BE, FR, PT, ES). This includes evaluating implemented measures, as reported to them by other stakeholders, and adapt measures whenever necessary. Depending on the urgency, this type of evaluation can occur on a daily, weekly or monthly basis.

Literature review. Evaluation is not limited to stakeholders involved in the plan, but can also be conducted by external researchers and experts. All studies included in the literature review, evaluate the effectiveness of the national plan in some way. Scientific evaluation often focuses on specific parts of the national heatwave plan. For instance, effectiveness of warning parameters, effectiveness in reducing heat health impact or effectiveness in improving risk awareness and behaviour. These evaluations can also lead to changes in the national heatwave plan (e.g. Bustos Sierra et al., 2016).

Interviews. The interviews confirm there are two types of evaluation: overall evaluation of the heatwave plan and evaluation during the occurrence of a heatwave. However, both types of evaluation seem to be informal rather than formal. Moreover, little is known about the actual effectiveness or impact of the national heatwave plans. Because evaluation is rather informal, the evaluation process often focuses mainly on the identification of difficulties and lessons learned and there are no specific indicators for evaluation. As a result, evaluations can be inconsistent and are mainly based on immediate needs. Nevertheless, it does seem that identification of difficulties and lessons learned feeds back into the update of the heatwave plan.

Based on these findings, we define two sub-elements for the criterion “organisational scheme” (see also chapter 4):

- **assign ≥1 evaluator(s) for evaluating the heatwave plan after the summer and for evaluating the situation and implementation during the occurrence of a heatwave**
- **evaluation includes assessing effectiveness of the plan and parameters, identifying difficulties and lessons learned and adapting when necessary**

Further, we also define one sub-element relating to evaluation under the criterion “measures and recommendations”:

- **develop a formal evaluation process that includes indicators for evaluation**

Implementer : stakeholder responsible for implementing the measures described in the national heatwave plan

National plans. The role of implementer becomes relevant once the warning system is activated and one of the alert levels is triggered. Each subsequent alert level requires additional measures to be implemented. Usually, almost all involved stakeholders have a role as implementer and implement measures to inform stakeholders and the public, and to protect the health of the public. The role of informer (see below) is a sub-type of the role of implementer, and most implementers are also informers. The protective measures that are implemented, are different for each type of stakeholder (see table 9 for a detailed overview or all measures). Most informative measures focus on preparedness and protective measures focus on response. There is less attention for long-term measures that promote mitigation.

Literature review. In order for implementers to fulfil their role, the literature review points out some requirements: sufficient funding and time need to be ensured, physical or phone contact needs to be enabled, delays due to bureaucratic procedures need to be limited and behavioural change strategies need to be optimised. Moreover, the role of implementer is not clearly assigned at lower levels but is instead assigned to groups of actors such as hospitals or nursery homes. Consequently, these actors may not be aware about the role they need to fulfil and how to do this. This lack of clarity can lead to confusion and a lack of engagement, especially when the responsibilities are not enforced.

Interviews. A similar finding emerges from the interviews: stakeholders need to know the plan and their role in it in order to be able to implement measures. At the regional and local level, this awareness is not very high and needs to be improved. Further, successful implementation also requires the availability of resources. Another finding is that implemented measures may deviate from those described in the plan as stakeholders may choose to adapt them to local or organisational circumstances.

To summarise these findings, we define two sub-elements relating to the criterion “organisational scheme” (see also chapter 4):

- **assign clear responsibilities to all implementers while allowing for adaptation to local or organisational circumstances**
- **implementers must know their role and have access to sufficient resources**

Informer : stakeholder responsible for diffusing information

National plans. Two different informer roles can be distinguished: internal and external. Internal informers are tasked with informing authorities and stakeholders identified in the plan of parameter values and the activation or escalation of the alert so they can implement the national heatwave plan. This role is usually well detailed and clearly assigned in the plan, and is usually assigned to multiple stakeholders on the national or regional level. External informers target other stakeholders (e.g. hospitals, care facilities), the general public and vulnerable groups and aim to inform them about the

occurrence of a heatwave, to raise awareness about the health impact of heat and to provide information on protective measures. This role is usually less clearly described and assigned in a general way to various stakeholders on all levels (from national to organisational). Moreover, it seems that all stakeholders are considered to be an external informer, but without assigning clear responsibilities those stakeholders may not be engaged. Most plans include the development and/or supply of information material for relevant stakeholders and the public (usually provided by the ministry of health or a public health agency), though no procedures are detailed for ensuring these materials reach stakeholders and citizens.

Literature review. The literature review does not include specific information about the assignment or performance of the role of informer. However, the review finds that not all information reaches the public and relevant stakeholders, and not all stakeholders are reached. This might be addressed by assigning and describing the role of external informer more clearly (e.g. who is responsible for informing which target groups).

Interviews. Based on the interviews, we find that the role of informers is to inform and ensure that preventive action will be taken. Hence, the role of informer should not be restricted to one-directional diffusion of information, but should allow for two-way communication and feedback (e.g. confirm that information did reach target groups). The interviews further confirm the existence of and necessity for internal and external informers, and that national heatwave plans lack details on how and by whom the role will be performed. Further, the role of external informer is often performed passively and the responsibility is given to the target group to actively seek out information. For instance, information is provided on websites, or brochures are laid out in meeting places. Consequently, target groups may not be aware of the available information or have difficulty in understanding it.

Based on this summary, we define three sub-elements relating to the criterion "organisational scheme" (see also chapter 4):

- **assign internal and external informers on all levels**
- **an informer must have the required network, communication skills and access to resources**
- **informing requires two-directional communication flows, and knowing target groups and how to reach them**

Monitor : stakeholder responsible for monitoring parameter(s)

National plans. The role of monitor involves monitoring defined parameters, anticipating when critical values may be reached and timely informing relevant stakeholders when threshold values are exceeded. In addition, monitors may be asked to provide advice on the definition of parameters and thresholds during the writing process of the national heatwave plan. The monitoring process itself is not described within the national heatwave plans. The national plans identify different monitors depending on the types of parameters to be monitored. Monitoring of meteorological

parameters is assigned to meteorological agencies. Monitoring of health parameters is assigned to public health agencies, care providers and/or research institutes.

Interviews. The interviews confirm the information on the role of monitor found in the analysis of national heatwave plans and no differences were found.

This leads us to formulate the following two sub-elements for the criterion "organisational scheme" (see also chapter 4):

- **assign ≥1 monitor to monitor defined parameters**
- **monitoring also includes communication of observed parameter values and advise on the definition of parameters and thresholds**

3.3.3. Collaboration and cooperation among stakeholders

National plans. Within the national heatwave plans, collaboration is mostly mentioned in the contexts of the development of the plan, the warning system and parameters, communication, information exchange and coordination. Collaboration is discussed among institutions, among national, regional and local levels, and among sectors. To ensure adequate collaboration and cooperation, relevant stakeholders need to be connected in networks. Some plans aim to formalise these relations in order to make the collaboration more effective, for instance with collaboration agreements (ES). Depending on the purpose of the collaboration or cooperation, different networks may be required (e.g. a central network and a network connecting national stakeholders to local organisations). Sufficient collaboration and cooperation are necessary to ensure consistency in the implementation of the national heatwave plan. In addition, collaboration increases the effectiveness of the national heatwave plan, as it allows for the exchange of knowledge and resources, sharing responsibilities and mutual decision making.

Literature. In the reviewed literature, collaboration is mentioned in relation to the development phase (Kunst and Britstra 2013; van Loenhout et al. 2016), the warning system and parameters (Elliot et al. 2014; Fouillet et al. 2008), awareness campaigns, information exchange (Van Loenhout and Guha-Sapir 2016) and care for vulnerable groups (Abrahamson and Raine 2009). Collaborations are found to be highly dependent on personal relations, and heatwave plans should build on existing relationships (Abrahamson and Raine 2009). Collaboration among national, regional and local levels can improve uptake of the national heatwave plan among stakeholders (de'Donato et al. 2018), and communication between public health authorities and media could improve risk awareness and behaviour in vulnerable groups (Van Loenhout and Guha-Sapir 2016). Some recommendations are also formulated: best practices for inter-sectoral collaboration should be identified, a formal structure (e.g. institutional platforms for collaboration) could be beneficial (Abrahamson and Raine 2009; Boyson et al. 2014; van Loenhout et al. 2016), and collaborations may suffer from a lack of sufficient resources (van Loenhout et al. 2016).

Interviews. Within the interviews, collaborations are mentioned in relation to the development and evaluation of the plan, the warning system, information exchange, implementation of measures and coordination. The interviews highlighted existing collaborations among stakeholders from different institutions (governmental and non-governmental), and among stakeholders from the same and different levels (i.e. national, regional, local, organisational). Stakeholders report to collaborate with others that have access to skills, information, resources or connections they don't have themselves. Although the respondents report to be satisfied with the quality of current collaborations, some issues are mentioned: personal views can influence quality of collaborations, need for more inter-sectoral collaboration, need for more and better collaboration with(in) the health sector, need for collaborative instead of top-down relations with government stakeholders, and a need for structures that make collaboration easier and lessen administrative difficulties. Finally, we find that there is currently no structural cross-country collaboration, though respondents point out that they would like to include this.

Based on these insights regarding collaboration, we define 3 sub-elements for the criterion "organisational scheme" (see also chapter 4):

- **develop formal structures for collaboration**
- **develop networks within and across institutions, sectors, levels and countries**
- **make use of existing and personal relations among stakeholders**

3.4. Warning system

The aim of a heat warning system is to warn the public and relevant stakeholders in a timely manner. The warning system is based on the monitoring of certain parameters. When pre-defined values of selected parameters observed, specific actions are implemented, which may include activating or escalating a certain alert level.

3.4.1. Warning parameters

National plans. In most countries, the warning system includes monitoring of temperature (BE, FR, DE, IT, MK, NL, PT, ES, CH, UK), as well as morbidity and mortality (FR, DE, IT, MK, PT, ES, CH, UK). Additional parameters (e.g. indoor temperature, medical capacity, air pollution, wildfires) are usually monitored as well, depending on the relevance and availability of reliable data. In general, there is a lot of diversity among countries regarding selected parameters and how these are defined and monitored. Additionally, since the task of monitoring parameters, as well as the tools and methods used, are considered to be part of the expertise of the stakeholder assigned as monitor, the process is not described within the national heatwave plans. This lack of transparency makes external evaluation and international comparison more difficult.
The activation and escalation of alert levels is mainly based on temperature, implying that only for this parameter threshold values are defined within the national heatwave plans. The threshold values either apply for the whole country, or different values are defined for each region. The latter allows to consider climatological differences within countries. Parameters relating to health are used to evaluate the health impact of a heatwave, though no threshold values are defined and no specific measures linked to these parameters are described. The information on the parameters may be used to determine the need for additional measures and/or to evaluate the implementation of measures.

Literature. Within the literature, some of the procedures by which certain parameters are monitored, how threshold values are defined and what the obtained data are used for are discussed in more detail. In general, studies recommended that the definitions of a heatwave and temperature threshold values are based on scientific evidence, and especially on epidemiological data on morbidity and mortality (Martinez et al. 2017; Vicedo-Cabrera et al. 2016). Further, we find that health surveillance data can be used to determine the need for a public health response to a heatwave alert (Brasseur, Berger, and Lokietek 2014; Cox et al. 2010; Elliot et al. 2014), to inform public health policy (Bustos Sierra and Aikainen 2017; Elliot et al. 2014), to identify groups vulnerable to heat (Bustos Sierra et al. 2016; Smith et al. 2016), to evaluate and adapt the definition of parameters and threshold values (Brasseur et al. 2014; Bustos Sierra and Aikainen 2017; Cox et al. 2010), and to improve the timing for activating the warning system (Brasseur et al. 2014; Cox et al. 2010; Linares et al. 2015; Martinez et al. 2017; Smith et al. 2016; Vicedo-Cabrera et al. 2016).

Interviews. The interviews confirm that temperature is monitored by all selected countries, and, deviating from the information in the national plans, mortality is also

monitored in all countries. Based on the interviews, it is unclear whether all countries currently monitor morbidity. The respondents provide specific recommendations to improve the monitoring of warning parameters (see table 9 D2.3): provide real-time data (BE, FR, DE), improve access to data (DE, NL), improve monitoring techniques (BE, DE, NL, UK), include other relevant parameters (BE, FR, ES, CH, PT) and redefine parameter threshold values based on new insights (NL, ES). Regarding the latter, threshold values need to be evaluated regularly but are not updated or changed during the summer season. Also, some issues are mentioned that hinder effective monitoring: data privacy regulations (BE, FR, DE), lack of resources (MK), and the issue of causally attributing health problems to heat (BE, DE, ES, NL, UK). In addition, the adaptation of threshold values to local or regional contexts can cause confusion when the alert is triggered in one community and not in a neighbouring community.

Based on this summary, we define the following sub-elements for the criterion "warning system" (see chapter 4):

- **define parameters (based on available data and relevance) to monitor morbidity, mortality, temperature and other meteorological factors, air pollution, indoor temperature, medical capacity, status of vulnerable groups, wild fires and forest fires**
- **define threshold values for parameters based on scientific evidence and epidemiological data**
- **determine and describe monitoring methods and tools**
- **adapt threshold values to local or regional contexts**

In addition, we define one sub-element relating to evaluation under the criterion "measures and recommendations":

- **use parameter data to evaluate the effectiveness of the plan and its components (e.g. threshold values, definition of parameters)**

Finally, we also define two sub-elements for the criterion "resources":

- **ensure timely access to daily data for effective monitoring of parameters**
- **create a data management plan**

3.4.2. Alert levels

National plans. The overview of the national plans shows that warning systems can include up to five different alert levels, ranging from levels 0 to 4[2]. Although not all

[2] **Level 0 – preparedness:** preparation all year round, long term planning, evaluation
Level 1 – vigilance: minimum alert level activated May-September, stakeholders and public should be aware of warning system and should be prepared to implement measures
Level 2 – hot weather: temperature threshold values are expected to be exceeded but the health risks are still limited, some measures are implemented (e.g. informing stakeholders and public)

selected countries implement all 5 levels, ideally this would be the case. The type of heatwave plan as well as the available resources and the local context may determine which alert levels are defined. For each alert level, specific actions are defined (see annex 2 in D.1 for a detailed overview). In general, the actions for a given alert level are a) an intensification of actions that were initiated under a previous level and b) additional actions to respond to the increasing urgency. Under level 0, the actions are directed at ensuring preparedness of internal stakeholders and evaluating the plan (before or after summer). Starting from level 1, the actions are also directed towards the public and vulnerable groups. See also chapter 3.6 for more information on implemented actions.

Literature. Activation periods do not always correspond to observed heatwave periods, as activators may decide to activate an alert before thresholds are exceeded or to keep it activated when the values are below the threshold level (Pascal et al. 2012).

Interviews. Within the interviews, most information on alert levels relates to activating the alert (see chapter 3.3.2) or implementing actions when the alert is activated (see chapter 3.6). Further, the relevance of defining a level 0 – preparedness is confirmed. The respondents highlight that this level allows stakeholders and the public to prepare themselves for and to be aware of the health impact of heatwaves. This is even more beneficial should a heatwave occur outside the official period (usually May-September), for which the risk increases due to climate change. In addition, level 0 allows responsible stakeholders to ensure that all stakeholders understand the plan and their role in it, and to provide additional support or information in case of need. With each increasing alert level, the priority given to heat increases and the awareness in the public on the increasing health risks is expected to grow. Moreover, by gradually increasing the alert level, everyone is given sufficient time to adapt to the increasing risks. We believe this underlines the importance of having five alert levels, as this allows for a more gradual escalation of the situation. However, the relevance of each alert level and its definition should also be assessed. For instance, in most countries the highest alert level has never been activated so far. It needs to be evaluated whether this is because an emergency situation has not yet occurred, or because the requirements for triggering the alert were too strict even in emergency situations. Finally, based on the interviews we find that the activation of an alert level can also happen before the threshold values are exceeded. The decision can also be made based on data on other parameters (e.g. surge in heat-related morbidity), when certain problems arise (e.g. understaffed hospitals) or when outdoor mass-events are planned (e.g. festival or demonstration). This type of activation is currently not discussed in the national heatwave plans, and increases the responsibility for the activator. To improve response, avoid confusion and ensure

Level 3 – heatwave: temperatures further increase and/or threshold values are exceeded during a longer period of time, likely to cause adverse health effects, measures taken under level 2 are intensified and additional measures are taken

Level 4 – emergency: heatwave causes significant health issues and affects other sectors (e.g. agriculture, traffic, energy, ...) besides health, measures taken under level 3 are intensified, a crisis cell can be activated to assess and manage risks

effective implementation, it may be helpful to also describe a procedure for this type of activation.

Following these insights, we define two sub-elements relating to the criterion “warning system” (see also chapter 4):

- **define five alert levels (0 preparedness, 1 vigilance, 2 hot weather, 3 heatwave, 4 emergency)**
- **define actions for each alert level**

In addition, we define one sub-element relating to “measures and recommendations”:

- **evaluate and assess the relevance and definition of the alert levels**

3.4.3. Communicating the warning

National plans. The warning should be communicated well in advance to involved stakeholders and the public in order to ensure readiness. Based on our analysis, we find that the exact time of communication varies from 1 to 3 days before a heat period or heatwave occurs. Usually, information to raise awareness on the health impact of heat and on protective measures is released in parallel with the warning. Within the national plans, the process to communicate the warning is generally described in detail. We find 3 types of communication flows for internal and external communication of the warning. The first flow is both internal and external communication to inform relevant stakeholders about the predicted parameter values and triggering of the alert. Next, the second flow is external communication to warn the general public, to raise awareness and to provide information on protective measures. Finally, the third flow is directed at informing vulnerable people and triggering the activation of certain services to protect them.

Literature. Warnings are disseminated to relevant stakeholders to manage heatwave related risks. When the communication process is not defined beyond the initial dissemination of the warning, other stakeholders need to organise the communication by themselves (Bittner and Stößel 2012). This may limit the effectiveness of the dissemination and the number of people reached. In addition, studies find that not all stakeholders are sufficiently informed about heat warnings and related information (Abrahamson and Raine 2009; Boyson et al. 2014; van Loenhout et al. 2016). Since coverage and dissemination of warnings are not sufficiently studied in most countries, it is hard to identify which communication processes are more effective. Further, one study finds that the interpretation of warnings, in particular of the colours associated with the different alert levels, is informed by cultural knowledge. This may cause cultural and linguistic barriers for interpretation of the warnings, especially for vulnerable groups. When designing a warning system, it is thus recommended to consider underlying environmental and social processes involved in the interpretation of warning information (Tang and Rundblad 2015). As a result, for instance, different colour codes may be used in different countries.

Interviews. When the warning system is communicated, the first days are very important to ensure that stakeholders and the public take action. This warning is communicated in parallel with information to raise awareness on the health impact of heat and on protective measures. The health impact of heat can be better limited when actions are implemented in time, before the temperature reaches the highest predicted values. Therefore, the warning needs to be communicated well in advance before the start of the heat period or heatwave. However, communication that is too early can be destabilising, especially concerning the highest alert level. In order to avoid panic and instability, the highest alert level should not be communicated more than 48 hours in advance. Based on the interviews, we identify three communication flows that slightly differ from those identified in the national plans. First, the warning is communicated internally to involved stakeholders. Afterwards or simultaneously, the warning is communicated externally to other stakeholders. In a final flow, which may occur after the first two or simultaneously, the public and vulnerable groups are informed by internal and external stakeholders.

Based on this summary, we define the following sub-elements for the criterion "warning system" (see also chapter 4):

- **communicate warnings 1-3 days in advance**
- **communicate warnings following clearly described processes**
- **describe communication flows among internal and external stakeholders, and to the public and vulnerable groups.**
- **consider underlying environmental and social processes when designing a warning system**

In addition, we define one sub-element for the criterion "measures and recommendations":

- **evaluate coverage of warnings**

3.5. Communication plan

3.5.1. Communication tools

National plans. To diffuse information on the health impact of heat and protective measures, the national heatwave plans prescribe a broad range of communication tools, from leaflets and posters to media broadcasts and online information. Often, multiple communication tools are used to communicate the same message. As mentioned earlier (chapter 3.3.2), almost all stakeholders are considered to be informers and are expected to use these tools to inform the public and specific vulnerable groups. A potential issue is that these communication tools are described in a general way, and it is not explained which tools are best to use specific target groups. Some plans do include factsheets to target specific vulnerable groups as well as their caretakers (BE, FR), but it is unsure whether this tool is the best way to reach those groups and realise changes in awareness and behaviour. We believe that the communication tools could be used more effectively if the plans include information on which tools are effective to disseminate information to which target groups.

Literature. We find few studies that assess the effectiveness of specific communication tools. In one study, the authors find that both leaflets and media are considered equally useful, though there is no consensus on whether these tools are effective or not (Abrahamson and Raine 2009). Another study finds that in Italy, almost total information coverage is reached by combining multiple communication tools (press releases, web pages, leaflets, emails and telephone hotlines) (de'Donato et al. 2018).

Interviews. Throughout the interviews, many communication tools are mentioned. We find that the choice for implementing a specific communication tool depends on the target group, the type of message and the available resources. Often, multiple communication tools are used simultaneously. However, respondents are unsure about which communication tools are more effective or suitable and the extent to which coverage is reached.

Following these insights, we define one sub-element for the criterion "communication plan" (see chapter 4):

- **diffuse information simultaneously using multiple communication tools**

In addition, we also define one sub-element for the criterion "measures and recommendations":

- **assess the effectiveness of the communication plan**

3.5.2. Type and content of the message

National plans. In general, the messages that are communicated in the context of the national heatwave plan are the warning, information on the health impact of heat and advice on protective measures. However, not all national heatwave plans provide

sufficient information on what exactly needs to be communicated. Only the UK plan formulates several messages for specific audiences. Some national heatwave plans (BE, DE, PT) include tips and recommendations on protective measures from which a message can be deduced; others refer to a website where this information can be found (FR, DE, PT); and others don't include a specific message (IT, MK, NL, ES, CH).

Literature. Different stakeholders and target groups may interpret communicated messages differently (Boyson et al. 2014; Tang and Rundblad 2015). It may help if the national heatwave plan provides support on how to formulate messages in such a way that the targeted audience is effectively reached. For instance, one study finds that elderly may perceive commonly used types of messages as inappropriate as they don't perceive themselves as elderly and would prefer the message to be less paternalistic (Abrahamson and Raine 2009). Also, earlier we described how underlying environmental and social processes may influence interpretation of the warning system, but the same holds for interpretation of other messages (Tang and Rundblad 2015). It is therefore important to understand what type of messages are most effective and how the information needs to be formulated in order to effectively reach the target audiences.

Interviews. We learn from the interviews that communicated messages need to be brief, easy and coherent, as people are more likely to read short, visual messages than long texts (FR, PT, ES, UK). Further, it is preferable that stakeholders all communicate the same message to the public and vulnerable groups as to avoid confusion, although this is not always feasible in reality (e.g. due to different interests). To ensure recognisability, messages can be structured similarly or use the same visual elements (e.g. logos).

Based on these insights on communication messages, we define two sub-elements for the criterion "communication plan" (see chapter 4):

- **design qualitative, coherent and easy messages**
- **provide template messages for communication to different audiences**

Further, we also define one sub-element for the criterion "measures and recommendations":

- **assess the effectiveness of the communication plan**

3.5.3. Impact on awareness and behaviour

The effectiveness of communication was only addressed within the literature review and key stakeholder interviews. Within the national plans, no information was found on this topic.

Literature. National heatwave plans can lay out best-practice guidance for how stakeholders can communicate during a heatwave (Wolf, Adger, and Lorenzoni 2010). However, not all communication plans are effective. We distinguish two types of

communication: to the public and vulnerable groups, and to other stakeholders. Two studies in France find that the communication efforts reach and manage to change behaviour of people taking care of vulnerable people and of those who have previously experienced negative health effects of heat (Léon et al. 2007; Pascal et al. 2012). In other countries (BE, NL, PT, ES), studies find that the population is not sufficiently aware of heat health risks and protective measures (Cuesta et al. 2017). Moreover, even if people are knowledgeable, this does not necessarily lead to a change in their behaviour (Khare et al. 2015; Lefevre et al. 2015) or adequate risk awareness, especially in elderly (Abrahamson et al. 2008; Bittner and Stößel 2012; van Loenhout and Guha-Sapir 2016; Wolf et al. 2010). Further, since communication is only initiated when a heatwave occurs, the messages focus on informing audiences on short-term protective measures. Consequently, information on long-term measures is lacking, which may prevent people from preparing in time (Wolf et al. 2010). There are only three studies included in the review that touch upon the effectiveness of communication to stakeholders. The results are ambiguous: some caretakers are informed, others are not. This may depend on their experience with patients affected by heat and/or vulnerable groups (Bittner and Stößel 2012; Herrmann and Sauerborn 2018; Kunst and Britstra 2013). Further, uptake of information may also depend on the priority stakeholders give to heatwaves (Abrahamson and Raine 2009; Boyson et al. 2014; van Loenhout et al. 2016).

Interviews. All knowledge (e.g. on health impact of heat, on protective measures, on risk management or risk assessment) that is included in the national heatwave plans can provide guidance in informing stakeholders and the public. Without this knowledge, stakeholders are dependent on their own experiences and resources to assess which communication is effective or not. Based on the interviews, we identify three methods to assess the effectiveness of communication: data on parameters before and after communication, population-based surveys to assess risk awareness and protective behaviour, webpage analytics to determine the reach of online messages. As each type of evaluation produces different insights and faces specific difficulties, it may be recommended to combine different evaluation methods to gain deeper insights.

Following these findings, we define four sub-elements for the criterion “communication plan” (see chapter 4):

- **design communication processes to stakeholders and to the public and vulnerable groups**
- **diffuse information at the appropriate times**
- **consider communication on the short- and long-term**

Further, we also define one sub-element for the criterion “measures and recommendations”:

- **assess the effectiveness of the communication plan**

3.6. Measures for emergency management

We describe our findings relating to measures and recommendations for five emergency management categories: mitigation, preparedness, response, recovery and evaluation.

3.6.1. Mitigation

Mitigation refers to those measures and recommendations that are aimed at reducing the damaging effects of heatwaves. Risk analysis can provide a solid foundation for developing these actions.

National plans. In general, the development of a heatwave plan can be seen as mitigation, but also within heatwave plans, there is room for specific mitigation measures. However, little attention is paid to this: only a few mitigation measures are identified and these are not described in detail. Of the identified measures, most focus on infrastructure (e.g. insulation, cooling of buildings) and policy and planning (e.g. land use, spatial or urban planning). Two other measures relate to care for vulnerable groups (development of a system to identify and support vulnerable people) and engaging communities and volunteers to strengthen local implementation. For none of these measures, it is described how they will be realised or who will be responsible for doing so. No mitigation measures are mentioned relating to informing stakeholders and the public, to optimise or adapt care, to monitor parameters in real-time, to reduce heat exposure or to evaluate and revise heatwave plans. The implementation of mitigation measures can happen all year, and can be assigned under alert level 0.

Literature. The development of (local) heatwave plans can mitigate adverse effects of heatwaves (Brasseur et al. 2014; Schifano et al. 2012). By giving legal mandates to responsible stakeholders, the development can be ensured (Abeling 2015). Efforts should also be made to ensure the continuity of heatwave plans and the measures included in them (de'Donato et al. 2018). Further, the education of professionals about health impact of climate and environmental issues, are a basis for mitigation (Herrmann and Sauerborn 2018). Therefore, trainings on this topic should not be limited to the period when a heatwave occurs but should be embedded in their overall education.

Interviews. Heatwave planning usually takes place within broader strategies for climate change adaptation and mitigation. These strategies are developed by, for instance, Ministry of Environment, who can reserve specific resources for this effort. However, these resources are usually allocated to the development of strategies and not for other, related mitigation measures, which may be the responsibility of another ministry or (local) stakeholders. Unless these stakeholders are also involved in the development of the heatwave plan, it may be hard to ensure (resources for) the implementation of mitigation measures.

Based on this synthesis, we define the following sub-element for the criterion "measures and recommendations" (see chapter 4):

- **develop mitigation strategies for limiting the health impact of heat**

In addition, we define one sub-element relating to the criterion “resources”:

- **allocate resources to develop and realise mitigation measures**

3.6.2. Preparedness

Preparedness refers to those measures and recommendations that allow stakeholders and the public to prepare for the event of a heatwave and possible undesired health effects.

National plans. Within the selected national heatwave plans, actions relating to preparedness cover almost all aspects of heatwave planning. We identify preparedness measures relating to care for vulnerable people (e.g. registering, ensuring support), informing stakeholders and the public (e.g. awareness campaigns; educating and training staff, ensuring awareness of stakeholders), infrastructure (e.g. ensuring availability of refreshed rooms, installing cooling aids), optimising or adapting care (e.g. capacity check of medical facilities, reviewing medical treatments), monitor of warning parameters, and reduction of heat exposure (e.g. develop prevention culture at work). However, not all countries focus on preparedness or distinguish an alert level 0 for the implementation of preparedness measures all year round (only BE, FR, DE, MK, UK do so).

Literature. Stakeholders with a role as implementer need to ensure that preparedness and awareness are maintained as set out in the heatwave plan, in anticipation of alerts being triggered (Abrahamson and Raine 2009). By improving preparedness, the adverse health effects of heatwaves can be limited (Boyson et al. 2014; Elliot et al. 2014). This also involves the monitoring of warning parameters (Elliot et al. 2014).

Interviews. Preparedness is about being ready to respond when an alert is triggered. It involves the monitoring of warning parameters, as this allows stakeholders to know when to increase their efforts and implement measures. Another important aspect is to raise awareness on the health impact of heat and provide information on protective measures. By providing this information in advance, stakeholders and people have access to it when a heatwave occurs. A third aspect is to check the capacity of stakeholders to respond to a heatwave. For instance, confirm the availability of staff or volunteers, identify/confirm access to climatised rooms, or confirm the availability of resources (e.g. water bottles) required to implement measures (e.g. hand out water). When heatwave plans provide no guidance on or specific measures relating to preparedness, stakeholders are assumed to ensure preparedness by themselves. However, without clear instructions stakeholders may not know what actions to take to prepare themselves or they may think preparedness is not important as it is not described in the heatwave plan.

We define the following sub-elements based on these insights for the criterion “measures and recommendations” (see chapter 4):

- **develop preparedness strategies for implementers**
- **define processes to ensure preparedness of stakeholders and the public**
- **include a level 0 in heatwave warning systems to foster preparedness**

3.6.3. Response

Response refers to those measures and recommendations that are implemented in the event of a heatwave.

National plans. Most of the national heatwave plans include measures and recommendations relating to response, and they are described in more detail compared to measures for the other emergency management phases. The response phase is activated when an alert is triggered (alert levels 1-4) and the measures are mostly targeted at the coordinators and implementers. We identify response measures relating to care for vulnerable people (e.g. implementing protective measures, ensuring follow-up), implementation of the plan (e.g. activation of the warning system), informing stakeholders and the public (e.g. communicate alerts, communicate protective measures, activate telephone hotline), infrastructure (e.g. activate climatised rooms), optimising or adapting care (e.g. implementation of contingency plan, support caretakers, mobilise additional staff), monitoring of warning parameters, and reduction of heat exposure (e.g. implement protective measures, reduce travel).

Literature. Measures and recommendations relating to response are implemented when an alert is triggered and are directly aimed at limiting adverse health impacts of heat (Abeling 2015; de'Donato et al. 2018). Mentioned response measures relate to optimizing or adapting care (e.g. mobilizing additional staff), increasing supplies, infrastructure (e.g. mobilise vulnerable people to climatised rooms, open public climatised rooms), monitoring warning parameters, and care for vulnerable people (e.g. plan hospital discharge, intensify health surveillance) (de'Donato et al. 2018; Elliot et al. 2014).

Interviews. The response phase is where most stakeholders are active, as the focus is often on response and as most involved stakeholders are implementers. Besides implementers, also coordinators play an important role in this phase. Response involves the implementation of measures and recommendations to limit the health impact of heatwaves, and the surveillance of parameters and activities to ensure that the implemented measures meet actual needs. The implementation of response measures can always be intensified when the alert level increases or when there is a need. This needs to be considered in advance, and stakeholders need to be prepared for such an intensification. Among care providers, mobilisation to implement response measures is considered to be easy, as these usually align very well with their core tasks. Response measures are mentioned in relation to infrastructure (e.g. open climatised rooms, ventilate rooms), increasing supplies (e.g. water bottles), care for vulnerable people (e.g. intensify health surveillance), optimising or adapting care (e.g. emergency beds), informing stakeholders and the public (e.g. instructions on protective measures).

Following these insights, we define two sub-elements for the criterion "measures and recommendations" (see chapter 4):

- **define strategies and measures to respond to a heatwave (e.g. care for vulnerable people, optimising or adapting care, monitoring warning parameters, reducing heat exposure, infrastructure, informing stakeholders and the public, increasing supplies)**
- **define processes to adapt the response when the alert level or need increases**

3.6.4. Recovery

Recovery refers to those measures and recommendations that are focused on returning everything to normal, pre-heatwave conditions and to repair any damage caused.

The recovery phase seems to not exist within the context of heatwave planning in the selected countries. Based upon our analysis, it is unclear whether recovery is ignored or simply not relevant in this context, so we cannot provide recommendations regarding this phase.

3.6.5. Evaluation

Evaluation refers to those measures and recommendations that allow the evaluation of implemented measures and recommendations during and after a heatwave has occurred.

National plans. While we know that most plans have been updated over time, assumedly based an evaluation, there is no mention within the plans of any procedures for systematic evaluation. Nevertheless, evaluation is mentioned in most plans. Aspects that are mentioned as needing evaluation are implemented activities (BE, DE, IT, FR, MK, PT, ES, UK), communication strategies (BE), the warning system (BE), the health impact of heat (IT, MK) and experiences of stakeholders (FR, MK, ES). This information can then be used to improve communication strategies (BE), evaluate the warning system (BE) or to revise the heatwave plan (BE, DE, FR, NK, PT, ES, UK). The evaluation phase can be activated immediately after the occurrence of a heatwave or after the summer period. In most countries (BE, FR,), the heatwave plan (or part of it) seems to be evaluated and revised yearly.

Literature. All articles included in the literature review, evaluate the effectiveness of one or more heatwave plans or aspects of it. The methodologies that are used for these evaluations vary. Qualitative research methods (e.g. interviews, focus groups) are used to evaluate stakeholders' risk knowledge (Abeling 2015), stakeholders' perceptions on the plan (Abrahamson and Raine 2009; van Loenhout et al. 2016), risk awareness and protective behaviours of the elderly (Abrahamson et al. 2008; Bittner and Stößel 2012), dissemination of the plan to stakeholders (Boyson et al. 2014), stakeholders' perceptions on heat-health risks (Herrmann and Sauerborn 2018), the interpretation of warning messages by vulnerable people (Tang and Rundblad 2015) and how policy addresses heat and cold risks (Wolf et al. 2010). Further, we also included a group of quantitative

research articles in the literature review. We can distinguish two types here, namely: those that use temperature and epidemiological data to evaluate the effectiveness of heatwave plans and the health impact of heat (Brasseur et al. 2014; Bustos Sierra and Aikainen 2017; Cox et al. 2010; de'Donato et al. 2018; Elliot et al. 2014; Fouillet et al. 2008; Linares et al. 2015; Martinez et al. 2017; Pascal et al. 2012; Schifano et al. 2012; Smith et al. 2016; Vicedo-Cabrera et al. 2016); and those that use population surveys to assess the effectiveness of the communication plan by surveying risk awareness and behaviour of the population (Cuesta et al. 2017; Khare et al. 2015; Lefevre et al. 2015; Léon et al. 2007; Van Loenhout and Guha-Sapir 2016) or to evaluate the extent to which the national heatwave plan is implemented (Kunst and Britstra 2013). This overview shows that depending on the aim of the evaluation, different methods are required. For instance, to gain insights into the impact of the communication plan on the awareness and behaviour of stakeholders and people, qualitative research methods or population surveys are more suitable. Epidemiological data and other data on parameters, are more suitable to assess the health impacts of a heatwave, during and after it occurs, and to assess differences in health impacts before and after the development or update of a national heatwave plan.

Interviews. Evaluation measures can be implemented 1) during the summer period after a heatwave has occurred or 2) after the summer season. The evaluation phase aims to gain insights in what has exactly occurred: which measures were implemented, were there any issues, what was the health impact of a heatwave, and how did the heatwave plan as a whole perform. The evaluation can make use of parameter data collected in the context of monitoring, and feedback from stakeholders on their activities and experiences. The focus can be on evaluating the plan as a whole, or on evaluating specific components (e.g. warning system, coverage of warnings, communication plan). Based on the evaluation, the heatwave plan or parts of it can be revised. For major changes, immediate adjustment may not be desirable. Instead, the adjustment may be applied behind the scenes during a trial period to assess the effectiveness. To properly evaluate a heatwave plan, there is a need for a systematic evaluation process and criteria on what constitutes an effective heatwave plan. To our knowledge, neither currently exist and most evaluations are ad hoc and informal. We believe that this report and the work done in SCORCH can provide a basis for developing such criteria, although this is not one of the project aims.

Based on these insights, we define the following sub-elements for the criterion "measures and recommendations" (see chapter 4):

- **develop a process for systematic evaluation and revision of the heatwave plan**
- **define criteria for an effective heatwave plan**
- **use parameter data to evaluate the effectiveness of the plan and its components (e.g. warning system, coverage of warnings, communication plan)**
- **use feedback from involved stakeholders on their activities and experiences**

3.7. Care for vulnerable groups

3.7.1. Identify vulnerable people

National plans. The national plans (BE, FR, DE, MK, NL, PT, ES, CH, UK) usually define several categories of vulnerable groups. Vulnerability can be defined based on age, environmental factors, medical characteristics or social characteristics. In addition, a differentiation can be made between vulnerability due to intrinsic risks (e.g. age, illness) and vulnerability due to exposure (e.g. outdoor workers). Few plans (FR, UK) describe procedures on how to identify vulnerable people. One possible method is to set up a register for vulnerable people (e.g. by local authorities), in collaboration with health and social services. Another option is to make use of existing services, e.g. by having health services identify vulnerable people on their practice lists, or by encouraging wardens to identify vulnerable tenants.

Literature. National heatwave plans provide general definitions of vulnerability and stakeholders are expected to identify people who meet these definitions. In reality, however, stakeholders often lack the knowledge and tools to identify and prioritise vulnerable people. Further, identification of vulnerable people is difficult because vulnerability is dynamic and can change rapidly, and it cannot solely be predicted based on someone belonging to a certain category (Abrahamson and Raine 2009). This issue may be addressed by combining epidemiological (e.g. hospital discharges, drug prescription, GP notifications) and demographic data (de'Donato et al. 2018; Schifano et al. 2012). Also city-scale censuses of vulnerable people and home visits to those people during alert periods can provide more accurate insights into vulnerability (Fouillet et al. 2008).

Interviews. Based on the interviews, we identify several methods to identify and register vulnerable people: conduct surveys during the summer period[3], have health and social services identify vulnerable people, use demographic data, or create a register to which vulnerable people can apply to for monitoring.

Based on these findings, we define the following sub-elements relating to the criterion "care for vulnerable groups" (see chapter 4):

- **define vulnerable groups**
- **describe methods for identifying and prioritising vulnerable people**
- **use epidemiological data, demographic data, census data and/or health and social services to identify vulnerable people**

[3] Although it would be desirable to start conducting these surveys before the summer period, the status of vulnerable people can change rapidly. Therefore, potential vulnerable people need to be contacted also during the summer period, to identify possible changes in their status and need for additional care.

3.7.2. Monitor and care for vulnerable people

National plans. The monitoring of vulnerable people is not discussed in detail within the national heatwave plans. Some plans (PT, UK) mention that stakeholders should ensure follow-up of vulnerable people, but little details are given on how this is to be realised. The plans make mention of monitoring the body temperatures of vulnerable people, monitoring room temperatures in the homes of vulnerable people. The task of monitoring vulnerable people is also not assigned to specific stakeholders, though examples are given (e.g. caretakers, wardens of housing facilities, neighbours, family members). Regarding the care for vulnerable people, some national heatwave plans (BE, FR, DE, MK, PT) include recommendations or instructions on how to care for specific vulnerable groups during a heatwave to prevent a negative health impact or to treat those who have been exposed. This information is aimed at family and community members, and/or professional caretakers and other relevant stakeholders. Some instructions can even be turned into legal decrees (e.g. relating to occupational health). Further, heatwave plans (FR) may recommend that additional solutions are explored, and that stakeholders collaborate to ensure care for vulnerable groups during the summer period. Regional or national public health agencies can play a supporting role in this, by being vigilant in coordinating health actions and by ensuring a balance between medical capacity (e.g. available beds, staff) and needs. Finally, in order for stakeholders and their staff to provide appropriate care to vulnerable people, they need to be trained (FR, DE, IT, MK, CH, UK). However, few information is given within the national heatwave plans on the content of this training or who will organise these.

Literature. When implementing monitoring and care for vulnerable people, it is important to prevent that the process is perceived as intrusive or patronising by vulnerable people, as this may lead them to refuse participation (Abrahamson et al. 2008). Solutions that merge into existing care services (e.g. home visits) may be more desirable. Moreover, such solutions could also be more feasible to implement for care providers. Further, not all stakeholders are sufficiently aware of the health risks of heat or protective measures. By providing trainings, this could be addressed (Abeling 2015; Herrmann and Sauerborn 2018).

Interviews. Within the interviews, we identify several possible measures to monitor the health status of vulnerable people and to optimise health services targeted at these groups: ambulant care (e.g. home visits, street teams, first aid posts), exceptional interventions (e.g. remove people from home), expand existing care (e.g. additional home visits), informal care (e.g. buddy system, home services) and tele-assistance (e.g. phone calls). Further, we find that efforts are made to train stakeholders, the public and vulnerable people on protective measures. Such trainings may take the form of educational talks, presentations for medical staff, volunteer trainings, and trainings in schools, nurseries and elderly homes.

Based on these findings, we define the following sub-elements relating to the criterion “care for vulnerable groups” (see chapter 4):

- **monitor the health status of vulnerable people**

- provide instructions for stakeholders, the public and vulnerable people
- build monitoring and care for vulnerable people into existing services
- describe methods for monitoring vulnerable people
- develop specific measures to care for vulnerable people (e.g. ambulant care, additional care, informal care, tele-assistance)
- provide information and training for formal and informal caretakers

3.8. Resources

The successful implementation of a heatwave plan is dependent upon the availability of certain resources. Based on our analyses, we identify three relevant types of resources: data, human resources and financial resources.

3.8.1. Data

National plans. Within the national heatwave plans, the monitors are responsible for surveying and analysing data on certain parameters. However, it is not specified how these data are to be acquired or by whom. It can be assumed that the data are usually collected by the monitor, although for some cases (e.g. morbidity data) data may be sent to the monitor by other stakeholders (e.g. hospitals, GPs).

Interviews. The interviews confirm that some data is usually collected by the monitor(s) as well as by other stakeholders who send the data to the monitor(s). However, several issues are mentioned relating to data collection and analysis, such as access to data, lack of real-time data and privacy issues. Currently, these issues seem to be placed outside the scope of the national heatwave plan and they are considered the responsibility of the monitor. However, this may impact the effectiveness of the plan. Therefore, we believe it may be helpful if the national plan provides more information and/or support relating to data as a resource to ensure the required data are available.

Following this synthesis, we define one sub-element for the criterion “resources” (see chapter 4):

- **ensure timely access to daily data for effective monitoring of parameters**

3.8.2. Human resources

National plans. Human resources are usually not discussed within the national heatwave plans as the plans focus on roles of stakeholders (institutions, organisations) and not on the internal functioning of these stakeholders. Some measures, however, do impact the field of human resources. For instance, care providers need to ensure sufficient staff members are available during the summer period and they need to be able to mobilise additional staff when an emergency situation occurs. In addition, some stakeholders (e.g. care providers, NGOs) will send additional mobile teams into the field and others will deploy volunteers. While these measures are identified within the national plans, it is not discussed how they need to be implemented.

Interviews. Within the interviews, several respondents identify issues relating to human resources. This is particularly so for implementers such as care providers and NGOs. These stakeholders are often confronted with staff shortages all year round, and struggle to ensure the availability of sufficient and additional staff during the summer months. In addition, heatwave plans provide insufficient guidance on this topic. As this may affect the continuity and quality of care during emergency situations, heatwave plans may need to consider this issue. For instance, a possible solution is to create a pool of care professionals from a certain region, who can be activated and deployed when

and where there is a need. Another issue that especially NGOs struggle with, is the use of volunteers. While using volunteers is a good solution to temporarily have additional manpower, they are not always sufficiently educated or legally allowed to perform certain actions. It is thus recommended that the national heatwave plan provides guidance on how to make use of volunteers effectively and how to train them.

Following these findings, we define two sub-elements for the criterion "resources" (see chapter 4):

- **provide guidance for ensuring the availability of sufficient and additional staff**
- **create a framework for deploying and training volunteers to support implementers**

3.8.3. Financial resources

National plans. The allocation of financial resources for developing, implementing and evaluating the heatwave plan is usually not specified within the national heatwave plans. Only a few of the selected plans (FR, PT, CH) mention the allocation of financial resources, and usually this relates to specific parts of the plan (e.g. developing information documents, television broadcasts). This funding is usually provided by the Ministry of Health, and in Portugal it is provided by State Budget Law.

Interviews. When financial resources are brought up during the interviews, it is usually to indicate a need for more budget. This need is expressed by implementers as well as monitors. First, the availability of financial resources can determine how many parameters can be monitored and to which level of detail, and to extent to which they can maintain their equipment. Without allocation of financial resources, monitoring is sometimes done voluntarily, although the same quality may not be always guaranteed. Further, financial resources impact the priority given to heatwaves. Without the necessary means, stakeholders may not be able to fulfil their assigned roles. For instance, they will not be able to deploy additional staff, disseminate information or organise a response. This can jeopardise the effectiveness of the plan as well as the health of the public and vulnerable people. Finally, a lack of budget may also mean that existing procedures cannot be improved, as changes may require money. The interviews reveal that financial resources can be allocated by national, regional or local authorities, or by public health agencies.

Based on these findings, we define the following sub-elements (see chapter 4):

- **allocate financial resources to develop and realise measures defined in the plan**

3.9. Other heatwave plans and policy documents

3.9.1. Localisation: regional, municipal and organisational heatwave plans

National plans. The organisational schemes in most national heatwave plans focus on the national level. As a result, the definition of roles and responsibilities is often more detailed for higher level stakeholders and vaguer for stakeholders on a subnational level. This issue can be addressed by developing a localised version of the national heatwave plan. Within some national heatwave plans (FR, DE, PT, ES, CH, UK), this is explicitly recommended or legally required. Localisation can occur in several ways: 1) the national plan is a general recommendation for lower level stakeholders to develop their own plan (DE, CH); 2) the national heatwave plan is coordinated nationally and regional and/or local actors are (legally) required to develop a local version of the plan (FR, ES, PT, UK); 3) the national heatwave plan may include roles for lower level stakeholders but the development of a local plan is not explicitly required or recommended (BE, MK, NL, UK).

Literature. The relation between the national heatwave plan and localised versions is not always clear. There is no formal regulation of which stakeholders are (not) involved and what roles they are assigned. Moreover, when it is legally required for stakeholders to develop localised versions of the plan (FR, ES, PT, UK), it should be ensured that these stakeholders have sufficient knowledge on heat risk management and that this demand is met by the national heatwave plan (Abeling 2015). For instance, national heatwave plans insufficiently detail how to identify or prioritise individuals at risk or how to coordinate interventions (Abrahamson and Raine 2009). In addition, national heatwave plans should clearly state priorities and a common thread for localised plans to follow. By including clear guidelines in the national heatwave plan, heterogeneity in local heat responses and implemented measures can be avoided (de'Donato et al. 2018). Furthermore, by not describing localisation in national heatwave plans, implementation and success of local plans depend on local stakeholders (van Loenhout et al. 2016).

Interviews. The interviews further confirm the existence of heatwave plans on other levels besides the national. In general, the national heatwave plan is used as a blueprint and is adapted to local circumstances. The localised plan can either focus solely on heatwaves, or heatwave preparedness planning is incorporated within a broader emergency plan. Despite the fact that localisation is only legally required in some countries (FR, ES, PT, UK), we find that, apart from the Netherlands, respondents from all countries report to work with localised plans, though less consistent compared to those countries where it is legally required. Therefore, if the national heatwave plan foresees a large role for localised heatwave plans, it may be better to create or embed this in a legal framework. Finally, without effective guidance provided by the national heatwave plan, localisation can lead to heterogeneity and confusion. For instance, locally developed warning systems that are not fully aligned with the national heatwave warning system may lead to confusion and conflicting actions.

Based on these findings, we define the following sub-elements (see also chapter 4):

- **include clear guidelines and priorities that support the development and implementation of local heatwave plans**
- **create a legal framework to ensure the development of local heatwave plans**

3.9.2. Relation to other policy documents

Within Annex 4, we provide an overview of all policy documents that were mentioned within the national heatwave plans and during the key stakeholder interviews. Policy documents mentioned within the literature are not included in this annex as the

National plans. Within the national heatwave plans, references are made to other policy documents, especially to laws and regulations (BE, FR, MK, NL, PT, ES, UK) and occasionally to other risk or climate plans or strategies (BE, DE, IT, PT, ES, CH, UK). By referring to laws and regulations, the heatwave plan is embedded in broader policy and its implementation is better ensured. By referring to other risk or climate plans, the heatwave plan is embedded in a broader risk management context. By building upon other, existing processes and plans, implementation becomes easier and less resources may be required to realise the heatwave plan objectives.

Literature. There is little information within the literature review on the relation between the national heatwave plan and other policy documents. What we do find, is that laws and regulations can assign responsibilities to stakeholders for preparing for and responding to heatwaves, but at the same time it also needs to be ensure that these stakeholders have the capacity, expertise and resources to fulfil this responsibility (Abeling 2015).

Interviews. During the key stakeholder interviews, respondents occasionally refer to other policy documents, i.e. laws and regulations (BE, FR, DE, MK, PT, ES, UK) and other risk or climate plans or strategies (DE, PT, ES). These references are less detailed compared to the information found in the national heatwave plans. But it does demonstrate that national heatwave plans are indeed embedded in a broader policy and risk management context, which seems to be effective.

Based on these insights, we define the following sub-element (see also chapter 4):

- **embed the heatwave plan in a broader policy and risk management context**

4. Components of a national heatwave plan

Based on the synthesis of our findings from the overview of national plans, literature review and key stakeholder interviews, we defined several sub-elements for each of the identified heatwave plan criteria (based on Bittner et al. 2013) that are summarised in table 3. This table can be used as a guideline in the development of a heatwave plan and/or the evaluation of existing heatwave plans.

Table 3 – Components of a national heatwave plan

CRITERIA	SUB-ELEMENTS

Organisational scheme	• identify and involve **stakeholders from various sectors**
	• clearly **define and assign roles** and responsibilities
	• **develop and write** the plan in a continuous process
	• **assign ≥1 activator(s)** to activate the plan and/or alert levels
	  o an **activator** must have the required authority and communication lines
	  o plan **activation** includes decision making, communicating the activation and activating implementation
	• **assign ≥1 coordinator(s)** for inter-organisational coordination at all levels
	  o a **coordinator** must have the right network and the required authority, skills and resources
	• **assign ≥1 evaluator(s)** for evaluating the heatwave plan after the summer and for evaluating the situation and implementation during the occurrence of a heatwave
	  o **evaluation** includes assessing effectiveness of the plan and parameters, identifying difficulties and lessons learned and adapting when necessary
	• assign clear responsibilities to all **implementers** while allowing for adaptation to local or organisational circumstances
	  o **implementers** must know their role and have access to sufficient resources
	• assign **internal and external informers** on all levels
	  o an **informer** must have the required network, communication skills and access to resources
	  o informing requires **two-directional communication** flows, and knowing target groups and how to reach them
	• **assign ≥1 monitor** to monitor defined parameters
	  o **monitoring** also includes communication of observed parameter values and advise on the definition of parameters and thresholds
	• develop **formal structures** for collaboration
	• develop **networks** within and across institutions, sectors, levels and countries
	• make use of **existing and personal relations** among stakeholders

Warning system	• **define parameters** (based on available data and relevance) to monitor morbidity, mortality, temperature and other meteorological factors, air pollution, indoor temperature, medical capacity, status of vulnerable groups, wild fires and forest fires • **define threshold values** for parameters based on scientific evidence and epidemiological data • determine and describe **monitoring methods and tools** • **adapt threshold values** to local or regional contexts • define **five alert levels** (0 preparedness, 1 vigilance, 2 hot weather, 3 heatwave, 4 emergency) • **define actions** for each alert level • communicate warnings **1-3 days in advance** • communicate warnings following **clearly described processes** • **describe communication flows** among internal and external stakeholders, and to the public and vulnerable groups. • consider **underlying environmental and social processes** when designing a warning system
Communication plan	• diffuse information simultaneously using **multiple communication tools** • design qualitative, **coherent and easy messages** • provide **template messages** for communication to different audiences • **design communication processes** to stakeholders and to the public and vulnerable groups • diffuse information at the **appropriate times** • consider communication on the **short- and long-term**

Measures and recommendations	• mitigation
	  o **develop mitigation strategies** for all fields of action (e.g. infrastructure, health care, monitoring parameters, informing stakeholders and the public)
	• preparedness
	  o **develop preparedness strategies** for implementers
	  o define **processes to ensure preparedness** of stakeholders and the public
	• response
	  o define **strategies and measures to respond** to a heatwave (e.g. care for vulnerable people, optimising or adapting care, monitoring warning parameters, reducing heat exposure, infrastructure, informing stakeholders and the public, increasing supplies)
	  o define **processes to adapt the response** when the alert level or need increases
	• evaluation

CRITERIA	SUB-ELEMENTS
	◦ develop a **process for systematic evaluation** and revision of the heatwave plan that includes **indicators for evaluation** ◦ **define criteria** for an effective heatwave plan ◦ **use parameter data** to evaluate the effectiveness of the plan and its components (e.g. threshold values, definition of parameters, warning system, coverage of warnings, communication plan) ◦ use **feedback from involved stakeholders** on their activities and experiences
Care for vulnerable groups	• **define** vulnerable groups • describe **methods for identifying and prioritising** vulnerable people • use **epidemiological data, demographic data, census data and/or health and social services** to identify vulnerable people • **monitor the health status** of vulnerable people • **provide instructions** for stakeholders, the public and vulnerable people • build monitoring and care for vulnerable people **into existing services** • **describe methods for monitoring** vulnerable people • develop **specific measures** to care for vulnerable people (e.g. ambulant care, additional care, informal care, tele-assistance) • provide **information and training** for formal and informal caretakers
Resources	• ensure **timely access to daily data** for effective monitoring of parameters • create a **data management plan** • provide guidance for ensuring the **availability of sufficient and additional staff** • create a framework for **deploying and training volunteers** to support implementers • **allocate financial resources** to develop and realise measures defined in the plan
Other policy documents	• include **clear guidelines and priorities** that support the development and implementation of local heatwave plans • create a **legal framework** to ensure the development of local heatwave plans • **embed** the heatwave plan in a broader policy and risk management context

References

Abeling, Thomas. 2015. “According to Plan? Disaster Risk Knowledge and Organizational Responses to Heat Wave Risk in London, Uk.” *Ecosystem Health and Sustainability*.

Abrahamson, V., J. Wolf, I. Lorenzoni, B. Fenn, S. Kovats, P. Wilkinson, W. N. Adger, and R. Raine. 2008. “Perceptions of Heatwave Risks to Health: Interview-Based Study of Older People in London and Norwich, UK.” *Journal of Public Health* 31(1):119–26.

Abrahamson, Vanessa and Rosalind Raine. 2009. “Health and Social Care Responses to the Department of Health Heatwave Plan.” *Journal of Public Health*.

Alexander, David. 2005. “Towards the Development of a Standard in Emergency Planning.” *Disaster Prevention and Management: An International Journal* 14(2):158–75.

Bittner, M. I., E. F. Matthies, D. Dalbokova, and B. Menne. 2013. “Are European Countries Prepared for the next Big Heat-Wave?” *The European Journal of Public Health* 24(4):615–19.

Bittner, Martin-Immanuel and Ulrich Stößel. 2012. “Perceptions of Heatwave Risks to Health: Results of an Qualitative Interview Study with Older People and Their Carers in Freiburg, Germany.” *Psycho-Social Medicine* 9:Doc05.

Boyson, Chris, Sarah Taylor, and Lisa Page. 2014. “The National Heatwave Plan – A Brief Evaluation of Issues for Frontline Health Staff.” *PLoS Currents*.

Brasseur, Olivier, Nicolas; Berger, and Sophie Lokietek. 2014. “EVALUATION SCIENTIFIQUE DE LA SURVEILLANCE ENVIRONNEMENT ET SANTÉ APRES 10 ANS D ’ APPLICATION DU PLAN OZONE ET VAGUE DE CHALEUR EN BELGIQUE .” 1–39.

Bustos Sierra, N., K. Tersago, R. Aerts, V. Van Casteren, and P. Mailier. 2016. *Overheidsopdracht Voor de Validatie van Een Nieuwe Drempelwaarde in Het Kader van Warmteperiodes. Bestek Nr. AZG/ Prev/MGZ/2016/WAP*.

Bustos Sierra, Natalia and Tommi Aikainen. 2017. *Rapport over de Surveillance van de Mortaliteit Door Alle Oorzaken in Belgie in de Zomer van 2017*. Vol. 20.

Cox, Bianca, Françoise Wuillaume, Herman Van Oyen, and Sophie Maes. 2010. “Monitoring of All-Cause Mortality in Belgium (Be-MOMO): A New and Automated System for the Early Detection and Quantification of the Mortality Impact of Public Health Events.” *International Journal of Public Health* 55(4):251–59.

Cuesta, Julita Gil, Joris Adriaan Frank van Loenhout, Maria da Conceição Colaço, and Debarati Guha-Sapir. 2017. “General Population Knowledge about Extreme Heat: A Cross-Sectional Survey in Lisbon and Madrid.” *International Journal of Environmental Research and Public Health* 14(2).

de’Donato, F., M. Scortichini, M. De Sario, A. de Martino, and P. Michelozzi. 2018. “Temporal Variation in the Effect of Heat and the Role of the Italian Heat Prevention Plan.” *Public Health* 161:154–62.

Elliot, Alex J., Angie Bone, Roger Morbey, Helen E. Hughes, Sally Harcourt, Sue Smith, Paul Loveridge, Helen K. Green, Richard Pebody, Nick Andrews, Virginia Murray, Mike Catchpole, Graham Bickler, Brian McCloskey, and Gillian Smith. 2014. "Using Real-Time Syndromic Surveillance to Assess the Health Impact of the 2013 Heatwave in England." *Environmental Research* 135:31–36.

Fouillet, A., G. Rey, V. Wagner, K. Laaidi, P. Empereur-Bissonnet, A. Le Tertre, P. Frayssinet, P. Bessemoulin, F. Laurent, P. De Crouy-Chanel, E. Jougla, and D. Hémon. 2008. "Has the Impact of Heat Waves on Mortality Changed in France since the European Heat Wave of Summer 2003? A Study of the 2006 Heat Wave." *International Journal of Epidemiology* 37(2):309–17.

Herrmann, Alina and Rainer Sauerborn. 2018. "General Practitioners' Perceptions of Heat Health Impacts on the Elderly in the Face of Climate Change-a Qualitative Study in Baden-Württemberg, Germany." *International Journal of Environmental Research and Public Health* 15(5).

Khare, Swarna, Shakoor Hajat, Sari Kovats, Carmen E. Lefevre, Wändi Bruine de Bruin, Suraje Dessai, and Angie Bone. 2015. "Heat Protection Behaviour in the UK: Results of an Online Survey after the 2013 Heatwave." *BMC Public Health* 15:878.

Kunst, Anton E. and Rieneke Britstra. 2013. "Implementation Evaluation of the Dutch National Heat Plan among Long-Term Care Institutions in Amsterdam: A Cross-Sectional Study." *BMC Health Services Research* 13:135.

Lefevre, Carmen E., Wändi Bruine de Bruin, Andrea L. Taylor, Suraje Dessai, Sari Kovats, and Baruch Fischhoff. 2015. "Heat Protection Behaviors and Positive Affect about Heat during the 2013 Heat Wave in the United Kingdom." *Social Science and Medicine*.

Léon, Christophe, Delphine Girard, Pierre Arwidson, and Philippe Guilbert. 2007. "Comportements Préventifs Des Français et Impact Des Campagnes de Prévention Durant La Canicule 2006." *Évolutions* 7.

Linares, C., R. Sánchez, I. J. Mirón, and J. Díaz. 2015. "Has There Been a Decrease in Mortality Due to Heat Waves in Spain? Findings from a Multicity Case Study." *Journal of Integrative Environmental Sciences* 12(2):153–63.

van Loenhout, Joris Adriaan Frank and Debarati Guha-Sapir. 2016. "How Resilient Is the General Population to Heatwaves? A Knowledge Survey from the ENHANCE Project in Brussels and Amsterdam." *BMC Research Notes* 9(1):1–5.

Van Loenhout, Joris Adriaan Frank and Debarati Guha-Sapir. 2016. "How Resilient Is the General Population to Heatwaves? A Knowledge Survey from the ENHANCE Project in Brussels and Amsterdam." *BMC Research Notes* 9(1):1–5.

van Loenhout, Joris, Jose Rodriguez-Llanes, and Debarati Guha-Sapir. 2016. "Stakeholders' Perception on National Heatwave Plans and Their Local Implementation in Belgium and The Netherlands." *International Journal of Environmental Research and Public Health* 13(11):1120.

Martinez, Gerardo Sanchez, Hans Hooyberghs, Maria Bekker-Nielsen Dunbar, Cristina

Linares, Vladimir Kendrovski, Raf Aerts, An Van Nieuwenhuyse, Rocio Carmona, Julio Diaz, Koen De Ridder, Dirk Lauwaet, and Cristina Ortiz. 2017. "Heat and Health in Antwerp under Climate Change: Projected Impacts and Implications for Prevention." *Environment International* 111(October 2017):135–43.

Pascal, Mathilde, Karine Laaidi, Vérène Wagner, Aymeric Bun Ung, Sabira Smaili, Anne Fouillet, Céline Caserio-Schönemann, and Pascal Beaudeau. 2012. "How to Use near Real-Time Health Indicators to Support Decision-Making during a Heat Wave: The Example of the French Heat Wave Warning System." *PLoS Currents*.

Ragettli, Martina and Martin Röösli. 2017. *Hitzewelle-Massnahmen-Toolbox. Ein Massnahmenkatalog Für Den Umgang Mit Hitzewellen Für Behörden Im Bereich Gesundheit*.

Schifano, Patrizia, Michela Leone, Manuela De Sario, Francesca de'Donato, Anna Maria Bargagli, Daniela D'Ippoliti, Claudia Marino, and Paola Michelozzi. 2012. "Changes in the Effects of Heat on Mortality among the Elderly from 1998–2010: Results from a Multicenter Time Series Study in Italy." *Environmental Health* 11(1):58.

Smith, Sue, Alex J. Elliot, Shakoor Hajat, Angie Bone, Gillian E. Smith, and Sari Kovats. 2016. "Estimating the Burden of Heat Illness in England during the 2013 Summer Heatwave Using Syndromic Surveillance." *Journal of Epidemiology and Community Health* 70(5):459–65.

Straff, Wolfgang and Hans-Guido Mücke, eds. 2017. *Handlungsempfehlungen Für Die Erstellung von Hitzeaktionsplänen Zum Schutz Der Menschlichen Gesundheit*.

Tang, Chris and Gabriella Rundblad. 2015. "The Potential Impact of Directionality, Colour Perceptions and Cultural Associations on Disaster Messages during Heatwaves in the UK." *PLoS Currents* 7(DISASTERS):1–21.

Vicedo-Cabrera, Ana M., Martina S. Ragettli, Christian Schindler, and Martin Röösli. 2016. "Excess Mortality during the Warm Summer of 2015 in Switzerland." *Swiss Medical Weekly* 146(August 2018):w14379.

WHO Regional Office for Europe. 2008. *Heat-Health Action Plans. Guidance*. edited by F. Matthies, G. Bickler, N. Cardenosa Marin, and S. Hales. Copenhagen, Denmark.

WHO and WMO. 2015. *Heatwaves and Health: Guidance on Warning-System Development*. edited by G. R. McGregor, P. Bessemoulin, K. Ebi, and B. Menne.

Wolf, Johanna, W. Neil Adger, and Irene Lorenzoni. 2010. "Heat Waves and Cold Spells: An Analysis of Policy Response and Perceptions of Vulnerable Populations in the UK." *Environment and Planning A: Economy and Space* 42(11):2721–34.

Annexes

Annex 1 – WHO core elements of heat-health action plans and their sub-elements (taken from Bittner et al. 2013)

Core element	Subelements
1. Agreement on a lead body and clear definition of actors' responsibilities	Clearly defined lead body Involvement of >1 other agencies Regular meetings and/or reviews Inclusion in national disaster preparedness Cross-border cooperations
2. Accurate and timely alert systems	Threshold definition scientifically sound Regionally adapted definitions Warning is issued well in advance Different alert levels for different levels of action Alert is communicated following a clear plan
3. Health information plan	Clearly defined actors/recipients/contents Effective dissemination of information (>1 channel) Quality of advice Public & professionals addressed Appropriate timing of information campaign
4. Reduction in indoor heat exposure	Giving advice Providing cool rooms/spaces Provision or use of mobile coolers Planning or support for increased albedo or shading Planning or support for better insulation
5. Particular care for vulnerable groups	Identification of relevant groups (>1) Activation of a telephone service Specific measures (buddies, neighbours…) Regular re-assessment of vulnerable population groups Information and training for caregivers
6. Preparedness of the health/social care system	Increase of capacity of health services Heat reduction in healthcare facilities Special precautions in nursing homes Special resources for patients/public Improving health-care networks
7. Long-term urban planning	Increased green & blue spaces Changes in building design (albedo, insulation, passive cooling) Changes in land-use decisions Energy consumption reduction Individual and public transport policies
8. Real-time surveillance	Less than 48-h interval Involving data from >1 region/city Involving data from >1 health effect Use for adjustment of measures Use for evaluation of effectiveness

Annex 2– Comparing role definitions

The table below provides a comparison between information from the overview of the national plans and from the key stakeholder interviews regarding the definition and assignment of roles.

Country	Comparison roles			No comparison possible	
	Completely similar	Somewhat similar	Completely different	Only in interviews	Only in plan
BE	Interregional agency Local authority Meteorological agency			Care provider Public health agencies NGO Media Research institute Social institutions	Crisis agency Ministry of Health
FR	Care provider Local authority Meteorological agency Media	Public health agencies		Cross-government body Local agency NGO Social institution	Ministry of Health Other ministries
DE	Care provider Emergency service Social institution	Local authority Meteorological agency	Other ministry	National agency Media Research institute	Crisis agency
MK	Care provider Local authority Meteorological agency Public health agency NGO Media	Crisis agency	Emergency service		Interregional agency Other ministries
NL	Care provider Emergency service Meteorological agency Media	Ministry of Health NGO		Local agency Social institutions	
PT	Care provider Emergency service Meteorological agency Media	Ministry of Health National agency		Local agency Regional authority	
ES	Meteorological agency	Local authority Regional authority Social institution		Care provider Local agency Ministry of Health NGO Media Research institute	Cross-government body Public health agency

Country	Comparison roles			No comparison possible	
	Completely similar	Somewhat similar	Completely different	Only in interviews	Only in plan
CH		Meteorological agency	Ministry of Health Public health agency	Care provider Regional authority Media Social institution	
UK	Care provider Community group Meteorological agency Public health agency Media			Emergency service Local agency NGO Social institution	Cross-government body Ministry of Health Other ministries

Annex 3 – Roles

The tables below provides a comparison between information from the overview of the national plans and from the key stakeholder interviews regarding roles stakeholders perform within the context of their country's heatwave plan.

Country	AUTHOR			
	National plans		Interviews	
	Stakeholder	Role	Stakeholder	Role
BE	Ministry of Health	Main author	Public health agency	Co-author, expert advisor
			Interregional agency	Co-author
FR	Ministry of Civil Security Ministry of Health Ministry of Interior Affairs	Main author		
DE	Ministry of Environment	Main author	Ministry of Environment	Main author
	National agency	Co-author	National agency	Main author
	Meteorological agency	Co-author	Meteorological agency	Co-author
	Regional authority	Expert advisor	Regional authority	Expert advisor
			Ministry of Transport	Co-author
			Ministry of Health	Co-author
MK	Public health agency	Main author	Public Health agency	Main author
	Ministry of Health	Main author	Crisis agency	Co-author
	Interregional agency	Main author	Emergency service	Co-author
	Meteorological agency	Co-author	Meteorological agency	Co-author
NL	Ministry of Health	Commissioning author	Ministry of Health	Commissioning author
	Public health agency	Main author	Public health agency	Main author
	Meteorological agency	Expert advisor	Meteorological agency	Expert advisor
			NGO	Expert advisor
PT	Ministry of Health	Main author	Ministry of Health	Main author
			Meteorological agency	Expert advisor
ES	Ministry of Health	Main author	Ministry of Health	Main author
	Meteorological agency	Expert advisor		
	Regional authority	Expert advisor		
CH	Ministry of Health	Commissioning author	Ministry of Health	Commissioning author
	Public health agency	Main author	Public health agency	Main author, expert advisor
UK	Public health agency	Main author	Public health agency	Main author

AUTHOR				
Country	National plans		Interviews	
	Stakeholder	Role	Stakeholder	Role
	Meteorological agency	Expert advisor	Meteorological agency	Expert advisor
			Local agency or institute	Expert advisor
			Emergency service	Expert advisor

ACTIVATOR				
Country	National plans		Interviews	
	Stakeholder	Role	Stakeholder	Role
BE	Meteorological agency	Heatwave warning levels 1 or 2.		
			Public health agency	Warning phase.
	Interregional agency	Vigilance phase, level 1 and 2.	Interregional agency	Activate the plan.
	Crisis agency	Alarm phase.		
FR	Ministry of Health	Level 1, level 3 depending on the situation, level 4.	Ministry of Health	Chain of alert.
	Meteorological agency	Yellow or orange heatwave alert.		
	Regional authority	Level 3 heat alert.		
DE	Meteorological agency	Heatwave warning.	Meteorological agency	Heatwave warning.
MK	Meteorological agency	Activate heat-wave warning system in the green phase.	Meteorological agency	Heatwave warning.
	Cross-government body	Activate yellow, orange and red phases.	Cross-government body	Activate plan.
NL	Meteorological agency	Heatwave alert warning.	Meteorological agency	Heatwave warning.
	Public health agency	Vigilance and (pre-)warning phases.	Public health agency	Activate plan.
PT	Ministry of Health		Ministry of Health	Activate plan (orange/red).
			Meteorological agency	Heatwave warning.
ES	Cross-government body	Activation of plan from level 0 to level 3.	Cross-government body	Activation of plan in early stages (May), activation of alert levels.
	Meteorological agency	Heatwave alert warning.	Meteorological agency	Heatwave warning.
CH	Meteorological agency	Heatwave warning.	Meteorological agency	Heatwave warning.
UK	Public Health Agency		Public health agency	Activate plan.
	Meteorological agency	Heatwave warning in levels 1,2 and 3.	Meteorological agency	Heatwave warning.
	National agency	Alert level 4.		

COORDINATOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
BE	Interregional agency	Coordinate the information on the heatwave warning to the actors (authorities, crisis agency, public, media etc.) involved in the plan.	Interregional agency	Coordinate dissemination of the information to the different actors in the heatwave plan.
	National agency	Coordinate national actions regarding the alarm phase.		
FR	Regional authority	Takes measures in coordination with municipalities involved in level 2. Coordinates the response of the healthcare system.	Regional authority	Coordination of (preventive) measures in their municipality.
	National authority	Coordinates a response during a level 4 warning.	NGO	Coordinates NGO actions in the field.
	Ministry of Health	Coordinates communication at the national level during a level 3 warning.		
MK	Cross-government body	Coordinates actions related to informing the public and health workers about the heatwave alert.	Public health agency	Coordinates with local stakeholders on which measures to implement.
			Crisis agency	Coordinates among various stakeholders during a crisis.
NL	Public health agency	Coordinates list of recipients to receive the heatwave alert.	Public health agency	Coordinates actions between the various stakeholders once a heatwave warning is given.
PT	Ministry of Health	Overall coordination of the heatwave plan.	Ministry of Health	Coordinates the drafting of the heatwave plan Coordinates the response during a heatwave.
			National agency	Coordinates among the various stakeholders that activate their own heatwave plans.
			Regional authority	Coordinates the response during a heatwave of decentralized services such as hospitals and health centres.
	National agency	Coordinate dissemination of the heatwave plan within their institution.		
	Local agency	Coordinate the plan at the local level.		
ES	Cross-government body	Coordinate the information output with the regional authorities. Coordination with public and private organisation to execute the heatwave plan.	Cross-government body	Coordinates with regional authorities on the regional heatwave plans. Coordinates with regional authorities on disseminating information in their regions.
	Regional authority	Coordination of the activation of specialized local resources.		

COORDINATOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
CH	Local agency	Local coordination of heatwave measures.	Regional authority	
UK	Public health agency	Coordinate the heatwave plan with other stakeholders to ensure vulnerable groups are supported.	Public health agency	Coordinator of the heatwave plan on behalf of the health and social care system. Coordinates with stakeholders on a local level on the development of local heatwave plans.
	National authority	Coordinate with other stakeholders in case of a level 4 warning. Coordinate across the government to prepare for severe climate events.	Emergency service	Coordination of the development of heatwave plans from the various stakeholders in the emergency services. Coordinates measures taken by the emergency services.
	Community group	Coordinate the implementation of measures in the heatwave plan in the local context.	Community group	Coordinates local community groups in taking measures during a heatwave Coordinate meetings between local community groups.
			Local agency	Coordinating activities from various stakeholders regarding mitigation of climate change effects.

EVALUATOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
BE	Ministry of Health	Evaluation of the meteorological parameters used during previous heatwaves as well as their impact on public health.	Interregional agency	Evaluates the heatwave plan twice a year during the summer and winter.
	Crisis agency	Evaluation of threshold criteria for the alarm phase. Evaluation of the crisis situation and adapt measures.	Meteorological agency	Bi-annual meeting between meteorological experts to discuss topics related to the national heatwave plan.
			Public health agency	Evaluate warnings
FR	Meteorological agency	Regularly evaluates the alert thresholds Takes part in an evaluation committee of the national heatwave plan before and after the summer season to carry out an evaluation.	Meteorological agency	Conducted evaluations of the vigilance levels in 2017 and 2018 by employing a citizen driven survey design.
	Cross-government body	Evaluation of the national heatwave plan especially for structural measures and the implementation in institutions as well as the training and awareness actions of the various stakeholders involved in the plan .	Public health agency	Conducted an evaluation of the national heatwave plan in 2006, 2008 and 2013 zooming into the heatwave plans recommendations to the public Evaluates the alert thresholds regularly in collaboration with the meteorological agency.
DE			Cross-government body	Annual meetings to evaluate actions undertaken regarding heatwaves.
			Meteorological agency	Evaluation of the heat warning system until the year 2015.
MK	Cross-government body	Evaluation of the national heatwave plan at the end of the season which involves assessing the effectiveness, efficiency and social acceptance of the plan.	Cross-government body	Evaluation of the national heatwave plan among all stakeholders involved in the plan.
	Public health agency	Evaluates the effects of heat-waves in terms of defined indicators as stated in the national heatwave plan.	Public health agency	Conducted several evaluations regarding the awareness of the national heatwave plan among the public.
NL	Public health agency	Evaluates the national heatwave plan after each activation.	Public health agency	Conducts an annual evaluation of the national heatwave plan among an homogenous target group.
PT	Ministry of Health	Compose monthly and an annual evaluation report on the national heatwave plan assessing several indicators.	Ministry of Health	Compose an evaluation report at the end of the season which allows for adjustments and corrections of the indicators. Use indicators to evaluate information, prevention, control and communication within the plan.
	Public health agency	Bi-weekly reports and evaluation of the occurrences.		

Country	EVALUATOR			
	National plans		Interviews	
	Stakeholder	Role	Stakeholder	Role
	Regional authority	Prepare monthly reports and a final evaluation of the implementation of the heatwave plan on a regional level.		Evaluate measures implemented by regional public health units and the situation in the region. Participate in evaluation meetings in case of need.
ES	Cross-government body	Evaluation of the impact of climate change on public health and the national healthcare system. Evaluate actions required to manage the risk.	Cross-government body	The national heatwave plan is evaluated monthly during the months of May-October according to several indicators. An evaluation at the end of the year is also performed.
CH				
UK	Public health agency	Annual evaluation of the national heatwave plan which takes place each spring.	Public health agency	Evaluated the public health response twice to cold spells and heat waves.

EVALUATOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
BE	Ministry of Health	Implementing the heatwave plan on a federal level	Public health agency	Implementation of the national plan on a regional level. To ensure the same thresholds are used across the country.
	Regional authorities	Implementing the organisation and execution of the heatwave plan in their regions		
FR	Regional authorities	Implement the heatwave plan on a regional level		
DE			Ministry of Environment, Nature Conservation and Nuclear Safety	Assist regions with the implementation of regional heatwave plans
MK	Cross-government body	Implementation of the actions and activities especially those connected with the provision of timely information to the public and health care workers of the heatwave plan	Public health agency	Implement the actions that are written in the heatwave plan with specific attention to measures regarding the information for the public and health care workers
NL	Public health agency	Implements actions regarding the heatwave plan on a national level assists local organizations with their heatwave plans	Public health agency	Implementation of the heatwave plan
	Local agency	Develop and implement the local version of the national heatwave plan		
PT	Ministry of Health	Implementation of the heatwave plan on a national level since its development	Ministry of Health	Implement the heatwave plan on a national level as the central entity
	Regional authority	Develop the regional heatwave plan, establish regional networks and provide the necessary resources for implementation of the regional heatwave plan	Regional authority	Define the regional guidelines, adapt to national guideline to a regional level and implement the regional guideline
ES	Cross-government body	Implementation of the heatwave plan on the national level.	Cross-government body	Implementation of the information campaign of the national heatwave plan.
CH	Regional authorities	Coordinates the implementation pf the measures of the regional heatwave plan.		
UK	Public health agency	Ensure the implementation of the heatwave plan on a national level.	Public health agency	Support the implementation of the heatwave plan.
	Community group	Support the implementation of local heatwave plans across the governmental and healthcare sectors.	Community group	Support the development and implementation of local heatwave plans.

INFORMER				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
BE	Meteorological agency	Informs the interregional agency when the weather will exceed the criteria set for different levels	Meteorological agency	Inform the interregional agency and the public .
	Interregional agency	Inform stakeholders if ozone, fine particular matter and nitrogen dioxide concentrations will approach or exceed limits. Inform stakeholders, the media and the public about the occurrence and ending of a heatwave. Inform the national crisis agency if the alarm phase will be reached	Interregional agency	Informing federal stakeholders and the public through various channels (e.g. social media, email, website).
	Crisis agency	Inform regional and federal crisis agencies about the alarm phase and in a later stage inform the media and public about the alarm	Public health agency	Inform the external stakeholders (e.g. care providers, social services) and the public about the heatwave warning through email, social media, newsletter.
	National agency	Inform stakeholders on a federal level during the various phases. Inform the public through their website about heat health.		
FR	Ministry of Health	Informs the public through a press release about the triggering of the seasonal surveillance of the heatwave plan. Informs the public about the availability of a free telephone number which the public can call during a heatwave.		
	Public health agency	Informs stakeholders and the public during the vigilance phase that information about a heatwave is freely available. Informs the public during a heatwave through methods such as leaflets and posters.	Public health agency	Inform the public about measures to take during a heatwave through mainly the media.
	Meteorological agency	Informs the regional authority about heatwave parameters.	Meteorological agency	Inform the government and the public about the heatwave warning
	Regional authority	Inform municipal authorities about the heatwave parameters they received form the meteorological agency .	Regional authority	Inform the public through media broadcast and leaflets.
	Media	Informs the public through a television and radio spots about recommendations during a heatwave.	NGO	Inform employees and volunteer about behaviour during a heatwave.

INFORMER				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
DE	Meteorological agency	Informs both health- and social intuitions and the public on the occurrence of a heatwave.	Meteorological agency	Inform the regional authorities, the public and vulnerable groups in case of a heatwave warning through methods such as a newsletter, an app and text messages.
			National agency	Inform the public through guidebooks, leaflets, a website and open days about the effect of climate change on human health.
			Ministry of Environment	Inform the public through a section on the website.
			Emergency service	Inform the public through a newsletter and social media.
MK	Meteorological agency	Inform the Ministry of Health about an evidence of the alert levels.	Meteorological agency	Inform the Ministry of Health and the general public of the heatwave warning.
	Cross-government body	Inform the media through a workshop about the heatwave plan. Inform the public about measures related to heat (health) through various channels e.g. the media and web sites. Inform local authorities about measures to take in preparation for a heatwave.		
	Public health agency in cooperation with applicable Ministries	Inform healthcare stakeholders to support and safeguard their population. Inform governmental agency on measures to implement. Inform emergency services on data collection and measures to take. Inform the public about measures related to heat (health) through various channels e.g. the media and web sites.	Public health agency	Inform external stakeholders (e.g. local public health centres, care providers) and the public about the heatwave warning.
	NGO	Inform the public about measures related to heat (health) through various channels e.g. the media and web sites.	NGO	Inform the public and vulnerable groups about measures to take during a heatwave.
			Crisis agency	Inform the public during level 2 of an heatwave using mainly the media .
			Emergency service	Inform the public through media about heat health and measures to take.
NL	Meteorological agency	Informs the public health agency on the warning levels being approached . Informs the public about the oncoming heatwave through a press release and online information.	Meteorological agency	Informs the public health agency directly about the warning levels being approach and the public indirectly through the media.

Country	INFORMER			
	National plans		Interviews	
	Stakeholder	Role	Stakeholder	Role
	Public health agency	Informs members that are part of the heatwave information list (e.g. local agencies, NGOs, community groups). Informs the public about the oncoming heatwave through a press release and online information	Public health agency	Inform the stakeholders of the heatwave plan through email of the occurrence of a heatwave Inform the general public about the occurrence of a heatwave through channels such as Twitter.
ES	Meteorological agency	Provide information on the weather together with the assignment of risk levels based on criteria in the heatwave plan to the ministries and regional authorities	Meteorological agency	Inform the public about the occurrence of a heatwave
	Regional authorities	Inform the public through their webpage about excessive temperature levels Inform health and social service professionals about a heatwave	Regional authorities	Inform the public and vulnerable groups about measures to take during a heatwave
	Public health agency	Inform the Ministry of Health there are warning signs in the monitoring of daily mortality	Cross-government body	Inform the public of the existence of the national heatwave plan and the plans of the regional authorities. Inform the public about protective measures to take during a heatwave. Inform the public about the meaning of the various risk levels in the plan. Inform the public about groups that are vulnerable to heat.
			Ministry of Internal Affairs	Inform the public about protective measures during a heatwave through a press release, social media and a website.
CH			Ministry of (Public) Health	Inform the public through a press release, flyers and publications about the heatwave warning. Inform the public and health professionals which measures to take for exposure to heat.
			Meteorological agency	Inform the ministry of (public) health, regional emergency services and regional agencies about the heatwave warning through email. Inform the public through the website and an app about the heatwave warning.
			Public health agency	Inform internal and external stakeholders about the availability of the heatwave plan through emails, a workshop and an annual national conference.

INFORMER				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
UK	Meteorological agency	Informs stakeholders on both internal (e.g. public health agencies, ministries, local agencies) and external (the public) about the heatwave alert.	Meteorological agency	Informs stakeholders on both internal (e.g. public health agencies, ministries, local agencies) and external (the public) about the heatwave alert.
	Public health agency	Inform the (local) services within the agency about the heatwave alert.	Public health agency	Inform the public, vulnerable groups and stakeholders such as care homes, emergency services, community health care about the heatwave alert through email, leaflets and media exposure.
	Local authority	Inform services (e.g. schools, residential homes, day care centres) about the heatwave alert.	NGO	Inform the public and vulnerable groups through leaflets, website and an app about measures to take during a heatwave.
			Community group	Inform the public through social media about the heatwave and the recommendations from the public health agency.

MONITOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
BE	Meteorological agency	Monitors temperature daily.	Meteorological agency	Monitor predicted maximum temperature.
	Interregional agency	Monitors ozone concentration, fine particles and nitrogen dioxide daily.	Interregional agency	Monitors ozone levels through measurements that the different regions take and report to the interregional agency, who collect and publish the data.
			Public health agency	Monitors excess mortality according to age.
FR	Meteorological agency	Monitors meteorological parameters such as minimum and maximum temperature and humidity and updates these parameters twice a day .	Meteorological agency	Monitors meteorological parameters and attached an alert phase to them.
	Public health agency	Monitors health data such as the activities of emergency services, the rate of admissions to emergency services through syndromic surveillance as well as morbidity- and mortality data at the local and national level.	Public health agency	Monitors health data from emergency services such as number of calls to an emergency telephone number and admissions to the emergency room. Monitors mortality based on death certificate data received.
			NGO	Monitors temperatures, forecasts and the evaluation of them twice a day .
DE	Meteorological agency	Monitors the thermal load each day during the summer and calculates the	Meteorological agency	Monitors temperature and assess the automatic weather warning system.

MONITOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
		probability of the occurrence of heatwaves.		
MK	Meteorological agency	Monitors the meteorological data.	Meteorological agency	Monitors the temperature, humidity and provides weather forecasts.
	Public health agency	Monitors mortality according to sex and age.	Public health agency	Monitors mortality on a monthly basis.
	Emergency services	Monitors the number of calls to the emergency services according to syndromes.	Emergency services	Monitors the number of calls and the amount of people who use emergency services based on their symptoms.
NL	Meteorological agency	Monitors the weather and calculates the chance of a heatwave.	Meteorological agency	Monitors meteorological parameters such as temperature, humidity, UV radiation and calculate the expected chance of a heatwave.
PT	Ministry of Health	Monitor meteorological parameters such as temperatures, ozone levels, Icarus Alert index and UV radiation levels. Monitor mortality data and assess excess mortality. Monitor the demand for health care in emergency services.	Ministry of Health	Monitor meteorological parameters such as temperature and humidity. Monitor the impact of temperature on morbidity and mortality. Monitors the number of calls to the emergency services hotline. Monitors health services such as the amount of beds available.
	National institute	Monitor occurrences in the medical emergency services searches by district.	Meteorological agency	Monitors temperature and makes forecasts.
ES	Meteorological agency	Monitor meteorological variables such as minimum and maximum temperatures expected to five days, recorded before the day of the prediction and threshold temperatures.	Meteorological agency	Monitors the temperature.
	National institute	Daily monitoring of mortality data.	National institute	Monitors mortality and specifically heat stroke mortality.
			Regional authority	Monitors the temperature on a regional level.
CH	Meteorological agency	Monitoring the weather situation and especially the maximum temperatures during the summer months.	Meteorological agency	Monitors the temperature which includes day and night temperatures and assess the heat index.
			Public health agency	Monitors mortality on a consultancy basis.
UK	Meteorological agency	Monitor and forecast temperatures on national and local level including he likely duration of the heatwave, the likely temperatures to be expected and the probability of regions exceeding the thresholds.	Meteorological agency	Monitoring of weather conditions and identify periods of time when the thresholds might be reached.
	Public health agency	Routinely monitor syndromic and mortality surveillance.	Public health agency	Monitors mortality and also syndromic surveillance.

MONITOR				
COUNTRY	NATIONAL PLANS		INTERVIEWS	
	STAKEHOLDER	ROLE	STAKEHOLDER	ROLE
			NGO	Monitors attendance to various emergency events.

Annex 4 –The national heatwave plan and other policy documents

The table below provides a comparison between information from the overview of the national plans and from the key stakeholder interviews regarding other policy documents and their relation to the national heatwave plan.

Country	Overview national plans		Key stakeholder interviews	
	Document	Link	Document	Link
BE	National Action plan Environment and Health (NEHAP)	Evaluates the surveillance of parameters, coordinates and informs environmental and health policy in Belgium	Legislation that requires residential care facilities in Flanders to have a heatwave plan	During the alert phases of the national heatwave plan, the organisational heatwave plans need to be activated
	EU guidelines on ozone concentrations (e.g. threshold value hourly maximum)	Used to inform definition of threshold values		
	Cooperation agreement among Brussels, Flemish and Walloon authorities on the monitoring of emissions and structuring of data (Belgisch Staatsblad 24.06.1994, p.17211)	Determines that the interregional agency is assigned as monitor and is required to inform relevant stakeholders on monitoring activities		
	Constitutional protocols (articles 128, 130, 135) between the national and regional governments on 1) the international notification by Belgium regarding the international health regulations of 11 December 2006 and 11 March 2008, 2) the focal point of the international health regulations. Royal decree of 31 January 2003 on emergency and coordination during crisis situations planning and coordination during crisis situations	Determine that the ministry of health is responsible during the alert phases for coordinating and implementing adequate national measures to limit the health impact of heat and ozone peaks		
FR	Constitutional articles (R121-2-R121-12, L121-6-1) of the Constitution on social action and families	Requires municipalities to set up a register where elderly and people with disabilities can register Requires municipalities to identify elderly and people with disabilities who have registered	2004 law for protecting against heatwaves	Created after the heatwave in 2003 Instructs local authorities and municipalities to put in place a system of heatwave prevention and protection of the public and vulnerable people
	Decree No 2004-926 of September 1, 2004	Determines the terms of collection, transmission and use of nominative data	ChalEx file	Document created by local authorities (spec. Paris) based on the registration of vulnerable people, used in combination with a questionnaire to monitor vulnerable people

Country	Overview national plans		Key stakeholder interviews	
	Document	Link	Document	Link
	The Management plan of a Departmental Heatwave (GCD)	The national heatwave plan is adapted to departmental circumstances and articulates the local organization of the response	Law on the coordination of the heatwave response	Determines that the prefect coordinate activities and response to heatwaves
	Decree No 2015-1446 of November 6, 2015	Integrated Reception and Orientation Services to ensure the orientation of people who accept it to a suitable place of reception (e.g. day care centre)		
	Decree No. 2008-1382 of December 19, 2008 Article R4121-1 of the Constitution on work	Protection of exposed workers to particular climatic conditions		
	Decree No 2005-768 of 7 July 2005	Determines minimum technical conditions for the functioning of institutions who provide accommodation for elderly, including the establishment of an organizational crisis plan		
	Articles D. 312-160 and D. 312-161 of the Constitution on social action and families	Ensures the installation of at least one acclimatized room in all establishments hosting elderly		
	Order of 24 July 2013 Article L.611-3-8 of the Constitution on public health	Determines the conditions for the collection and processing of medical activity data produced by public or private health facilities with emergency medicine		
	Article 158 of Law No. 2016-41 of 26 January 2016 of the Constitution on public health	Development of organisational emergency plans to deal with the influx of victims in health facilities		
	Article L.1435-1 of the Constitution on public health	Determines that regional public health agencies (ARS) are placed under the authority of the representative of the State when an event carrying a health risk may constitute a disturbance public order.		
DE	WHO recommendations on heat-health action plans Hesse HEAT study	Form the basis of the German heatwave plan	WHO recommendations on heat-health action plans Klimzug program, state of Hesse Heatwave action plan in Hesse	Form the basis of the German heatwave plan
			Adaptation Action Plan of the Federal Environmental Agency	Broader adaptation plans and strategies on climate change, of which heatwaves are one aspect

Country	Overview national plans		Key stakeholder interviews	
	Document	Link	Document	Link
			German Adaptation Strategy to Climate Change Strategies for spatial development on climate change by KlimaMoro Berlin Energy and Climate Protection Programme 2030 (BEK) Adaptation to the impacts of climate change (AFOK) Integrated climate protection plan – Hesse 2025	These documents provide a framework for national and other heatwave plans and information for their development
			Population protection and disaster control plan	Provides a legal mandate to the meteorological agency in the context of disasters, of which heatwaves are considered one
			The Occupational Health and Safety Act The Labour Protection Act for employees	Ensure protection of workers during a heatwave
			Contractual agreements among 16 German states	Relates to the heat warning system and the diffusion of warnings
IT	Guidelines for the prevention of the effects of heatwaves on health	Guidelines for representatives of local institutions involved in prevention and response activities to a heatwave		
	Guide to fight forest fires-recommendations for the public	Addition to the national heatwave plan		
MK	Safety and Health at Work Act (Government Gazette of the former Yugoslav Republic of Macedonia No. 92/07	Provides the protection of workers' health during heatwaves	Safety and Health at Work Act	Provides the implementation of measures in the national heatwave plan to protect the health of workers during a heatwave
			Bylaws on crisis management	Supports the development of the national heatwave plan and the implementation of measures
NL	Law of Public Health of October 9, 2008	Determines that municipalities are responsible for the wellbeing of their citizens and need to signal undesirable situations, inform the citizens on risks and answer their questions		
	Guideline medical environmental science from a RIVM working group in 2012	Guideline on health risks which is used to inform the national plan		

Country	Overview national plans		Key stakeholder interviews	
	Document	Link	Document	Link
PT	Decree-Law 137/2013, of October 7	Concerns the registration of organisation and operation of Health Centre grouping	Regulations regarding heatwaves	Determine the role of regional health authorities in the national heatwave plan Detail the role of regional and local level stakeholders Provides the use of regional media
	Decree-Law 135/2013, of October 4	Provides attributions for entities that exercise the power of the health authority	National emergency plan for civil protection	Provides guidelines for the elaboration of other plans at district and municipal levels to protect from all national level risks, including heatwaves
	State Budget Law of the intervening entities that participate in the plan	Provides annual appropriations of financial resources	Organisational contingency plans	Incorporate a heat module to deal with the health impact of heatwaves
	Regional contingency plans	Incorporate a heat module to deal with the health impact of heatwaves		
ES	Order of the Ministry of the Presidency, Order PRE / 1518/2004	Creates the interministerial commission that allows the coordination of activities of involved administrations	MeteoAlerta Spain	Broadcasts weather alerts, including on heatwaves
	Working Groups I, II and III of the Fifth Report of the Evaluation (AR5) of the Intergovernmental Group of Experts on the Climate Change (IPCC), published between September 2013 and March 2014; Framework Convention of the United Nations, in the Kyoto Protocol and more recently in the agreement reached at the Paris summit (COP21, December 2015)	The conclusions of the working groups provide background information used in the national heatwave plan	MeteoAlarm Europe	Broadcasts weather alerts on the European level
			Law banning polluting cars from city centre in Madrid	Measure to reduce air pollution, which can mitigate the health impact of heatwaves
CH	WHO recommendations on heat-health action plans and international studies	Form the basis of the Swiss heatwave plan		
UK	Civil Contingency Act	Provides a duty to category 1 responders to warn and inform the public before, during and after an emergency	Civil Contingency Act	Provides a duty to category 1 responders to warn and inform the public before, during and after an emergency
	Health and Social Care Act of 2012	Resulted in the creation of new health agencies (NHS, PHE) and clinical commissioning groups		

Country	Overview national plans		Key stakeholder interviews	
	Document	Link	Document	Link
		Transferred authority from public health to local authorities at the local level		
	Health and Wellbeing Boards	Work with Local partners on longer term strategic planning and heatwave management at a local level Responsible for strategic needs assessments and Health and Wellbeing Strategies		
	Public Health Outcomes Framework	Contains planning regarding severe heat which is in line with the national heatwave plan		
	Cold weather plan	Similar in style and described as a sister plan to the national heatwave plan but instead of heat the subject is cold weather		
	National Adaptation Programme (NAP)	Sets out actions to address the risks identified in the UK Climate Change Risk Assessment, in which long-term heatwave planning is a key consideration		