



RAMSES

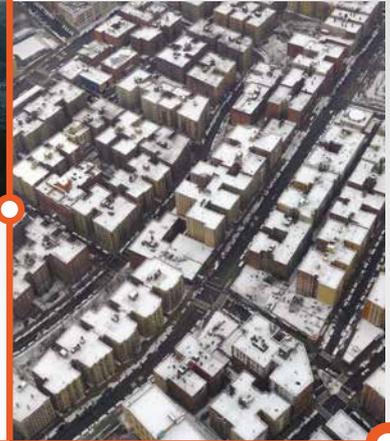
Science for cities in transition

Final publishable summary report

Rio de Janeiro

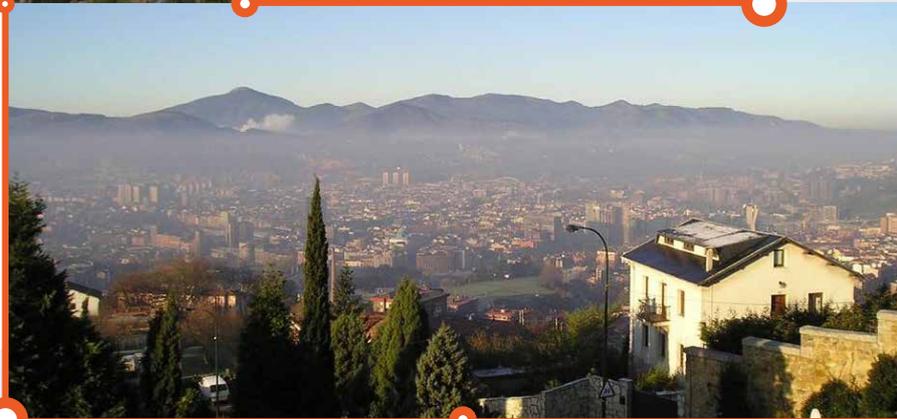


Antwerp



New York

Bogotá



London

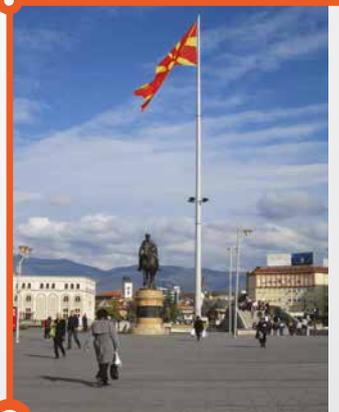


Bilbao



Hyderabad

Skopje



For more information: www.ramses-cities.eu/

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List of abbreviations

ACC	Adaptation Cost Curves
ADB	Asian Development Bank
AR5	IPCC Fifth Assessment Report
CCC2017	Cities and Climate Conference 2017
Climate-ADAPT	European Climate Adaptation Platform
CMIP5	Coupled Model Intercomparison Project Phase 5
CPU	central processing unit
DEM	Digital Elevation Model over Europe
EC	European Commission
EU	European Union
GCM	Global Climate Model
GDP	Gross Domestic Product
GEA	Global Energy Assessment
GHG	greenhouse gas
GVA	Gross Value Added
IFRC	International Federation of Red Cross and Red Crescent Societies
IPCC	Intergovernmental Panel on Climate Change
MENA	Middle East and North Africa
OECD	Organisation for Economic Co-operation and Development
PET	Physiological Equivalent Temperature
RCP	Representative Concentration Pathway
SREX	Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation
UHI	Urban Heat Island
UK	United Kingdom
UN	United Nations
UNISDR	United Nations Office for Disaster Risk Reduction
UrbClim	Urban climate model

An executive summary

RAMSES (Reconciling Adaptation, Mitigation and Sustainable Development for cities) was a five-year project focussing on climate change adaptation planning, including the calculation of climate change-related damage and adaptation costs. Given the overwhelming complexity and diversity of urban centers, rigorous analyses in this context are rare and in most cases not comparable. Therefore, in order to achieve some progress in terms of inter-comparability of approaches and results, and in order to foster action on urban adaptation, the consortium developed analytical frameworks for the implementation of adaptation strategies and measures in EU and international cities. Consequently, the project developed a set of innovative methods and tools that quantify the impacts of climate change and the costs and benefits of adaptation to climate change, thus providing evidence to enable policy makers to design adaptation strategies. It integrates the assessment of impacts and costs to provide a much more coherent approach than currently exists, exploring the balance between top-down and bottom-up approaches necessary to ensure effective policy making in urban areas.

RAMSES delivered: 1) A strategic framing for evidence-based adaptation decision-making. A pragmatic and standardised framework for decision making using comparable climate change impact assumptions, impact and adaptation costs which also takes account of uncertainty. This applies and combines a suite of novel, smart, and unconventional scientific methodologies. 2) Multi-level analysis. As local administrative units, cities traditionally develop adaptation (and more generally sustainable development) strategies from the bottom-up/top-down, that could be aggregated to consider costs at the national,

EU and international levels. 3) Quantification of adaptation costs. A framework for assessment of economic costs and benefits of adaptation, with methodologies developed to consider both direct and indirect costs of climate-related impacts. 4) Policy relevance and acceptance of adaptation measures. City case studies and stakeholder engagement ensured the relevance of the framework for policy-makers and ensured adaptation measures become more acceptable to other stakeholders. The framework was converted into a user-friendly Toolbox for city stakeholders who make adaptation and mitigation decisions and prioritise investment. This Toolbox comprises a Transition Handbook (a step-by-step guide), training materials, and a web-based audio-visual guidance application called on-urban-resilience.eu, which synthesise project results in an accessible way for implementation by city stakeholders.

Overall the project published 38 journal articles (with an additional 10 in press or under review), organised several workshops, conferences, and dissemination activities. In addition to novel scientific approaches and methodological developments, the political and institutional context in case study cities was examined allowed the identification of mechanisms that shape concrete policy making. It became obvious that a shift from pure technical and/or simple cost benefit considerations must occur, and that city stakeholders require a portfolio of options rather than one optimal pathway, with the empowerment of people being a fundamental element in increasing the acceptance of climate change adaptation measures. RAMSES succeeded in creating a variety of valuable scientific and policy-related stimuli which can be built-upon in future projects.

1. A summary description of project context and objectives

Cities are the focal point of many climate change-related challenges. Over 75% of the European Union population lives in urban areas, and this percentage is expected to grow to 82% by 2050 (UN Habitat, 2011). Cities on one hand concentrate cultural, technological, and economic activities resulting in innovation and human wealth, but also consumption of

materials and waste production. On the other hand cities occupy only 2-3% of land and often lie in risk-prone areas, like in low-lying coasts or mountainous regions and, if not properly managed, they concentrate vulnerabilities. Hence urban areas are hotspots of vulnerability to climate change impacts such as flooding, drought and heatwaves (cf. e.g. IPCC-SREX, 2012),

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Globally, cities are still undergoing unprecedented growth dynamics. Between 1950 and 2015, urban infrastructure had to be provided for approximately 500 million new urban residents per decade, new infrastructure will be needed for approximately 700 million future urban residents per decade between 2015 and 2050 (own calculations). This shows the pressing need for sustainable concepts of urban development, but also number of opportunities to design liveable cities, which are in line with climate protection goals and safe environments for urban residents. Addressing climate change and related risks begins in cities, and whilst most of future urban growth dynamics will

take place in smaller cities in the developing world (e.g. GEA 2011, ADB 2017), Europe must still strive, through new smart concepts of growth and development, for a truly sustainable urban future (cf. Walker et al. 2017, Heidrich et al. 2017).

The RAMSES consortium took these challenges as the basis for developing a project that was highly ambitious in terms of its scientific goals. Although climate change-related challenges are increasingly rising up the agenda of urban stakeholders, concrete action and decision-making often suffers from incomplete evidence and or limited knowledge. Questions are often raised regarding the potential impacts on a certain city, what kind of adaptation such impacts would imply, and how costly any adaptation action will be. While local effects of climate change, and the associated costs and benefits of adaptation, vary greatly from one city to another, typically assessment tools are also bespoke to a particular city, so techniques and studies are rarely comparable. However, such comparison is necessary to utilize and distribute available resources for climate risk management most effectively. Therefore, RAMSES aimed not only at the provision of valuable insights for city stakeholders, but developed a pragmatic research approach which allowed the comparison of both top-down (simplified) and bottom-up (more detailed) approaches (cf. Fig. 1). By doing so, new tools for impact and cost assessment were developed, and capabilities of existing tools further advanced.

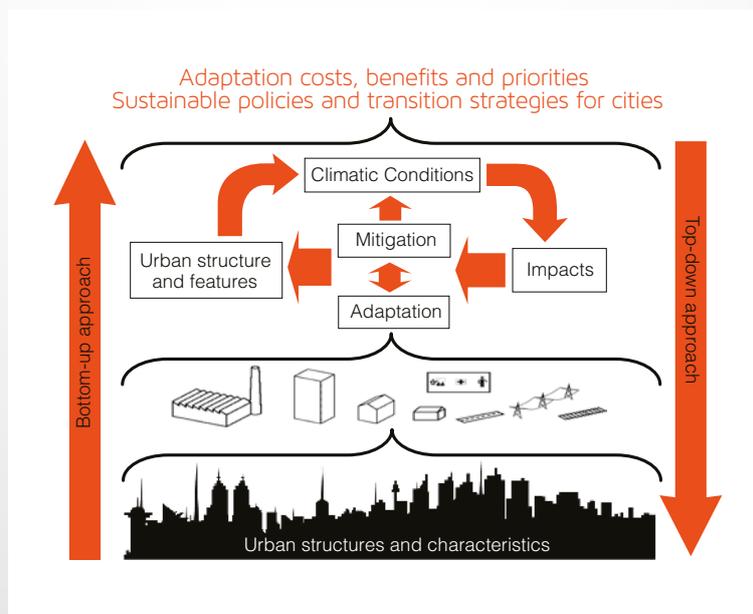


Figure 1: Overarching RAMSES methodology (source: own elaboration, skyline image from Photoshop Graphics 2012).

The consortium as a whole is proud that this shared overarching philosophy was taken up by all partners and maintained during the 5-year lifetime of the project. This commitment made it possible to provide a large number of high-quality final outputs. This overall project philosophy served to achieve the following objectives and goals:

- The development and application of tools to assess climate impacts, vulnerability, and risks in cities that evaluate climate impacts on priority sectors, and provide a rational basis for testing the effectiveness of adaptation strategies;
- New methods to quantify damages and economic costs for adaptation and benefits of climate change adaptation;
- The definition of a taxonomy for architecture, infrastructure and planning, which can be used as basis for the development of approaches for impact and adaptation cost assessment;
- The generation of urban climate projections at appropriate spatial and temporal scales in order to evaluate the effect of adaptation measures on future urban climate;
- The assessment of the environmental, social and economic effects of climate change at sector level, e.g. for health, transport, etc.;
- The identification of general and specific factors forcing cities to successful transitions and develop a transition model which builds on the pathway approach;
- New methods and tools and a Training Handbook tested in city-cases, including Antwerp, London, Bilbao, Skopje, and Paris that allow the discussion of experiences of city stakeholders and lessons learnt through a step-by-step methodology for urban transformations;
- The provision of outputs that inform decision-makers and enlarge databases of socio-economic data related to climate change impacts, vulnerability, and adaptation, e.g. via Climate-ADAPT and the RAMSES Common Platform;
- The creation of concepts for a structured and robust stakeholder engagement to share and communicate the project results, but also, and maybe even more importantly, to inform their development and ensure their applicability in cities in Europe and beyond;
- The publication of a toolbox for policy makers to assess impacts, adaptation and costs for European cities on an intermediate scale of complexity in order to provide assessments on Pan-European city level and for other cities to widely adopt project results.

Through achieving these objectives and goals RAMSES defined cornerstones for future research and generated policy-relevant knowledge which enables city stakeholders to take action on urban adaptation. To achieve this, the consortium overcame a variety methodological issues, such as how to aggregate/disaggregate data at different scales, which types of cost categories or climatological threats to consider. Although not all methodological problems have been solved entirely, the project exceeded initial expectations. For example, it provided climate change scenarios for 100 cities, vulnerability and risk analysis for 571 EU Urban Audit cities and damage and adaptation cost

curves for 600 European coastal cities. During the project 38 journal papers have been published, with a further 2 in press, and 8 under review. The consortium was one of the main organisers of the 2015 ECCA conference in Copenhagen and responsible for the Cities and Climate Conference 2017 at the Potsdam with more than 120 international speakers. In summary, the RAMSES project created a large number of scientific results, finished on time despite delays to deliverables during the project caused by consortium changes, and created a variety of valuable scientific and policy related stimuli which can be considered both in future research projects and in on-the-ground city adaptation planning.

2. A description of the main S&T results/foregrounds

The RAMSES project results focus broadly on six main themes. First, climate change scenarios have been developed for the RAMSES case study cities (in particular Antwerp, Bilbao and London). These were used as an input for impact assessment and cost calculations. Complementary to these detailed model-based outputs, the surface heat island effect for more than 100,000 European settlements has been assessed via a newly-developed empirical model. Second, new methodologies have been developed for cost assessment frameworks in different sectors, considering different levels of detail (top-down and bottom-up approaches). Third, analyses have been undertaken in order

to estimate the role that structural features (typologies) of cities may play in terms of greenhouse gas emissions or urban heat burden. Fourth, a detailed vulnerability assessment methodology was developed for all European Audit cities. Sixth, together with intensive Stakeholder Dialogues, major factors determining how policy makers implement climate change adaptation measures have been assessed. Based on these experiences, the intensive work with case study cities, and the achieved scientific outcomes, a transition pathway approach has been developed which synthesises the various elements of project work. This approach has been tested in Antwerp, Bilbao and London.

2.1 Climate Change Scenarios for Cities

There is increasing recognition of the need for cities to consider the impacts of climate change. Air pollution, flooding, and extreme heat stress are increasingly perceived as problems that may increase considerably if no action is taken. Indeed, climate projections indicate that extreme heat waves, such as the one that occurred in 2003 in Europe, are expected to become the new normal towards the end of the century (cf. e.g. Mueller et al. 2016, de Ridder et al. 2017). The need to consider such threats is increasingly important given that cities are home to the majority of humans (in particular in Europe), and that cities are also particularly vulnerable due to the concentration of infrastructure and economic activity. Little detailed city-scale information has hitherto been available regarding future urban climate, particularly climate projections at the scale of urban agglomerations, which is in part related to the computational constraints facing fine-scale climate models. In order to remedy this, a new urban climate model (UrbClim) has been developed and employed in RAMSES (cf. deRidder et al. 2015).

During the first half of the project the UrbClim model was improved and evaluated for the case study cities, namely Antwerp, London, and Bilbao. One lesson learnt from this exercise was that the model achieves an accuracy comparable to that of existing traditional models, but at a speed that is more than a hundred times faster. As a result, UrbClim is one of the only urban climate models in the World capable of covering

periods long enough (decades) to deduce relevant climate statistics at city scale. During the second phase of the project this model speed was exploited, coupling the UrbClim model to the Global Climate Models (GCMs) contained in the IPCC/CMIP5 archive, and conducting long simulations representing present (1986-2005) and future (2081-2100) climate conditions (considering the RCP8.5 climate scenario). This was done for Antwerp, Bilbao, London, Rio de Janeiro, Hyderabad, New York, Berlin, Almada and Skopje. This was indeed a major computational undertaking, considering that, for any of these cities, we simulated two periods covering twenty years each. Moreover, all of these simulations were run 11 times, i.e. using forcings from 11 different GCMs to account for the uncertainty related to the climate projections. In total, the simulations taken together required a staggering 45 CPU years (fortunately we had access to several hundred CPU's simultaneously), and generated almost 7000 Gigabytes of simulation data. The following main conclusions could be drawn (cf. Fig. 2) :

1. Based on the results for the present, it was found that, overall, urban areas experience twice as many heat wave days as compared to their rural surroundings. This is problematic, as in most countries, heat-health action plans are triggered using background (rural) temperature forecasts only. Consequently, the – often vulnerable – urban populations regularly undergo several heat wave

- When analysing the future urban climate projections, it was found that, towards the end of the century, the number of heat wave days is expected to increase by a factor of nearly ten. This appears to be the case in both urban and rural areas but, given the higher number of urban heat wave days to start with, it means that many cities will be facing one month or more of heat wave conditions each year, on average.

The latter is particularly problematic as in most countries so-called ‘heat health action plans’ are triggered using rural temperature forecasts only.

The improved model has been applied to 102 cities throughout Europe (cf., e.g. Lauweat et al. 2015, Wouters et al. 2013, Zhou et al. 2015, Garcia-Diez et al. 2016), a far higher number than promised in the original project description. Based on the obtained results, it was shown that the average Urban Heat Island (UHI) intensity of these cities is well explained by population density and the mean regional wind speed. The main conclusion here is that cities in Central and Eastern Europe are especially at risk for enhanced heat stress. Complementary to UrbClim, which is a simplified and therefore very fast model operating at the scale of an urban agglomeration and its nearby surroundings, the ENVI-met model was applied (Lobaccaro & Acero 2015). This considers much finer scales, zooming in on a city quarter while resolving individual obstacles such as buildings and trees. (cf. Sect 2.5).

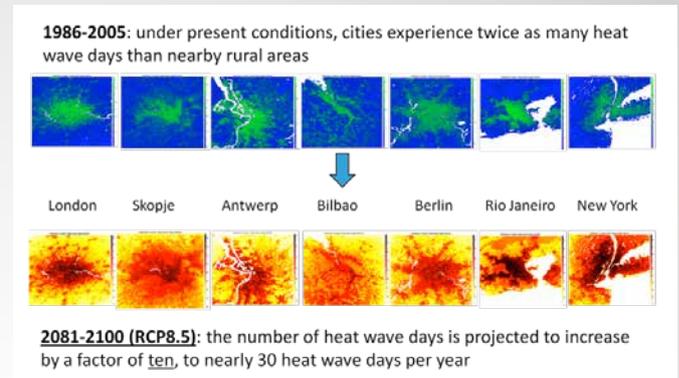
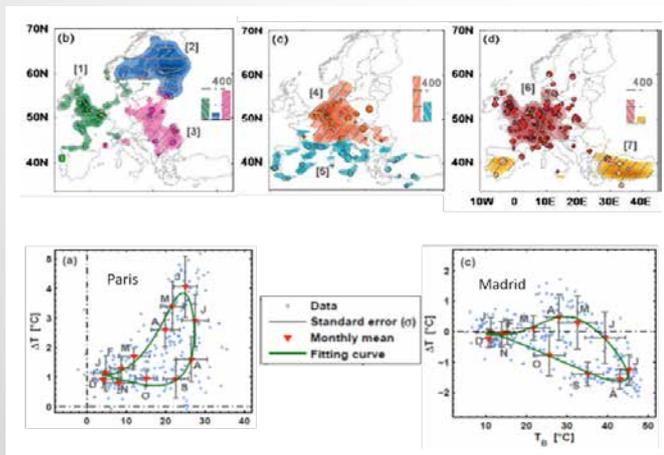


Figure 2: Assessment of current and future heat burden for RAMSES cities (Source: VITO/UrbClim Model).

Complementary to the above approach, a semi-statistical model has been developed to overcome the computational demands of dynamical model runs and make use of increasingly-available remote sensing data (Zhou et al. 2013). Thus, for 130,000 villages/cities in Europe and MENA the so-called surface heat island effect was investigated. By doing so seven typologies for surface heat islands have been identified (Fig. 3). Two types are characteristic for central Europe (e.g. for larger and smaller cities), one type each for northern and eastern Europe, one each for the coastal Mediterranean and coastal northern European regions, and one for the continental southern Europe. These are characterised by the annual cycle of the heat island effect and therefore provide indication how such an effect can be avoided.

Figure 3: Different typologies (clusters) of Urban Heat Island in Europe and in the MENA region (cf. Zhou et al. 2013). The cities show a distinct annual characteristics of heat burden in cities. While in Paris heat burden approaches highest intensity in June for Madrid peak season is in April/May. Moreover, Madrid exhibits a cooling effect during the rest of the year (known as the oasis effect).

This approach has been compared with the output of dynamic model runs (cf. Zhou et al. 2016). A result is that the surface heat island effect can be reproduced, while the 2m air temperature is different. This has to do with the fact that air temperature has a different diurnal cycle as heat storage of the physical infrastructure. Nevertheless, the surface heat island can be understood as a proxy for the air temperature in cities, although a lot of work is still needed to investigate the relationship between surface and air temperature.

2.2 Cost Assessment Frameworks for Damages and Adaptation

The basis of cost assessment frameworks are so-called impact and adaptation functions. They translate climate related threats into the costs of damages, and the costs avoiding them respectively. Moreover, in order to utilise limited public finance resources and mobilise private finance effectively, city governments will need appropriate processes and resources for sound investment planning and execution. Despite this, most cities lack the tools for performing economic assessments of damages, adaptation, and financing options.

Under the RAMSES costing component, existing empirical damage data related to climate change in the context of RAMSES case study cities were reviewed. These, along with activities of stakeholder engagement and analysis, were used to identify gaps in data, methods, and existing knowledge. This information was used to develop a range of methodologies and frameworks to help policymakers make adaptation decisions more effectively and efficiently. Specifically, RAMSES developed both a transferable methodology that allows to measure costs and benefits of climate change and adaptation, as well as an overarching cost assessment framework describing a process for evaluating and financing adaptation planning.

Costing Methodologies

Specifically, RAMSES developed transferable methodologies for generating data on the economic costs of climate change impacts and adaptation in cities. Two directions have been followed, namely a top-down and bottom-up approach. Specifically, RAMSES developed an economic cost bottom-up methodology to assess the impact of specific climate change hazards through different channels of urban productive activity. The methodology is based on the premise that each hazard affects one or more parameters of city production in different sectors, and their overall impact through this particular channel is estimated. This approach allows policy makers to assess various characteristics of urban production, including the flexibility of the productive system in terms of the degree of substitution between labour and capital, its labour intensity, and the relative importance of different sectors in the economy. The methodology was used to measure the city-wide costs of heat stress through its impact on labour productivity for the cities of Antwerp, London, and Bilbao, as well as to compare the effectiveness of different adaptation

measures. The approach starts from the micro-level evidence that, e.g. heat burden induces a decrease in productivity at the individual level and shows how this decrease aggregates into production losses at the macro/city level. We use estimated future urban temperatures and study the costs to the urban economy and the relative benefits of different adaptation measures (cf. Hooyberghs et al. 2017). A high-level description of the model is presented in Figure 4.

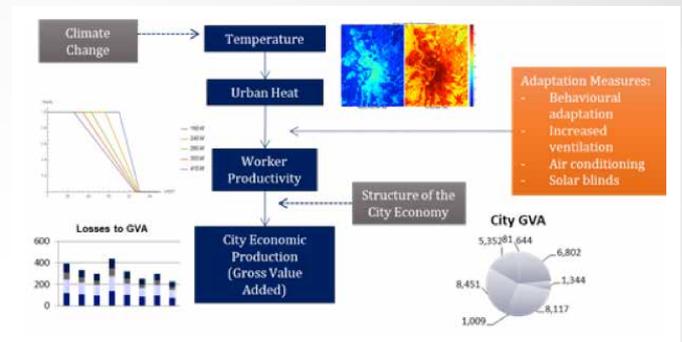


Figure 4: A transferable cost assessment methodology: from global temperature to the urban economy (Hooyberghs et al., 2017).

The results show that the impacts of heat on the urban economy are highly variable and depend on characteristics of production, such as the elasticity of substitution between capital and labour, and the sectoral division of production. Under certain conditions, in a warm year in the far future (2081-2100), the total losses to the urban economy could range between 0.4% of Gross Value Added (GVA) for London and 9.5% for Bilbao in the absence of adaptation. Figure 5 presents an estimation of GVA losses at different points in time. In addition to differences in temperatures, the structure of the city's economy – in terms of the size of different sectors of the economy – has a major influence on the magnitude of damages, with large urban construction sectors being particularly vulnerable to heat effects.

For the three case study cities examined, the averted losses due to adaptation measures such as behaviour change, air conditioning, ventilation, insulation and solar blinds were estimated to range from minus €314 million (i.e. a cost of adapting) to over €23 billion. The resulting cost and averted loss data are available in the RAMSES Common Platform (see Section 3.4.5) for the cities of Antwerp, London, and Bilbao. Finally, the results in terms of

averted losses were further combined with the approximate costs of adaptation for two adaptation measures (air conditioning and solar blinds) collected during the project and used to estimate ACCs and critically judge their use for policy makers (cf section 2.5).

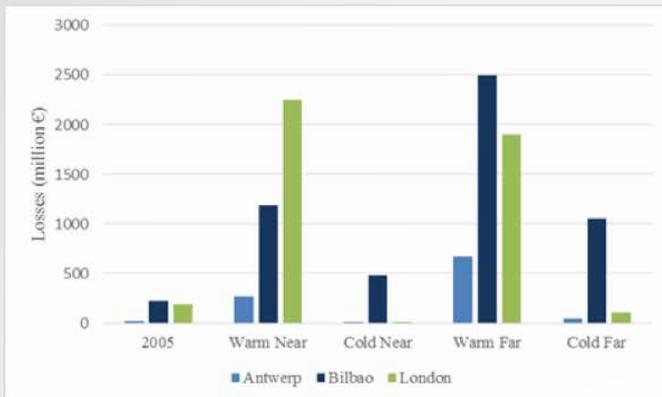


Figure 5: Heat related GVA losses across time through decreases in productivity (years 2005, and warm and cold years in the near – 2026-2045 – and far – 2081-2100 future) (Source: Costa and Floater, 2015, D5.2, Costa et al., 2016).

Because of the characteristics of urban agglomerations, city dwellers are especially vulnerable to some of the health impacts of climate change and city planners are particularly interested in costs related to the expected heat burden. Many of the preventive actions needed to deal with the additional risks of climate change are fairly clear and agreed upon, and basically entail widening the coverage of proven and effective health interventions. Current shortfalls in health and public health systems at the global and European level leave several populations and groups exposed to climate impacts on health. Thus, strengthening basic public health services is critical to the efforts to adapt to climate change, particularly for vulnerable groups and poorer cities and countries of the European Region. In particular, heat-related health effects are likely to exacerbate in these urban settings under climate change, with projected rising temperatures, an increase in frequency and intensity of heat waves in the European Region and an intensification of the urban heat island effect.

In the absence of adaptation, an increase in heat-related adverse health effects is expected. Notwithstanding the increase in the available evidence, there are several major urban agglomerations in Europe for which no study has been published on the local links between heat and health. (Martinez et al. 2015). Under

the RAMSES health component, the projected health impacts of heat under climate change scenario RCP8.5 were estimated for two case study cities: Skopje in Macedonia, and Antwerp in Belgium (cf. Martinez et al. 2016, Martinez et al 2018). Assuming alternatively no acclimatisation and acclimatisation based on a constant threshold percentile temperature, the estimates suggested that without adequate adaptation, mortality would increase significantly in both cities, with a strong influence of population dynamics. This is closely connected with an increase in health related costs (cf. Martinez et al. 2017).

These results were mainstreamed into ongoing policy processes: in the case of the Skopje results, these fed actively into the Skopje City Climate Change Adaptation Strategy, as well as into the Macedonian National Heat-Health Action Plan. In the case of Antwerp, the results were made available to the municipality as they prepare to design local complementary measures to the upcoming regional heat-health action plan in Flanders. Moreover, as it was the aim to assess and estimate the past and future impacts of climate change on health and to translate them to damage costs and adaptation costs an assessment tool, tailored to city needs, and to be integrated into the RAMSES toolbox (cf. Section 3.5). In terms of health related costs two observations clearly emerging:

- most studies on the cost of health damage of climate change showed steep health costs of climate change impacts in the absence of adaptation; and
- most studies on the cost, cost-benefits and/or cost-effectiveness of health adaptation showed high health benefits per unit invested, with higher returns the earlier the action.

In summary, despite its shortcomings, the existing evidence clearly indicates that more resources need to be allocated to averting the health impacts of climate change, particularly in the poorer countries, which suffer from the highest vulnerability and the least climate resilience.

The micro-scale approaches applied in the RAMSES project were complemented by an empirical approach which was based on theoretical considerations. This has been done for coastal floods and winter storms, for example (Prahl et al. 2015, 2016, Böttle et al. 2016). Many climate related impacts on cities have the character of extreme weather events. Thus, in order to assess the monetary impact and adaptation options, one needs

to know the likelihood of a natural hazard and the damage costs it causes. Damage curves or functions then provide the typical damage that needs to be expected from a natural hazard of

given magnitude, i.e. how disastrous it would be. Accordingly, combining both one can estimate how likely an event with certain damage is (see Fig. 6).

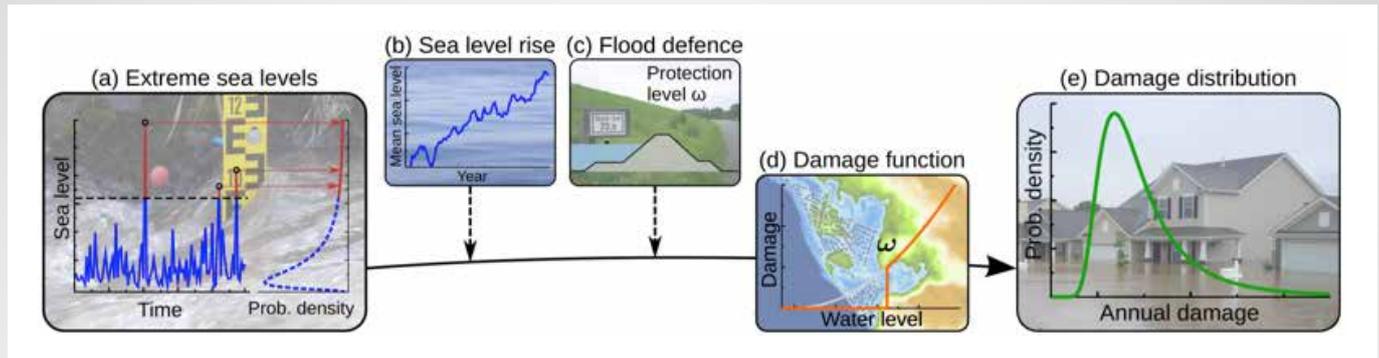
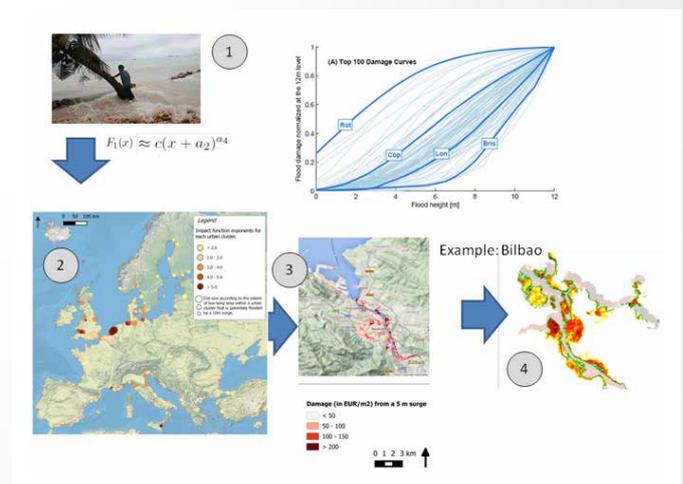


Figure 6: From extreme sea levels to damage. (a) The analysis of extreme sea levels provides parameter estimations for the generalised Pareto distribution. (b) The distribution of sea levels is influenced by mean sea level rise. (c) Flood defence measures, such as dykes, set the threshold below which any damage is prevented. (d) The distribution of extreme sea levels is combined with the corresponding damage via a damage function, providing the total damage in the region under study at a certain maximum flood level. (e) From the resulting distribution of total annual damage the expected annual damage and its standard deviation can be derived, (Photographs: “Ilmpegel Ilmenau” by Michael Sander (2006), “Sea” by Dedda71 (2008), “Kilometermarkierung Deich” by Georg HH (2006), and “Nashville Flood” by Eric Hamiter (2010) from Wikimedia Commons – CC:BY-SA), after: Boettle et al. 2016.

Figure 7: Based on empirical considerations, existing land-use data and unit costs for infrastructure damage curves for European coastal cities have been derived (step 1). It has been shown that damages show a power law behaviour. The exponent (a4) serves as an indicator for the vulnerability to sea level rise, while the size of the bullet indicates the potentially inundated area (step 2). Damage data are available for 600 European cities. As the developed approach considers also land-use and elevation an automated methodology has been developed which calculates also costs for coastal adaptation (step 4). Also these adaptation cost curves are available for 600 European cities (cf. Prah1 et al. 2018).

Damage curves and the resulting costs have been estimated according to existing land-use and unit costs for existing infrastructure. It was analytically derived that for coastal floods the damage always increases faster than the sea-level rises (Boettle et al. 2016) while the intrinsic (relative) uncertainty decreases with sea-level rise. This insight has a general quality since it only relies on few plausible assumptions, with a broad applicability to various other hazards. However, in order to be able to make an assessment in absolute terms, actual damage cost curves or functions are required (Fig. 7). Therefore, based on an automatized methodology, a library consisting of coastal flood damage curves for 600 European coastal cities has been systematically assembled on the level of intermediate complexity from a variety of freely available data sets, including orography, land-cover, and land-use (cf. Prah1 et al. 2018). These curves can be consulted in the RAMSES Common Platform (<http://www.ramses-cities.eu/common-platform/>) (cf. Sect. 3.4.5) and have been uploaded for open data purposes and will be of use for



other researchers, practitioner, and municipalities.

In addition, the work includes so-called protection cost curves, which analogously give an estimate of the costs necessary to protect the city via dikes against a flood of certain maximum level. Such curves are unprecedented beyond the case-study level, in particular for the large set of 600 European coastal cities considered here, and can be a starting point for cost-benefit analyses (cf. also Fig 7). In the context of dike cost estimation,

the RAMSES consortium was also able to empirically support the so-called unit cost assumption (Lenk et al. 2017), basically stating that constructing a dike of 10km length and 1m height costs the same as one of 5km length and 2m height. However, the intrinsic uncertainty of such adaptation costs is large, i.e. the range required to cover 95% of uncertainty, is given by multiplying and dividing the cost estimate by a factor 3.

Certainly, the damage function approach also works for other climate change intensified natural hazards. In particular, a storm-damage model inter-comparison was performed (Prahl et al. 2015) indicating that it makes a fundamental difference if one aims at asserting the wind-damage relation from the full range of events or from only the few largest events. If the data are known to be representative of the extremes, the latter and more commonly used approach is likely to provide good results, whereas the former approach offers more insight

into the damage characteristics in particular for regions with fewer observations and either scarce or no data on extremes. The range of model performances also suggests the intrinsic uncertainty (Prahl et al. 2012).

Theoretically, comparing the damage functions for different hazards (flood, storm, health), it was possible to identify common properties and to develop a unified approach (Prahl et al. 2015, 2016) and thereby to generalize the concept of damage functions. In simple words, the damage function for a city (macro-scale) is the superposition of damage functions of constituent units, such as buildings (micro-scale). As plausible for coastal floods, each building has its own threshold beyond which damage starts. Thus, mathematically, the city damage function is given by the convolution of a building damage function and threshold distribution. This generalization opens the perspective to assess other cases which so far could not be considered.

2.3 City Benchmarking by Analysing Structural Features

Achieved results indicate that structural features of cities may have an influence on urban climate and subsequent impacts, but may also drive further climate change. Consequently the RAMSES consortium investigated also structural aspects. The first approach analysed city densities and urban carbon dioxide emissions from cities. Due to lacking data for Europe this has been done for North-American cities (cf. Gudipudi et al. 2016). The results show that the total emissions (i.e. the sum of on-road and building emissions) decrease starkly with population density on a per capita basis and population density exerts a higher influence on on-road emissions than buildings emissions. From an energy consumption point of view, the results suggest that ongoing urban sprawl will lead to an increase in on-road energy consumption and therefore stress the importance of developing adequate local policy measures to limit urban sprawl. Consequently, to make cities more climate friendly one could apply a redensification strategy. Nevertheless, a densification of cities represents a conflicting target. As Zhou et al. (2017) pointed out urban heat burden clearly depends on the city structure as well. Using anisotropy and density measures (fractal dimension) and considering city size of 5000 European cities, clear conclusions can be drawn in terms of the mitigation of urban heat burden. In general smaller cities, more open and stretched cities perform better in terms of a mitigation of urban heat load, although

the different factors have different regional relevance (cf. Fig. 8).

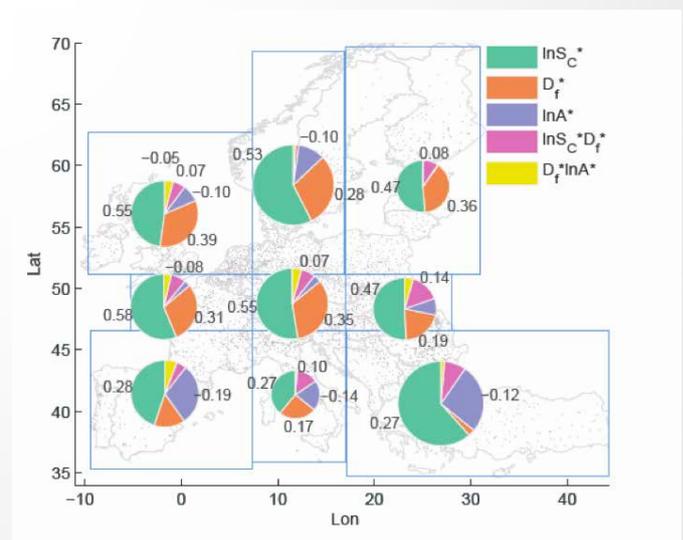


Figure 8: Influence of structural city features on urban heat load depending on the location of a city. While the size of the city ($\ln SC^*$) is always most important the anisometry ($\ln A^*$) is more important in the Mediterranean regions. This can be interpreted by the fact that in this region cities are located along the coasts and being additionally cooled, e.g. by the sea breeze. The fractality (D_f^*) is most relevant in central or northern Europe (Source: PIK/unpublished)

These results show that simple approaches and measures are likely to imply conflicting targets and usually do not solve climate change related problems in cities. For real sustainable cities we have to think out of the box, for example a densification under a parallel implementation of vertical gardens. The city benchmarking for European cities indicating their ecological performance provided further hints for a future design of sustainable cities (cf. e.g. Gudipudi et al. 2018).

In terms of emissions, cities in OECD and Developing Countries also have been compared by applying scaling analysis. It was found that in developing countries large cities emit more CO₂ per capita compared to small cities. The opposite was found for cities in developed countries (Rybski et al. 2017). These findings suggest that from the climate change mitigation point of view efficiency-gaining technologies should be implemented in cities in developing countries. This outcome is also supported by introducing the “Urban Kaya Relation” (Gudipudi et al. 2017). It represents the city extension of the well-known Kaya Identity which combines population, gross domestic product (GDP), energy consumption, and CO₂ emissions. The analysis indicates that the better CO₂ efficiency of large cities in developed countries is mostly due to the so-called carbon intensity, i.e. large cities in developed countries are more efficient in terms of emissions per energy consumption. In addition, if the GDP production doubles also the energy consumption would double. The latter can be interpreted as “infrastructure lock-in”, i.e. the existing infrastructure in OECD cities are assumed as already efficient enough and is therefore it is only changed with a slow speed. In developing countries two other factors dominate the performance, namely that large cities are more productive in terms of GDP per capita and less efficient in terms of emissions per energy consumption. This implies that these cities have some leap-frogging potential, which calls for an intensified international cooperation in terms of technology transfer.

In order to facilitate the design, evaluation and monitoring of measures being deployed to strengthen urban resilience

RAMSES provided guidance for assessing the quality and efficiency of architecture and infrastructure in terms of adaptation and mitigation actions, working towards the development of a taxonomy of resilient architecture, infrastructure and urban environment indicators (cf. also e.g. Tiwary et al. 2016). Resilience frameworks and corresponding indicators that are available to assess architecture and infrastructure resilience today were identified (Kallaos et al. 2014a). Analysis show that resilience assessment is in its infancy, but progressing rapidly. The derivation of a methodology to assess resilience relies heavily on which concept definitions are selected (Pickett et al. 2004), the type and scale of the system of interest, as well as the scope of the boundary conditions. Cost effective solutions involving resilience must simultaneously balance site-specific social, technical, programmatic and environmental conditions, as well as economic ones. This concept is clearly challenging to operationalise, as evidenced by the lack of working evaluation and monitoring criteria. In addition the contribution of architecture, infrastructure and urban planning measures to climate change mitigation and adaptation in cities and urban environments was summarised (Kallaos et al. 2015a). The analysis is based on planning documents gathered from the RAMSES case study cities (Antwerp, Bilbao, Bogotá, Hyderabad, London, New York, Rio de Janeiro, and Skopje), academic literature, and scientific reports.

Finally, a taxonomy of indicators and measures for resilient architecture and infrastructure was presented (Kallaos et al. 2015a), which can be used by cities in their efforts to create more robust strategies in the face of climate change. The measures and indicators are divided into different classification systems based on an array of attributes, allowing for a more flexible and customisable approach to their organisation. The taxonomy was developed in cooperation between RAMSES researchers and city representatives, and focuses on structural and physical adaptation options for blue, green, and grey infrastructures, to support cost and impact assessment in the RAMSES project.

2.4 City-scale Vulnerability and Risk Assessment

In order to effectively plan and budget for a transition to increased resilience, cities must first understand the level of

risk they face from current and future climate-related hazards. These analyses, provide quantitative assessments of the

locations, scale, and nature of climate risks faced in urban areas. Risk is a function of hazard, vulnerability, and exposure; hazard can be defined as a potentially damaging physical event, such as a flood or heatwave and future changes in the severity or frequency of such hazards are driven by climate change. Vulnerability, “the characteristics of a group in terms of their capacity to resist” (IFRC, 1999), and exposure, “the degree to which a system is exposed to significant climatic variations” (IPCC, 2001) are governed by socio-economic, land-use, or infrastructure changes.

The quality and level of detail of such risk assessments is contingent, however, on the availability of, quality of, and access to data. There are many EU-wide or global datasets which provide information on both the climate hazard, and the exposure and vulnerability aspects of risk. Datasets such as Urban Audit, Globcover30, EU DEM, European Climate Assessment & Dataset programme, or the WorldClim climate observations give some of the necessary information but with a limited number of variables or reported at low resolutions. Some countries and cities, however, have bespoke datasets on climate hazards, vulnerability, or exposure, which could allow more detailed analysis. Two approaches were developed in RAMSES, therefore, to provide risk assessment tools that take advantage of ‘the best available’ data, providing a transferable and comparable platform for risk assessments:

1. A top-down, data-driven indicator approach identify risks across all 571 EU Urban Audit cities.
2. A bottom-up detailed ‘systems-based’ assessment of risks for selected case studies.

The top-down approach was developed to assess future changes in risk from heat-waves, droughts, river flooding, and pluvial flooding in European cities using widely-available datasets. Climate hazard simulations for river flooding, heatwaves, and droughts, were driven with model outputs shown for Low (10th percentile of all climate model runs), Medium (50th percentile) and High (90th percentile) scenarios. A low-resolution (25m) pluvial flood model of every Urban Audit city was developed using the CityCAT model to assess potential pluvial flooded area of each city for a given return period (Guerreiro et al, 2017, 2017a). Alongside hazard simulations, measures of vulnerability and exposure in each city were estimated from a large number of qualitative and quantitative data, including population,

sensitivity, and adaptive capacity factors.

The results from the high-level analysis show a large spatial variation in hazard severity across Europe, and between the various impact scenarios. Figure 9, for example, shows the change in both the number of heatwave days across the 571 cities, but also the maximum temperature experienced during a heatwave event. It can be shown that whilst the number of heatwave days increases mostly in the Mediterranean cities (with as much as a 60% increase in the High scenario), the biggest increase in the severity of heatwaves is in central Europe. In the High scenario, the severity of a heatwave increases by as much as 14 degrees Celsius, challenging the ability of these cities to adapt to such climate extremes. Changes in pluvial flood risk are shown to vary considerably between cities; with the same increase in rainfall producing very different changes in flooded area in different cities, highlighting the need for other local-scale processes to be understood with place-based knowledge.

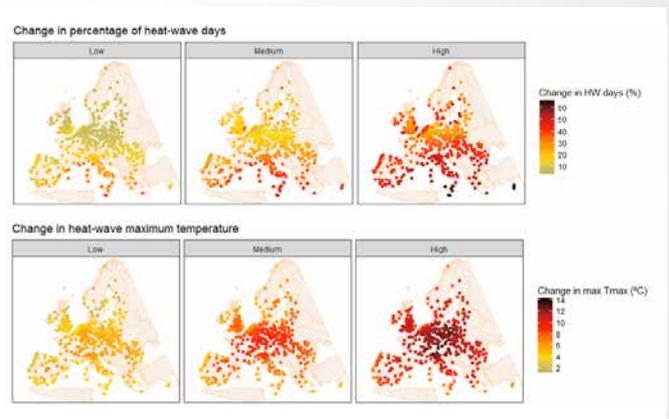


Figure 9: changes in both heatwave days and heatwave temperature for the Low, Medium, and High scenarios across the 571 EU Urban Audit cities.

Comparing climate risks, the high-level analysis shows that droughts and floods are spatially- variable and climate model dependent, with droughts in the Low impact scenario mainly affecting Southern Europe and river flooding mainly impacting on North-west Europe (particularly the British Isles). In the High impact scenario, however, most European cities show increases in both drought conditions and river flooding, with Southern Europe moving to a fundamentally different climate showing future droughts up to 14 times worse than the ones in the historical period.

Alongside the high-level analysis, RAMSES also developed city-scale methods for climate risk assessment. It is at city-scale where adaptation planning takes place, so the bottom-up city-scale analysis included simulations of both impacts and adaptation options. After discussion with stakeholders in our key case study cities of London, Antwerp, and Bilbao, most of the city-scale analysis focussed on the simulation of impacts from pluvial flooding caused by extreme rainfall. Urban areas, which have an increasing number of extreme precipitation events and high levels of impermeable surfaces (leading to reduced natural drainage) are likely to face higher risk of surface water flooding under climate change (EEA, 2012).

Future vulnerability of cities to climate change is shaped by their operation as a system of interdependent components and it is the examination of these spatial patterns of vulnerability and of climate change impacts that will allow city planners, engineers and other organisations to start to map the most vulnerable spatial locations within cities. The IPCC Fifth Assessment (AR5) identified the complex nature of climate vulnerability in urban areas (Revi et al, 2014) making it clear that climate change will impact a large cross-section of urban functions, infrastructure, and services, with such impacts occurring both at the location where the climate threat is experienced and, via interdependent networks of resource supply, in other more remote locations (Seto et al., 2012).

In large metropolises such as London, transport links support daily commuter flows from surrounding areas and the movement of goods. As such, any impacts from extreme weather events on transport infrastructure in a city has the potential to have knock-on effects on city populations and across multiple economic sectors. These impacts can be both direct (in terms of damage to the infrastructure itself and the cost of reconstruction) and indirect (in terms of the disruption to the functioning of the urban economy as the result of the damage). RAMSES looked at ways of assessing the direct and indirect impacts of extreme rainfall events and pluvial flooding on the transport networks in cities, developing tools and models to estimate the economic cost of such disruptions.

The modelling in RAMSES linked simulations of pluvial floodwater depths from the CityCAT model, with spatial information on the location of transport infrastructure in the urban area. Development work during the project significantly-improved the capabilities of CityCAT to include sewerage and drainage networks, moving rainfall events, and large modelling domains (covering the whole 1500m² of London). The impacts on the transport network were

calculated using a set of damage functions which linked water depth to the speed of road or rail journeys along flooded links (see Pregolato et al, 2017a,b, Guerreiro et al. 2017). Combining this with a knowledge of the number of commuters travelling on a particular journey allows the calculation of the total delays experienced during a given flood event, and therefore an estimation of the total cost of disruption. Figure 10 shows the analysis framework used to calculate the risk to transport disruption from pluvial flooding.

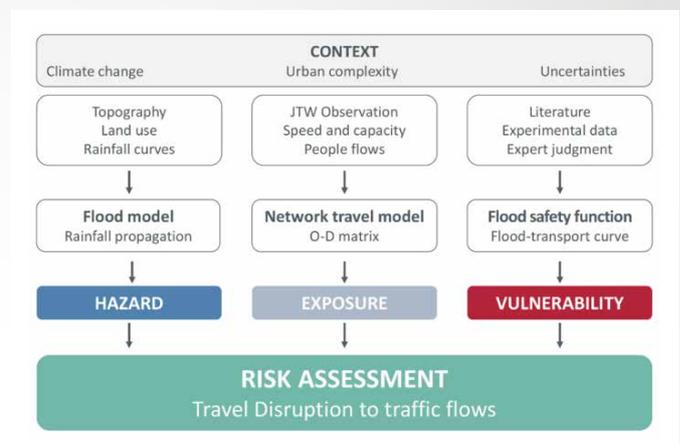


Figure 10: Methodology for calculation of the risk of disruption to transport used in RAMSES. Hazard, exposure, and vulnerability are combined to give the overall risk, which is consequently a product of a number of urban characteristics, such as topography, climate, land-use, infrastructure location, and driver behaviour.

The first order cost of such disruption only tells part of the story, as indirect impacts can often be as large as the initial disruption. By using Input-Output tables, which estimate the amount of interaction between economic sectors, an estimation of the second order costs to business can be made. For London’s economy, work in RAMSES showed that first order costs of disruption to rail passengers, in terms of loss of productive time, for an extreme rainfall event (1 in 200 years) could be around £188m without adaptation. Second-order effects from the same event could total €198m.

RAMSES explored city-scale adaptation options that could be used to reduce the cost of such disruption. By thinking of impacts in terms of a Source-Pathway-Receptor approach, various green, grey, and soft adaptation measures were identified. Green adaptation could involve additional greenspace in the city to soak up or delay floodwater, grey adaptation could involve protecting or moving key infrastructure, and soft adaptation

could involve improvement management or information for urban dwellers. By thinking of climate impacts in a systematic way, the effectiveness of various adaptation options can be assessed at city scale.

Simulation for London showed that green adaptation has the potential for limited reduction in the impacts of extreme events on transport networks, but even a comprehensive roll-out of green roof and permeable paving across the entire urban area would lead to a 54% reduction of risk to road users. The existing green infrastructure in London is shown to have an effect of reducing flood risk to the road network by 20%, or contributing to reduction of a minimum of €0.46m per rainfall event in costs of flood disruption on commuters travelling by road. The benefits of green adaptation in reducing the indirect costs of flooding are shown to be worth up to €1.29m in averted disruption for 1-in-100-year rainfall event with a

comprehensive roll-out of roof storage and permeable paving.

Integrated modelling of the type developed in RAMSES requires a substantial effort, but it is essential to understand long term climate risks and interactions between different sectors which influence indirect climate impacts. Before the type of detailed city-scale analysis undertaken in RAMSES can become routine across the EU, however, cities and nations will need to routinely collect and make available more high resolution data. This will need to be complemented by continuous dialogues between city stakeholders and researchers to enable genuine co-development in order to build the capacity to fully exploit the rich information urban integrated assessment can provide. Moreover, such analysis can help bring stakeholders together to develop a common understanding of processes and consequences of climate change. This collective understanding is essential to managing global environmental change rather than becoming its victims.

2.5 Investigating Adaptation Options/Comparison of Top-Down and Bottom-up Approaches

RAMSES investigated adaptation options, also from various points of view. For this purpose the concept of adaptation cost curves (ACC) has been developed (cf. Fig. 11). As an example it was applied for microscale adaptation in cities, i.e. by calculating costs and benefits of installing air conditioning and solar blinds and estimating ACCs for the RAMSES focal case study cities. In addition adaptation cost curves have been estimated for the implementation of coastal protection measure of variable height. Generally speaking ACCs have the advantage of being visually easy to read. The height of the column is the cost-benefit ratio. As long as the cost-benefit ratio of any measure is lower than unity then the measure is estimated to provide more benefits than costs generated. Moreover, the area of each column corresponds to the costs (i.e. cost-benefit ratio \times averted loss), (cf. Fig. 11).

Thus, reading the ACCs one can easily infer a set of relevant quantities to assist decision makers. Nevertheless, there are also important problems when basing decision making on ACCs. The representation of aligned columns of adaptation measures can be misleading since it suggests additivity: for example, that implementing the top three measures would

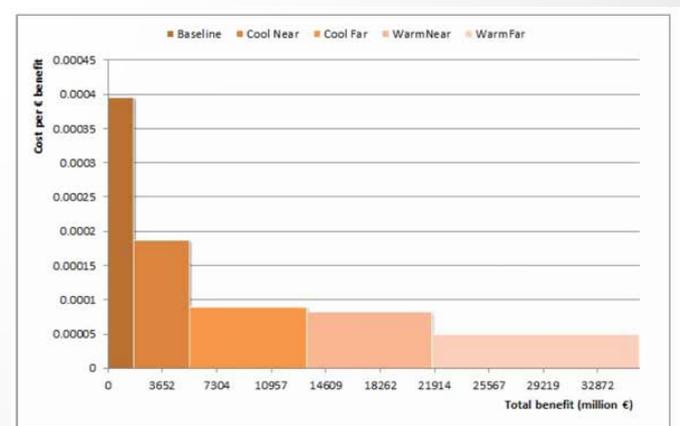


Figure 11: Example for an adaptation cost curve for solar blinds: Bilbao, five years.

avert the specific, cumulative loss. On the contrary, ACCs only compare individual measures against the others and – contrary to what they suggest – combinations are not represented. Moreover, in some situations a clear message about a “best” adaptation measure might be desired, which ACCs are not meant to provide. The decision-maker needs to be clear about

the planning horizon and define it beforehand, since it plays a crucial role in the comparison of costs and benefits. Thus, a decision maker should be assisted during the interpretation of adaptation cost curves. In addition, ACCs represent only one way to compare costs and benefits of adaptation measures. They should not be used as a single decision-support tool, but be complemented with alternative representations, such as optimal adaptation or amortization (cf. paper Prahel et al. 2017).

Another approach followed in the RAMSES project was a more detailed analysis of the roles of changed infrastructure in regard to urban climate development. Particularly, we evaluated the impact of adaptation actions on local climate conditions, focusing on the implementation of urban green infrastructure as a heat mitigation measure. At the scale of an entire city, model simulations suggest that vast amounts of vegetation are required in order to noticeably reduce the urban heat island effect. For instance, increasing the amount of vegetation in Antwerp from its current value (approximately 25%) to 60% everywhere would lead to a mere average cooling of around 0.6 °C. Furthermore, when considering relatively big park areas such as Antwerp's central park, the cooling effect is limited very much to the nearest areas only. Hence, at the scale of an entire city, the effect of vegetation on air temperature appears to be limited, unless the percentage of urban vegetation is radically (unrealistically) enhanced.

While this may appear somewhat discouraging at first, we also found that vegetation has a potentially very considerable favourable effect on local thermal comfort. Indeed, vegetation definitely does have a strong impact on local climate, especially when also accounting for the influence of radiant exposure that comes with the shading effects of trees. To address this, simulations were conducted with the ENVI-met microscale model, allowing to investigate such local effects with a high level of detail, owing to its very fine spatial resolution. Importantly, this model also allows the calculation of advanced human thermal comfort indices such as the Physiological Equivalent Temperature (PET).

A simulation study was conducted with ENVI-met for Bilbao, to compare different local urban greening scenarios to improve outdoor thermal comfort conditions (Acero & Herranz-Pascual 2015). The evaluation was performed in three typical urban street canyons characterized by different geometric proportions, and evaluating several urban greenery scenarios in typical summer day conditions (Figure 12). For each scenario, the mean radiant temperature, relative humidity, air temperature, surface temperature and wind speed were analyzed using the ENVI-met model (Lobaccaro & Acero 2015). The study quantitatively confirms that the vegetation elements such as grass, green roofs and trees, improves the thermal comfort at pedestrian level. It was found that incorporating trees and grass in the considered street canyons achieved a PET reduction of up to 10°C.



Figure 12: Visualisation of the green infrastructure based heat-reducing measures that were evaluated in different settings in the city of Bilbao.

As a result, it is fair to conclude that applying vegetative measures inside urban street canyons can be a relevant climate

change adaptation strategy when designing liveable public spaces and/or walkable areas. The vegetation elements that

look more promising are trees, preferably aligned, which provide local benefit, while grass can affect heat accumulation and help to maintain an adequate surface temperature. Considering the above results, our results plead for a judicious use and design of urban green infrastructure, putting the vegetation where it most efficiently reduces exposure to heat stress, such as e.g. in green cycling/walking corridors.

Finally, RAMSES engaged in comparing existing model (top-down/bottom-up approaches) approaches for impact and cost

assessment. Such a model comparison was extremely ambitious as most of the approaches are still under development and vary broadly in terms of the analytical target and necessary input data. However, results for the coastal flood damage in London indicate that both approaches lead to congruent (comparable) cost curves (Fig. 13), i.e. under rescaling with only 3 parameters the curves become identical (Rybski et al. 2017a). This implies that not in all cases, particularly if comparable results for a large number of cities are needed, detailed analyses need to be undertaken.

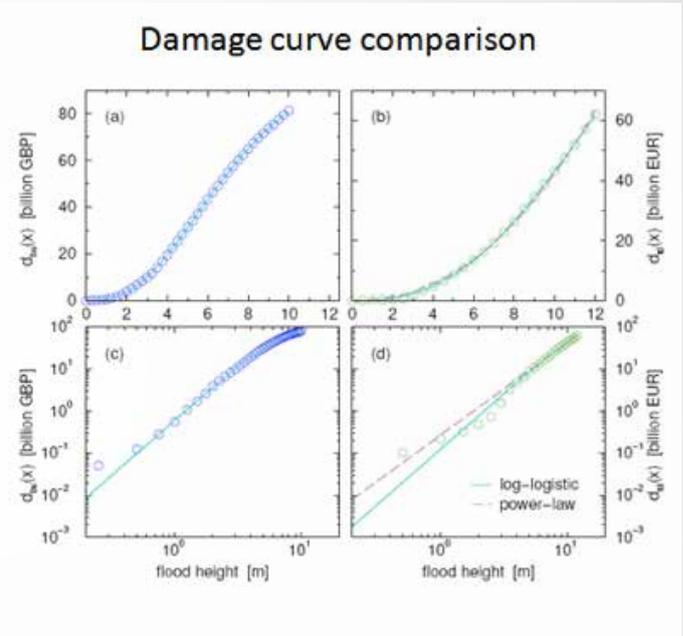
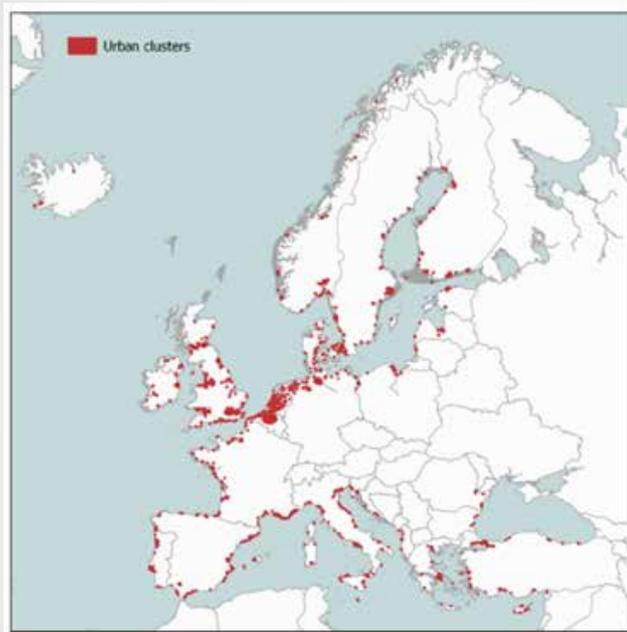


Figure 13: Left: Urban clusters with calculated damage and adaptation cost curves (top-down). Right: Damage cost curves for hypothetical floods in London. (a) and (c) Bottom-up damage cost curve as obtained from Dawson et al. (2011) (billion GBP, year). (b) and (d) Top-down damage cost curve as obtained from Prahel et al. (2017) (billion EUR, 2016). The damage is plotted against the flood height in meters. While (a) and (b) are in lin-lin scale, (c) and (d) are in log-log scale. In terms of the general behaviour both approaches are comparable. However, more detailed investigations are needed in order to assess whether the approaches can be mutually substituted. Nevertheless, the top down-approach can provide relevant much faster and therefore foster adaptation.

2.6 Development and Validation of a Transition Model

The RAMSES project developed a novel approach to stimulate European urban strategies for transition towards more sustainable urban development and resilient cities. One important aspect for adaptation planning and the transitions

to local resilience is flexibility for dealing with uncertainty. Adaptation requires multiple actions tiers to be deployed and implemented which are managed sequentially over time and supported by various methods and tools. In this

context, RAMSES proposes the pathway approach to stimulate European urban strategies for transition. The RAMSES transition model includes elements to become a decision support tool for stakeholders managing sustainability, resilience and climate change adaptation. Two main challenges are addressed by the model: (i) identifying the key components of the pathway (which are already mentioned in the literature); and (ii) defining a step-by-step methodology for its design (different authors describes superficially the pathway approach and therefore there is a lack of a clear step-by-step methodology proposal).

The step-by-step methodology could be implemented with different level of detail: it can be applied quickly with less resolution (high level adaptation pathway), without existing empirical data or information and involving a small group of stakeholders; or it can be applied with high specificity and high resolution to develop a detailed adaptation pathway.



Figure 14: Adaptation Pathway approach followed in RAMSES (Mendizabal et al., 2017).

The pathway design methodology contains 5 general steps: define objectives, pre-identify an adaptation options list, develop adaptation pathway alternatives, recommend an

adaptation pathway, implementation and monitoring (cf. Mendizabal et al. 2017, 2017a). These general steps are composed of the following sub-steps (see Figure 14):

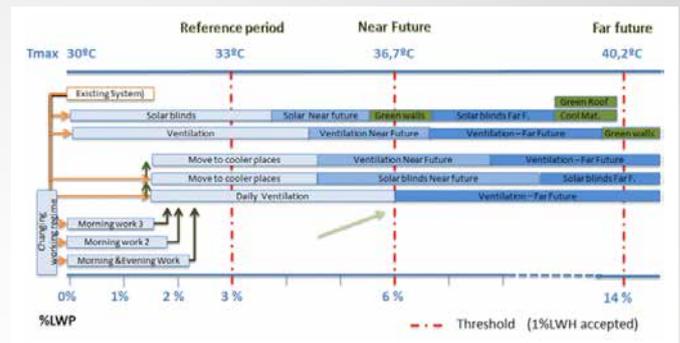
- Analysis of the system (vulnerability & risks) and threshold definition (for the general step “objectives”);
- Review existing plans to identify adaptation assets, identify new options that complements the previous ones and characterise the adaptation options (for the general step “adaptation options”);
- Group options, assess effectiveness and efficiency, sequence over time and identify tipping points (for the general step “develop pathway alternatives”);
- Prioritisation and ranking (for the general step “recommend pathway”);
- Mainstreaming and monitor indicators (for the general step “implement and monitor”).

This step-by-step methodology has been validated and received relevant feedback from two workshops and a pilot application: The validation was carried out in an open Stakeholder Dialogue and a closed workshop with invited participants from different sectors and institutions of the city of London as well as other municipalities (in collaboration with the London Climate Change Partnership). The Antwerp pilot case analysed the heat effect in health and work productivity. Three exposed elements (individuals, buildings and city) and the relationship between them were considered. Two key impact chains have been analysed: heat to human health (considers mortality & morbidity impacts due to outdoor thermal comfort) and heat to productivity (takes into account school & work loss productivity due to indoor thermal comfort). In Bilbao experiences from the other two cases were presented to the city adaptation committee. It decided to apply the adaptation pathway approach in the near future. This showed that it is useful also an early stage of adaptation planning.

2.6.1 Building scale Adaptation Pathways for the city of Antwerp

Different alternative adaptation pathways were developed and proposed for each level (building and city scales) (see Figures 15 and 16).

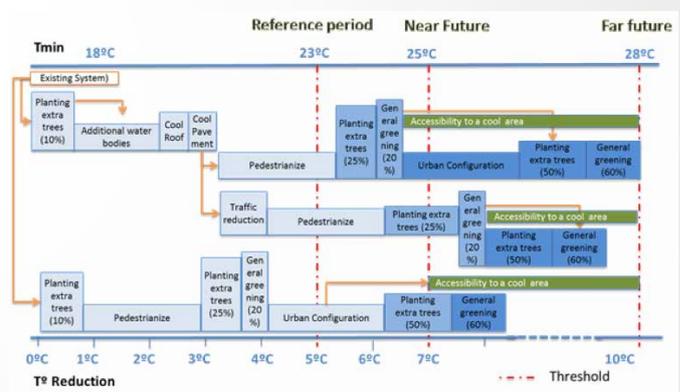
Figure 15: Building Level Adaptation Pathway in Antwerp in which all the adaptation alternatives are included and different pathways are illustrated (with the arrows). In the bottom part the lost working productivity (LWP, %) is presented and in the upper part the maximum temperature values in different time periods (reference, near future and far future). The adaptation options that are in light blue need to be implemented as soon as possible. The darker blue means that the adaptation options needs to be implemented in the near future. The dark blue represents the adaptation options that need to be implemented in the far future. For the adaptation options in green it has not been assessed their effectiveness in LWP but their effectiveness in air temperature reduction is given.



2.6.2 City Level Adaptation Pathway for the city of Antwerp

In addition a City Level Adaptation Pathway in which all the adaptation alternatives are included and different pathways are illustrated was developed as well (see Figure 16).

Figure 16: City Level Adaptation Pathway in Antwerp in which all the adaptation alternatives are included and different pathways are illustrated (with the arrows). In the bottom part the minimum temperature (°C) acceptable threshold is presented and in the upper part the minimum temperature values in different time periods (reference, near future and far future). The adaptation options that are in light blue need to be implemented as soon as possible. The darker blue means that the adaptation options needs to be implemented in the near future. The dark blue represents the adaptation options that need to be implemented in the far future. For the adaptation option in green it has not been assessed the effectiveness but is considered in the pathway.



As conclusions, the Antwerp Pilot application evidenced a need of assessing the effectiveness of adaptation options as well as monitoring climate events with impacts on mortality, morbidity or even work productivity (absences, days off work) as those are key components and a necessary input for evidence based pathway design. Additionally, the pathway design

complements existing planning approaches as it is an input to develop long-term adaptation strategies. The proposed approach is an additional tool for the Urban Adaptation Support Tool developed by developed by the European Environmental Agency in support of Majors Adapt, providing the essential flexibility to develop a dynamic adaptation plans.

2.6.3 Cost Assessment Framework

Central element of the transition model is the cost assessment framework which has been developed by the RAMSES consortium. This framework follows a hierarchical approach for prioritising and financing adaptation.

The cost assessment framework is divided into three key iterative phases across four levels, and is designed to support the comprehensive process developed in the RAMSES Transition Handbook (see Chapter 3). The three phases define a procedure for:

1. assessing risks and vulnerability based on damage costs;
2. identifying and assessing adaptation options based on their economic net benefits; and
3. planning and implementing city investments based on a range of financing mechanisms and funding models.

Figure 17 provides an overview of the cost assessment framework. Each of the three phases comprises four levels. Level 1 corresponds directly to the phases of RAMSES Transition Handbook. Level 2 corresponds to the quantified costs and investments that support the Handbook. At this level, policy makers may decide on which type of costs to include (e.g. direct and/or indirect costs, market and/or non-market costs) in order to support level 1 decisions that include wider evidence than costs alone. Level 3 corresponds to the methods and mechanisms used to assess costs, estimate economic benefits and channel city investments. Finally, level 4 corresponds to inputs that are required to perform assessments of damage costs (e.g. hazards and exposure, vulnerability, risks and uncertainty), economic net benefits of adaptation (e.g. types of adaptation measures, their implementation costs, timing and discount rates) and the effectiveness of alternative financing options (e.g. sources of finance).

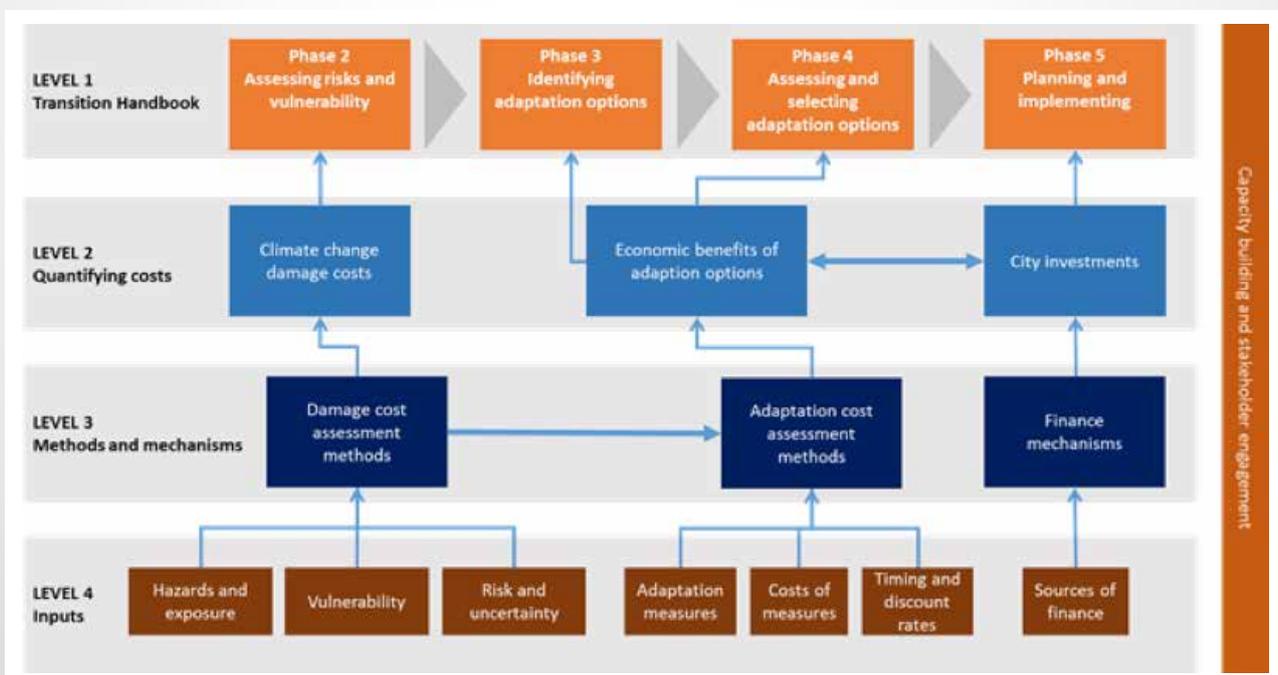


Figure 17: Cost assessment framework for adaptation in cities (Source: Costa et al., 2017).

Following conclusions from further stakeholder engagement activities, the cost assessment framework was designed to be sufficiently flexible so as to include a wide range of damage costs, adaptation benefits and finance mechanisms. The aim was to provide policy makers with guiding principles and methodological options that can support them in the decision making process rather than providing a prescriptive approach that is unable to be tailored to city-specific circumstances and wider policy priorities.

Part of the difficulty in performing cost and benefit assessments for climate impacts and adaptation investments relates to factors including (but not restricted to) uncertainty (e.g. related to the timing and severity of the climate change/event; the assets, systems and people who will be exposed, the scale of the damage, and the prices to mitigate against the damage and to restore/rehabilitate, etc.); the cost-optimal timing of the investment; data availability, especially at the city level; and thresholds or tipping-points after which damage scales dramatically and adaptation measures are ineffective. The cost assessment framework allows decision-makers to better identify the right tools and processes to prepare cost-effective adaptation strategies given the inherent information limitations.

At the same time, policy-makers tasked with determining how to implement adaptation options deemed worthwhile from their economic benefits will be influenced by the available local government finance or likelihood of finance instruments becoming available and ability of local government to influence finance flows from other public sources; and ability for investments to be borne by private actors based on the private and public co-benefits realised. Without this knowledge related to financing, a full determination of which options to prioritise cannot be completed.

The framework offers guidance to understanding finance mechanisms available at the city level and their application to adaptation projects. It examines three areas of government action that will be needed for channelling substantial investments into sustainable infrastructure: (1) raising finance (e.g. through national government transfers, international funding and bond markets), (2) steering finance (creating markets for sustainable infrastructure investments through pricing, standards and regulation) and (3) blending finance (to leverage the scale of private and institutional capital required).

2.7 Analysis of the Policy Context and of Urban Governance

The understanding of the policy context was a prominent work strand during the course of the RAMSES project as it provided important input for the development of the transition model for cities. Urban governance has been explored both in terms of current practices and in terms of governance-centred or policy-centred potential social innovations. A first element consisted in the development of an analytical framework that allowed to approach the issues associated with adaptation-centered governance. This has been achieved in a way that takes into account the deep uncertainties associated with climate change. The originality of this framework and its contribution to progresses beyond the state of the art reside in that it seeks to identify what can be done in a practical sense. RAMSES has thus managed to answer the following question: what can be done in order to enhance cities' resilience to climate change, how and by whom? The framework developed considers, the adaptation needs in each case study from a practitioner's view with due regard to the drivers and obstacles to adaptation.

This analytical framework allowed for the analysis of grey,

green and soft adaptation measures, seen through the lens of city governance. The application of this approach to field sites (Bogota, Bilbao, New York) has demonstrated that context is central to devising adaptation policy tools. These results show that ready-made tool-kits for adaptation can be useful to give guidance to cities on how to approach the challenge, on the first steps to take towards a more comprehensive plan, on assessment methodology, but they could be counterproductive if specific measures suggested are not tailored to the local context. Furthermore, through the Stakeholder Dialogues, it emerged that local authorities should place special attention on "soft" measures as central contextualization device, notably social empowerment and participatory tools for multiple stakeholders. These stakeholders will, hence, be in a position to act as successful enablers of an effective adaptation plan.

In order to further progress in the analysis of policy tools, RAMSES has furthered the understanding of the incentive structure under which certain cities conceive, negotiate and start an adaptation plan. In order to explore this incentive

structure the following questions were explored using case study analysis (New York, London, Antwerp):

- What drives action against climate change in the context of urban adaptation plans?
- How do institutions absorb the progress of climate science at the city level?
- To what extent are top-down governmental decisions mixed with bottom-up approaches aiming at greater civic enrolment in the fight against climate change?

A major contribution of RAMSES in the understanding of these issues lie in the identification of interactions between local politics and bureaucratic forces as a central determinant of the successful implementation of adaptation measures. By focusing on these interactions RAMSES could put attention

on an insufficiently researched issue, namely that climate change related decision making is forced by a variety of factors and rooted on different institutional levels (so-called wicked problems). However, the disentanglement of this decision making process allowed for the identification of institutions, fiscal conditions and social dynamics as determinants of successful adaptation effort. RAMSES results demonstrate that adaptation cannot succeed without people empowerment and the consideration of social, institutional and political settings, as well as the nature of urbanization trends. The RAMSES analysis demonstrates that the design and implementation of adaptation strategies calls for horizontal (across sectors) and vertical (across governance scales) integration, including the actions and initiatives of civil society. These results have been taken during the development of the transition model, although for sake of generality the latter had to abstract from too much details.

2.8 Summary

Summing up RAMSES has developed and provided a broad range of methods and tools. This was expected for a 5 year project than RAMSES. The reason for this long journey indeed is rooted in the overwhelming complexity of cities which makes it difficult to apply comparable methods to achieve results which supports planner in their decision making. Many more insights the interested reader can gather from the deliverables, which are

available online. The same holds from the various publications the consortium have been prepared. To conclude the RAMSES project paved the road towards a more systematic view on cities and showed that by doing so, valuable results can be obtained. These scientific achievements made in RAMSES finally ended up in policy documents and a transition methodology which will be further discussed in the subsequent section.

3 The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results

3.1 General impact of the RAMSES project

RAMSES addressed the rapidly evolving and urgent need for information on climate change impacts, vulnerability and adaptation by having:

- contributed to an advancement in the state-of-the-art in regard to standardised and comparable cost assessments for urban adaptation. This was in line with the increasing demand for a systematic adaptation research; and
- provided tools to vulnerable stakeholders at appropriate levels in EU member states and other countries.

In particular, RAMSES has achieved excellent results both for the scientific and for the policy oriented part of the project. Given the overwhelming complexity of cities, the project has generated huge amount of useful and applicable knowledge which is now accessible for the scientific and broader community, but in particular for city stakeholders. Worth to say that this comprises a vulnerability assessment for more than 570 European cities, the analysis of the surface heat island effect for more than 100.000 villages in Europe and the MENA region. The assessment of structural features of cities and how they relate to heat islands for the 5.000 largest European centers. The development of an

overarching framework for assessments of damage and adaptation costs. The idea of adaptation cost curves has been elaborated in order to make adaptation cost more comparable for stakeholders. The provision of damage cost and adaptation cost data for 600 European coastal cities and climate change scenarios for approx 100 European cities. This list of data and scenarios is only part of the results that are now accessible either via the RAMSES Common Platform (see below) or via the European Climate Adaptation Platform (Climate-ADAPT) and will provide a valuable source of information for planners, politicians and researchers.

One of the essential outputs of the project is the RAMSES Toolbox which aims at fostering urban adaptation and which is described in detail below. It comprises the audio-visual guidance application on-urban-resilience.eu, a Transition Handbook and a Training Package, all accessible through the RAMSES website and through the Urban Adaptation Support Tool on Climate-ADAPT. Additional buy-in by stakeholders to use these tools was ensured through several policy briefs, videos and, most immediately, through intensive Stakeholder Dialogues and cooperation that took place throughout all the project phases. Several model approaches have been co-designed and tested with, for example, the RAMSES case study cities.

3.2 Stakeholder engagement throughout the project and co-creating science with practitioners

One of the key objectives throughout the RAMSES project has been the creation of a structured exchange between cities, regional and national governments, adaptation practitioners and researchers, and the RAMSES research community in the process

of developing the research questions and the project results. The RAMSES project has taken an innovative approach in this sense. In fact, cities and climate adaptation practitioners were not only considered the recipients of the results developed by the project

researchers, but also, and most importantly, a ‘community of practice’ that informed the development of the research results.

In particular, three systematic Stakeholder Dialogues were organised (see Figure 18) in the course of the project (in addition to the intensive exchange with city authorities in the case study cities). At the Stakeholder Dialogues, a community of interest revolving around urban climate adaptation including cities, regional and national governments, European institutions, researchers and scholars has met. They were informed about the different activities of the RAMSES project at different stages of their evolution, and have been asked to comment

and contribute to the RAMSES research through interactive exercises, thus engaging in the project development first-hand. This engagement has had a twofold effect. On the one hand, it provided all the research done in RAMSES with indispensable insights into local adaptation policy-making and created direct links with actors holding precious knowledge for the scientific development of the project. On the other hand, this regular exchange, particularly the one occurred during the three RAMSES Stakeholder Dialogues and webinars, was a successful means of dissemination and engagement, creating a RAMSES Community, which has actively followed the project and its development throughout the years.



Figure 18: Images from the RAMSES Stakeholder Dialogues.

The three Stakeholder Dialogues (complemented by webinars following each event) represented powerful tools to create a community of interest and knowledge-sharing around the RAMSES Project. The events were successful in raising interest and affiliation amongst a wide range of stakeholders and therefore fundamental in disseminating project results.

Summing up, it is recommended to any research project on urban adaptation to organise regular Stakeholder Dialogues to keep an open and constant dialogue with practitioners and policy-makers, as science and practice can and should influence each other positively. The various activities conducted over the course of the project have potential impacts including:

- Operationalisation of the flexible adaptation planning concept through the pathway step-by-step design approach, offering a methodological framework as a resource for municipalities to tackle the challenge of climate uncertainty;
- Improved capacity of local decision makers, practitioners and stakeholders to manage climate change risks;
- Increased local and societal resilience through an innovative evidence based planning approach;
- Development of new tools to analyse risk at city scale based on widely-available data: providing capability for benchmarking and comparison of EU cities, and methodology for cities to analyse risks within their urban area;
- Co-development means that our case study cities have been involved in the research from the outset, and analysis undertaken during the project has fed into discussions on risk and adaptation in city authorities;
- A set of guidelines for the use of integrated-assessment of climate risks in cities was produced at the end of the project, outlining the key considerations, necessary data, and potential pitfalls of such analysis.

3.3 The RAMSES training events

Further to the Stakeholder Dialogues, 2 training events of 1-2 days duration each were implemented at a later stage of the project to train cities on the use of the resources produced by RAMSES (see Figure 19). The first event took place in Athens on the 15th February 2017 and focused on cities in Southern-Eastern Europe. The second event took place in Bonn on the 3rd-4th of April 2017, back-to-back to the RAMSES Project Partner Meeting and focused on cities in North-Western Europe. The training events targeted and were open to cities solely, with the exception of a small number of other participants that were allowed to take part as observers. In

order to ensure that cities were offered a training that focused on their specific hazards and problems, the two training events were organised according to a principle of regional representation. This allowed cities to discuss comparable situations and exposures to hazards, as well as to reflect on appropriate adaptation solutions for their climatic region. Both trainings were structured along the Transition Handbook and Training Package (see below), which were also printed and handed to all participants. At the training events, cities were trained through interactive exercises, thus learning on the use of RAMSES tools and resources first-hand.



Figure 19: Images from the RAMSES training events.

3.4 New Tools and Data

RAMSES developed a range of new tools and data which can be immediately applied by stakeholders involved in adaptation planning.

3.4.1 Assessing the Health Consequences

In order to foster urban adaptation and urban transformation RAMSES provided a number of assessment tools and datasets for further usage. Amongst them a tool was developed to evaluate the economic consequences of disease and injuries resulting from climate-related health outcomes. The methodology consists of four steps:

- Calculate the economic cost of the health impacts considered, including the cost of premature mortality, the cost of additional healthcare and the cost of lost work days associated with illness;
 - Calculate the cost of health adaptation, that is, of the interventions planned and necessary to avert or minimize the health impacts considered;
 - Estimate the economic benefits of such interventions, by monetizing the avoided cases of the health impacts considered; and
- Choose and report against indicators needed for planning and decision-making, such as cost-effectiveness estimates and benefit-to-cost ratios.
 - The tool consists of: 1) a document providing background information and guidance for the use of a tool which can be used to estimate the economic costs of health impacts of climate change, and 2) the tool itself, as a simplified model based on Microsoft® Excel™. The tool together with the accompanying document thus aim at contributing to the overall goal of the RAMSES project to facilitate local engagement in adaptation planning, policy and implementation. The document presents a simplified methodology for the evaluation of the economic consequences of disease and injury resulting from climate-related health outcomes and is based on a limited number of inputs, which makes it applicable also in settings of low data availability.

3.4.2 The Adaptation Cost Assessment Framework

Another application is the so-called cost assessment framework (cf. also Sections, 2.2, 2.6.3). RAMSES has engaged with stakeholders, through Stakeholder Dialogues, webinars, training events, and formal and informal meetings, to ensure that the cost related research is policy relevant and enables the design and implementation of adaptation strategies in the EU and beyond. The cost methodology developed in RAMSES was applied to three case study cities, Antwerp, Bilbao and London. The economic production functions were calibrated to each city economy and productivity loss functions with the

output from urban heat models, in order to estimate costs of heat stress to the urban economy through productivity losses. Additionally, the use of the methodology was used to measure costs of heat waves and flooding through their effect on labour losses via transport disruption in the city of London. All these results are publicly available in the RAMSES Common Platform. Beyond the three RAMSES main case study cities, the results of RAMSES could benefit most cities where adaptation research is at an initial stage. Here, cities can make use of the cost methodology developed by the project team to measure costs

of adaptation and climate change, as well as of the approach for prioritising and financing adaptation. The cost assessment

methodology became also a prominent part in the Transition Handbook.

3.4.3 Framework for the transfer of policy tools

As described in Section 2.7 RAMSES developed a very much needed framework allowing for the transfer of policy tools and experience between cities. This framework consists of a tool typology associated to evaluation criteria and helps local policy makers to enhance cities' resilience to climate change, how and by whom. The framework developed considers the adaptation needs in the analysed cases from a practitioner's view with due regard to the drivers and obstacles to adaptation. RAMSES extensive fieldwork indicated that the tools identified within this typology had to go beyond traditional adaptation strategies to incorporate

other types of policies that are not initially intended for adaptation. For instance, civic involvement can develop into adaptation initiatives, despite the fact that engagement was initially for other reasons. The main categories of the developed typology are information and education tools, planning and infrastructure tools, participation and organization tools, assessment and decision-making tools and economic tools, while the criteria for evaluation are efficiency, cost, need for regulatory change, ability to target vulnerable groups, and replicability. The insight have also been fed into the development of the transition model.

3.4.4 The Transition Model

The transition model (see also Section 2.6) is the major policy oriented output of the RAMSES project. Based on this model, the Transition Handbook was structured (see below). The idea of this tool is to support and to foster urban transformations with practical hints how such a process can be organised. Consequently, the concept was applied to the RAMSES case studies:

- London: validating the RAMSES Transition model methodology and fostering first-hand knowledge exchange between participants from London and other UK areas;
- Antwerp: the implementation of the adaptation pathway approach opened an internal discussion into the municipality to analyse the potential use of the pathways;
- Bilbao: the adaptation pathway approach will be transferred to the city in the future (after the RAMSES project and into the RESIN H2020 project).

3.4.5 Contributing to Data Availability - the RAMSES Common Platform

In order to make the project results publicly accessible, a knowledge library called RAMSES Common Platform has been developed. Applying state of the art web technology, it enables intuitive and flexible access to the project results – in a combined bottom-up and top-down process. Therefore,

suitable content elements and their appropriate representation to the targeted audiences have been identified and data contents, data formats, and responsibilities for input preparation and input delivery have been discussed and specified. In order to ensure its continuance beyond the project's time, PIK has

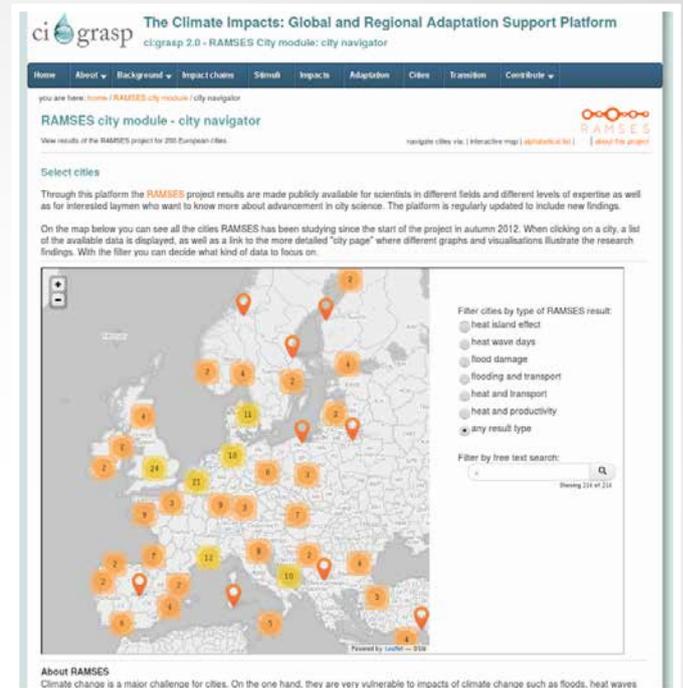
developed and hosts the RAMSES Common Platform as part of ci:grasp. The platform benefited from a continuous learning processes where experiences and RAMSES results iteratively

were included. The RAMSES Common Platform displays project results in a spatially explicit manner and is available at: <http://www.ramses-cities.eu/common-platform/> (see Figure 20).

Figure 20: Screenshot of the RAMSES Common Platform (status 13 November 2017), www.ramses-cities.eu/common-platform/.

The fact that both - top-down and bottom-up results - had to be included represented a particular challenge for the development of the platform. On the one hand, top-down results were available for a large number of cities, and on the other hand, bottom-up results only for a few. The RAMSES Common Platform is designed in a way so that the user can navigate without losing the overview.

Therefore, two ways of accessing the cities are implemented. First, one can use the main map which displays the cities for which results are available (one can also choose the type of results). The map has the typical features like zooming and moving. Second, the results can be accessed via an alphabetical list, providing a table of cities and available results. In both ways one can still navigate from the corresponding cities page to any other available result.



3.5 The RAMSES tool box – guidance and training materials for city administrations

In order to facilitate the engagement of stakeholders and policy-makers, RAMSES aimed to:

- motivate the need for adaptation and communicating a vision for the transformation;
- provide an overview on problem perceptions and particular interests of different stakeholders and their integration in various options for action; and
- initiate an interactive design process of realistic and politically feasible methods.

This knowledge transport is supported by the RAMSES Toolbox, which enables cities to assess impacts, adaptation options and

sustainable pathways for European cities on an intermediate scale of complexity. The RAMSES tool box contains:

- a web-based audio-visual guidance application called “On Urban Resilience” presenting the policy relevant scientific information, points of view of different stakeholders, and implementation examples from other cities;
- the RAMSES Transition Handbook to support cities in the definition of transition plans; and
- the ‘Training Package’ for using the RAMSES methodology and cost assessment tools within local adaptation work.

Based on the Training Package, RAMSES exemplified trainings with the cities selected as case studies.

The RAMSES Toolbox is available on the RAMSES website <http://www.ramses-cities.eu/>.

3.5.1 The web-based audio-visual guidance application on-urban-resilience.eu

The RAMSES application on-urban-resilience.eu is an explorative guidance tool that enables users to inform themselves about urban adaptation to climate change impacts in general and on concrete strategies and measures in particular.

By connecting more than 100 short film sequences from interviews with scientists, city and adaptation experts from the public and the private sector and best practice examples from well-chosen adaptation practitioners, the interactive guidance tool “On Urban Resilience” presents a broad range of policy relevant scientific information, perspectives, knowledge bites, and experiences. This enables an intuitive and flexible access to the main ingredients of the urban resilience discussion and helps policy makers and city stakeholders to assess climate change impacts in general and on concrete strategies and measures for their cities in particular.

The tool offers the opportunity to follow a preselected pathway through the material which is structured around issues like flood, heat, health, social adaptation policies, political commitment, from understanding to action, or implementation. A search function and an overview mind map (see Figure 21) alternatively allow for choosing individual entry points and diving into special topics. The application therewith caters for individual needs with respect to interest and level of knowledge of the user.

Providing city planners and other stakeholders with an intuitive way to gain insights in the field of urban adaptation through experts sharing their insights and lessons learnt, the video guidance tool is designed as a complementary service to the other, rather text based parts of the tool box described in the following.

3.5.2 RAMSES Transition Handbook

The RAMSES Project has produced an immense and highly valuable collection of reports and resources on the topic of climate change adaptation and resilience in cities. The Project



Figure 21: Mind map “lose yourself” of RAMSES web-based audio-visual guidance application on-urban-resilience.eu.

The tool was used heavily after its launch (>10.000 video plays) and was received very warmly by the audiences we have been asking for feedback. It was valued as being a “great resource!” (Amy Howden-Chapman, movie maker and environmentalist, cf. <http://www.amyhowdenchapman.com/>) or as “a real treasure trove of information and experience on the topic” (Rasmus Valanko, World Business Council for Sustainable Development, Director: Climate Change and Energy, cf. <http://www.wbcsd.org/Overview/About-us/Our-team/Geneva/Rasmus-Valanko>). Both, the whole tool box components, as well as topical sections are now mentioned and advertised for by the Urban Adaptation Support Tool of the European Climate Adaptation Platform (Climate-ADAPT).

Consortium has developed cutting-edge research on some of the most relevant topics for climate adaptation in cities. These include:

- Modeling climate projections and scenarios to understand future climate impacts and illustrate the effects of specific adaptation measures for cities;
- Understanding how to make architecture and infrastructure more resilient to climate change and how to assess the effects of improved architectural design on cities;
- Evaluating the costs of climate change and the benefits of different adaptation measures;
- Understanding the costs that climate change has on health and how different adaptation measures can reduce climate impacts on public health;
- Conducting high-level vulnerability assessments in order to understand which the climatic trends in European macro-regions are and consequently which are the main risks that cities in these regions are exposed to;
- Conducting detailed vulnerability analyses in the cities of London, Antwerp and Bilbao at a high spatial resolution to draw lessons from these cities' experiences;
- Understanding existing political frameworks and decision-making tools that support adaptation, and drawing lessons from those.

All the knowledge generated by the project is available on the project's website but in order to present this to cities in a synthesized and practical way that can be used to acutely make concrete decisions on climate change adaptation, the Transition Handbook and Training Package has been developed (see Figure 22).

The aim of the handbook is to be a dissemination, awareness and training tool, targeted to city stakeholders, for supporting the definition of their transition towards successful adaptation. Therefore, the handbook provides guidelines and advices to local administrations to help them advancing towards more resilient cities adapted to climate change.

The Transition Handbook has been conceived as a complementary guide to other stepwise manuals and materials already developed by different entities, i.e. Urban Adaptation Support Tool, developed by the European Environmental Agency in support of Majors Adapt. It mainly encompasses the methods and tools applied

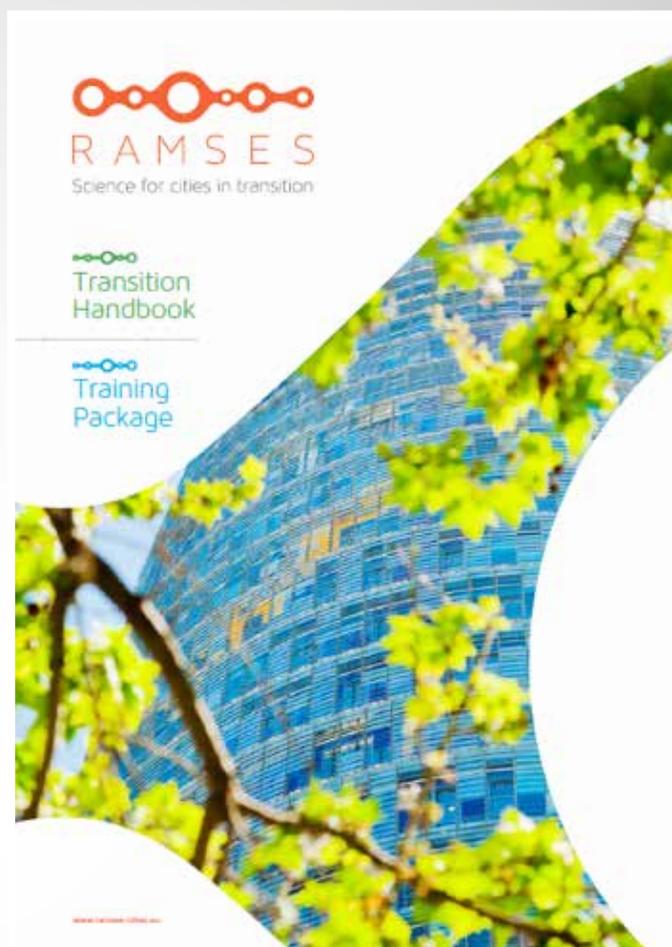


Figure 22: Title page of Transition Handbook and Training Package

in the context of the RAMSES project and its key outcomes, and therefore it is context specific and refers to the European policy landscape and mainly to European cities. However, the suggested adaptive management cycle and supporting tools are also applicable to other urban realities outside Europe.

The targeted audience are local decision makers, practitioners and consultants from municipalities and cities.

The conceptual framework used for the development of the Transition Handbook is shown in the following Figure 23.

The handbook explains in an instinctive way how to approach the process of adaptation. The proposed methodological sequence suggested in this handbook is composed of six iterative phases, not necessarily linear that can be adjusted according to the strategic objectives, needs and resources, which vary significantly from one case to another.

3.5.3 The 'Training Package'

A Training Package (see Figure 24) was produced as part of the RAMSES tool box. It is a complementary document to the Transition Handbook and part of the same electronic and printed file, and it operationalises the RAMSES findings into a support mechanism for local decision-making through nine worksheets.

Additionally, a Slidedeck summarising the most policy-relevant project findings to support cities in raising awareness on climate adaptation was produced.

The Urban Adaptation Support tool has been used to punctuate the navigation of the nine modules contained in the document, replicating the structure of the Transition Handbook. Furthermore, cross-references have been added, which allows users navigating the Transition Handbook to directly jump to the corresponding module of the Training Package and vice versa. Modules include topics such as:

- Stakeholder mapping and involvement;
- Identification of climate impacts;
- Assessing vulnerabilities and risks in cities;
- Calculating the economic costs of health impacts;
- Identifying and prioritising adaptation options;
- Developing a backcasting to identify long-term strategic goals for cities;
- Identifying indicators for resilient architecture and infrastructure;
- Communicating climate adaptation.

The Training Package worksheets also have cross-links to the audio-visual guidance application, so that users can click open videos related to the topics of the worksheets.



Figure 23: RAMSES Urban Support Tool vs Urban Adaptation Support Tool.

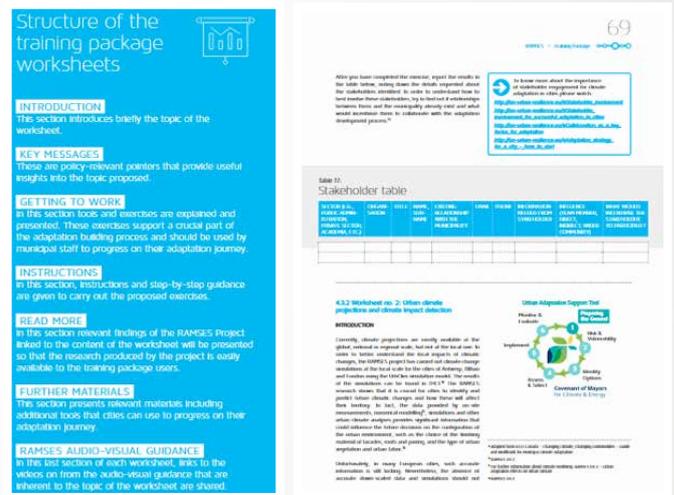


Figure 24: Images from the RAMSES 'Training Package'.

The Slidedeck has proven to be a useful tool to present the main findings of the RAMSES Project and has already been used during the project life-span. For example, the Slidedeck has been used during a training for Belarusian municipalities in Minsk on the 25th January 2017, and parts of it were even translated into Russian for that occasion. The format of the Slidedeck, a simple Powerpoint, allows in fact every user to tailor it to their needs and use the most relevant parts for their presentations.

3.6 Adaptation policy on European level – Informing policy with science: the RAMSES policy briefs

Throughout the RAMSES Project, three policy briefs were produced and distributed at several conferences and events. They presented key findings from the RAMSES Project and gave key messages to

policy makers (especially at the EU level) on how to tackle climate change challenges. The policy briefs are available on the RAMSES website (<http://www.ramses-cities.eu/results>).

3.7 Outreach to the scientific community – the Cities and Climate Conference 2017

The final RAMSES event “Cities and Climate Conference 2017” took place from 19th to 21st September 2017 in Potsdam, Germany, at the Potsdam Institute for Climate Impact Research (PIK).

Approx. 180 participants attended during the three days and listened to 120 talks in 19 sessions, selected through a call of abstracts. Invited speakers complemented the programme, they gave panel keynotes in the three morning plenary sessions and contributed to an interesting final panel discussion. The “Cities and Climate Conference 2017” was planned first of all as the final conference of the RAMSES project, therefore all partners submitted papers and presented their work; but the consortium also wanted to address the scientific community to discuss about the results and topics with the intention to initiate building up a network and being a run-up event for the upcoming cities related conferences in 2018 (like IPCC ‘Cities and Climate Change Science Conference’ in May 2018 in Edmonton). RAMSES provided more systematic methodological

approaches for cities, but also fostered by – a close stakeholder interaction – the transformation needs within cities. As the project partners dealt with different approaches and topics consequently the conference provided also a wide range of topics and thus could achieve a very interdisciplinary as well as international audience.

Conference Proceedings

All presenters, guests, and project partners who attended the Final Conference were invited to contribute their results to the conference proceedings which will be published mid of 2018 by Springer (publisher). So the proceedings will also reflect the RAMSES project results but enrich them with contributions by a wider scientific community like the final conference. Details: “The cities and climate change complex” (working title) – Proceedings of the Cities and Climate Change Conference held in Potsdam 2017, Publisher: Springer, announced publishing date 2018.

4 Main dissemination activities and exploitation of results

The RAMSES project focused on urban adaptation planning and as such through the project’s many dissemination, communication and engagement activities raised awareness of city administrations and other stakeholders, e.g. scientists and policy makers at different levels. With its events tools and dissemination activities the project created a community of interest and knowledge-sharing and raised interest and affiliation amongst a wide range of stakeholders and therefore fundamental in disseminating project results. The RAMSES project website describes the various project outputs for the various target groups and should support the exploitation of results also after the end of the project.

The chart below (Table 1) offers an overview of the dissemination activities conducted over the course of the RAMSES project as well as the level of the activity and target group:

Dissemination activity, tool or material	Level of activity	Target groups
Online:		
RAMSES website: www.ramses-cities.eu/	Local/regional/European	Scientific community / adaptation research community, policy-makers at various levels (local, regional, national, EU), other stakeholders, mainly from Cities, general public
CCC2017 website: ccc.ramses-cities.eu/	European, international	Policy makers, city stakeholders
Audio-visual guidance application: on-urban-resilience.eu/	Local/regional/European	CBIs, activists, policy makers
RAMSES Common Platform: www.ramses-cities.eu/common-platform	European, international	Scientific community / adaptation research community
RAMSES Video	European	Scientific community / adaptation research community, policy-makers at various levels (local, regional, national, EU), other stakeholders, mainly from Cities, general public
3 RAMSES Stakeholder Dialogue webinars (available at RAMSES website)	Local/regional/European	Policy makers, city stakeholders
RAMSES e-newsletter (available at RAMSES website)	Local/regional/European	Scientific community / adaptation research community, policy-makers at various levels (local, regional, national, EU), other stakeholders, mainly from Cities
3 RAMSES training webinars (available at RAMSES website)	Local/regional/European	CBIs, activists
2 videos “Impressions from 1st and 2nd Stakeholder Dialogue” (available at RAMSES website)	Local/regional/European	Policy makers, city stakeholders
2 videos for the promotion of the CCC2017 conference (available at: ccc.ramses-cities.eu/)	European, international	Scientific community / adaptation research community

Dissemination activity, tool or material	Level of activity	Target groups
On- and offline:		
Three RAMSES Policy briefs	local/regional, European	Polymakers
Transition Handbook	local/regional	Policy makers, city stakeholders
Training package and slide deck	local/regional	Policy makers, city stakeholders
Project leaflet	European	Researchers, EC, other stakeholders
Scientific publications	European and international	Scientific community / adaptation research community
RAMSES factsheet	European	EC
RAMSES Scientific deliverables	Local/regional/European	Scientific community / adaptation research community, policy-makers at various levels (local, regional, national, EU)
Posters	European and international	Scientific community / adaptation research community
Articles and communication with the media	Local/regional	General public, media
Events/networking:		
ECCA2015 (co-organiser)	Local/regional, European	Scientific community / adaptation research community, policy-makers at various levels (local, regional, national, EU), businesses
Cities and Climate Conference 2017 (with proceedings)	Local/regional, European	Scientific community / adaptation research community
3 RAMSES Stakeholder Dialogues	Local/regional, European	Policy-makers at various levels (local, regional, national, EU)
3 RAMSES training events	Local/regional, European	City administrations
Participation in working groups or network meetings	Local/regional, European Local/regional, European	Scientific community / adaptation research community
Presentations at scientific conferences	European and international	Scientific community / adaptation research community

Table 1: Dissemination activities conducted over the course of the RAMSES project.

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An interdisciplinary team

RAMSES was a partnership of leading European scientific institutions, SMEs and an agency of the United Nations. The RAMSES partners have expertise in climate modelling, impact assessment, climate change adaptation, economics, cost assessment, health, architecture, stakeholder involvement and science communication.

Potsdam Institute for Climate Impact Research
 Department: Climate Impacts & Vulnerabilities
 Research area: Climate Change & Development (CCD)



London School of Economics and Political Science
 Research Centre: LSE Cities
 Research Unit: Cities, Environment and Climate Change



Newcastle University & Tyndall Centre for Climate Change Research
 Department: School of Civil Engineering and Geosciences & Centre for Earth Systems Engineering Research
 Research area: Climate Change Impacts & Adaptation



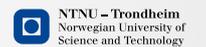
Flemish Institute for Technological Research
 Department: Environmental Modelling (Atmospheric Processes Research Group)
 Research area: Urban climate modelling



TECNALIA Research & Innovation - Energy and Environment



NTNU Norwegian University of Science and Technology
 Research Centre on Zero Emission Buildings



World Health Organization Regional Office for Europe

T6 Ecosystems S.r.l.



ICLEI - Local Governments for Sustainability, European Secretariat



Seneca | The Climate Centre



Climate Media Factory UG



University of Versailles Saint-Quentin-en-Yvelines
 Laboratory: Cultures Environnements Arctique
 Représentations Climat (CEARC) (from end of 2013)



RAMSES started on 1 October 2012 and run until 30 September 2017.



Where can you find more information?

Potsdam Institute for Climate Impact Research (PIK)
Telegraphenberg A 31
14473 Potsdam – Germany
Prof. Dr. Jürgen Kropp
E-Mail: nsp@pik-potsdam.de

www.ramses-cities.eu



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