Foreword

RAMSES is in its final phase. At the end of September 2017, a large city conference (Cities and Climate Conference 2017) took place at the Potsdam Institute for Climate Impact Research presenting the main outcomes of the project and fostering further exchange with approx. 200 scientists and stakeholders.

The project started with the idea of understanding how much information is really needed for sustainability planning in cities, specifically focusing on damage and adaptation costing. To this end, we compared information-rich (bottom up) approaches as well as (top-down) approaches of intermediate complexity. What we learned is that science can (and should!) provide a great contribution to policy-making if it works closely together with stakeholders, but it cannot replace local planning and political decision making. The RAMSES project was itself a fruitful meeting point of different disciplines and despite of all difficulties, remarkable progress has been made in terms of understanding cities. As it usually happens, in some parts the project has achieved more than planned, while for others the limits of the research became obvious. Even so, the project unveiled key evidence to deliver loud and clear messages to policy making. For example, based on an advanced urban climate model, we calculated the future heat burden for hundreds of cities. And the signals are worrying: by the end of this century, many cities in Europe will face ten times the number of heatwave than at the end of the last century! Moreover, we found out that the annual cycles of heat islands are different, leading to the identification of seven heat island typologies.

Further to that, we developed new approaches to calculating adaptation costs. We considered typical building features and different adaptation measures for heat mitigation and managed to calculate losses and averted losses on a sound scientific and comparable basis, despite of the differences between cities. We developed similar approaches for the assessment of flood related damages. Using a new remote sensing based model, existing infrastructure for hundreds of coastal cities was considered to calculate flood related damage and adaptation costs. Based on the same methodology we calculated the role of urban agriculture for thousands of cities, i.e. how climate change will influence its development and how many emissions can be saved by a reduction of food transport to urban areas. Last but not least, RAMSES invested significant effort in interacting with city practitioners and raising their awareness through stakeholder dialogues, webinars and the development of media tools. The exchange with stakeholders fostered a much needed mutual understanding between science and policy-making: it was a major driving force for our project work and paved the way for a closer cooperation with cities. To leave a legacy of this work and support sustainability planning in cities after the project’s end, we created a ‘Transition Handbook’.

In summary, RAMSES was a very successful project. It brought together scientific expertise from very different disciplines, produced more than 35 scientific journal publications, and developed solutions which can be used in and for future city planning. Not all results can be discussed here, therefore the interested reader is referred to the relevant publications. However, at the end of this five-year project one point remains crucial. Adaptation to the unavoidable consequences of climate change is imperative for cities, but it needs to be considered in a dynamic way and more than ever coupled with mitigation. Otherwise, the effects of the solutions that we produce today might be overshadowed by an ongoing climate change, taking us far away from the future we are working for.

25th September 2017,

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Introduction

The difficult situation faced by many urban areas around the world has become evident: cities are exceptionally vulnerable to climate change, and their vulnerability is only going to increase over time. Urban areas are responsible for about 80% of global greenhouse gas emissions and home to two thirds of the world’s population. The EU funded research project RAMSES has conducted innovative and extensive research over the past five years (2012-2017) to equip cities with the knowledge necessary to develop and implement climate resilience strategies and measures.

RAMSES has focused on the impacts of climate change and their associated costs. Specifically, the project has delivered much needed quantified evidence on:

- Modelling climate projections and scenarios to understand future climate impacts and illustrate the effects of green infrastructure on cities;
- Understanding how to make architecture and infrastructure more resilient to climate change;
- 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 the climatic trends in European macro-regions and the main risks for cities;
- Conducting detailed vulnerability analyses in the cities of London, Antwerp and Bilbao to draw lessons for other cities;

Furthermore, RAMSES has produced a set of policy-making support tools that synthesise the project findings and present them to cities in a practical fashion to support them making political decisions on climate adaptation.

This is the third and last RAMSES policy brief. It presents the latest project findings and results.
Key findings from the RAMSES Project Research

The paragraphs below summarise some of the key findings of the RAMSES project research, highlighting crucial points on urban adaptation. The full RAMSES reports, which elaborate on these topics, are available at: www.ramses-cities.eu/results.

RAMSES has produced a wealth of knowledge that can support climate adaptation policy-making in cities. Such knowledge is extensively presented in the RAMSES Project Deliverables¹, which offer a detailed account of the scientific findings of the project. Nevertheless, RAMSES aims to support cities in their endeavours to make policies that will contribute to their climatic adaptation and resilience. For this reason, the project has developed a ‘Toolbox’ composed of three elements, which condense key adaptation knowledge from the RAMSES Project and are tailored to providing policy support to city practitioners². These are:

1) The Audio-visual guidance at www.on-urban-resilience.eu, where cities can find more than 100 videos from experts in different sectors - fellow cities but also scientists and experts of various disciplines, who present and communicate in a short and easy-to-listen format some of the crucial issues that revolve around adaptation;

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1 These can be retrieved from: www.ramses-cities.eu/results
2 The Toolbox is available at: www.ramses-cities.eu/toolbox
2) The Transition Handbook and Training Package, which incorporates some of the project’s key findings into a process for adaptive management. This follows the widely-regarded Urban Adaptation Support Tool (UAST)³, which was developed specifically for use by cities and is also used by the Covenant of Mayors for Climate and Energy⁴. For each step of the UAST cycle, the handbook presents supporting findings and case studies. This provides cities with a step-by-step process that they can use to structure their climate change adaptation action. The handbook is complemented by an accompanying training package, which is included in the same document. This package follows the steps laid out in the handbook and suggests some hands-on activities for each step that city administrations can use to operationalise climate change adaptation, for example guidance on how to involve stakeholders, collect understanding of risks, or organize targeted planning meetings specifically related to adaptation;

3) The slide-deck, which cities can use as a tailor-made support tool to explain climate adaptation to their local stakeholders, and which presents the scientific evidence from the project in a concise and clear way. The slide-deck is in .pptx format. Therefore, it can be downloaded and tailored to the needs of different cities.

More information: 
www.ramses-cities.eu/toolbox

³ Available at: www.climate-adapt.eea.europa.eu/knowledge/tools/urban-ast/step-0-0
⁴ Available at: www.covenantofmayors.eu/index_en.html
Developing more climate-resilient cities is necessarily becoming a greater priority for governments and businesses. And increasing investment flows for adaptation is without question a major financing challenge. 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.

To help policy makers make adaptation decisions more effectively and efficiently, a cost assessment framework has been developed that follows a hierarchical approach for prioritising and financing adaptation. The cost assessment framework is divided into three key iterative phases that follow a hierarchical process across four levels: describing the UAST phases 2 to 5 (level 1), quantifying costs (level 2), cost assessment methods and financing mechanisms (level 3) and a range of inputs (level 4). Specifically, this can support cities in [1] assessing risks and vulnerability based on damage costs, [2] identifying and evaluating adaptation options based on their economic net benefits, and [3] planning and implementing city investments. Figure 1 describes the costs assessment framework, including its relation with the UAST Tool.

![Cost assessment framework for adaptation in cities](image)
The difficulty in performing cost and benefit assessments for climate impacts and adaptation investments includes (but is 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; and thresholds or tipping-points after which damage scales dramatically and adaptation measures are ineffective.
- The long-term, multivariate, and probabilistic nature of climate change assessments, which makes perfect knowledge impossible.

The damage cost and adaptation benefit assessment methodologies presented in the cost assessment framework provide decision-makers with better guidance on 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 economically beneficial adaptation options will be influenced by:

- The available local government finance or likelihood of finance instruments becoming available and the ability of local government to influence finance flows from other public sources;
- The 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.

More information:
Innovative city scale models for flooding allow cities to evaluate cascading effects on transport and target investments towards most vulnerable infrastructure

Changing climate will increase the vulnerability of urban areas to extreme weather events. Damage to key infrastructure in cities from extreme events is often costly to repair and can result in a reduction in performance and discomfort for users. The work carried out in the RAMSES case study city of Antwerp has highlighted the need for better information about pluvial flood risk in cities. Working closely with the city authorities, the University of Newcastle (UNEW) has developed a new functionality in their CityCAT model to provide better simulations of surface water flooding and its interaction with the urban environment and drainage networks. Such models, run under current and future climate conditions, can help cities to understand the effectiveness of various adaptation measures (such as green roofs) in dealing with extreme weather events. Specifically, by using an integrated framework combining flooding and transport modelling, disruption from changing rainfall extremes can be simulated. Simulations show that disruption to transport from a 1-in-50 year event could increase by 66% in the 2080s. By targeting adaptation to the most critical pieces of the transport network, disruption can be reduced in a cost-effective manner (Pregnolato et al, 2017)\(^5\).

To deal with these risks, work by UNEW has shown how adaptation investment can be targeted using a city-scale risk assessment approach. By combining together maps of hazards (e.g. temperature or pluvial flood depths) with knowledge of the infrastructure and function of the urban environment, critical areas of the urban system can be identified and action taken to reduce risks (Pregnolato et al, 2016)\(^6\).

More information:

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\(^5\) Available at: [http://ascelibrary.org/doi/10.1061/%28ASCE%29IS.1943-555X.0000372](http://ascelibrary.org/doi/10.1061/%28ASCE%29IS.1943-555X.0000372)

\(^6\) Available at: [http://rsos.royalsocietypublishing.org/content/3/5/160023](http://rsos.royalsocietypublishing.org/content/3/5/160023)
RAMSES investigated how different core functionalities of cities may be affected by climate change simultaneously. For example, the considerable increase in heat burden in the future (Hooyberghs et al. 2015, Lauweat et al 2015) may cause serious health consequences for urban dwellers. When looking at these cascading effects, it becomes clear that climate change is a wicked problem. For example, the project has shown that open city structures can reduce heat load (Zhou et al. 2017) but require more land consumption, which is costly and may also lead to more traffic and emissions. This is the reason why, nowadays, many regions are further concentrating urban agglomerations, thus also increasing their vulnerability to heat risks. In other words, cities juggle between conflicting priorities. To solve this conundrum, cities have to seriously invest in green infrastructure (e.g., vertical forests, green roofs and façades) while still increasing in density. In this way, the trade-offs of a further concentration can be avoided. Furthermore, when thinking about climate adaptation and mitigation in cities, we should not only consider built-up areas, but also local transport and food production as fundamental urban functions, which can contribute to overall resilience. For example, the RAMSES project has proved that peri-urban agriculture can reduce food transport, save emissions and ensure food self-sufficiency in many cities worldwide (Kriewald et al. 2017).

More information:
Cities need a flexible transition model to design pathways towards resilience

RAMSES developed a transition model to support cities in reaching a more climate adaptive state. The Transition model is a cyclical approach that guides cities from assessing their risks and vulnerabilities to selecting adaptation options and to monitoring their effectiveness and contribution to achieve a desired scenario. Some of the key methodological traits of a transition pathway towards resilience in cities are:

- A consistent chain of actions, which enables cities to plan ahead in order to prevent reaching adaptation tipping points, thus reducing risks;
- First of all, the ‘owner’ of the pathway needs to be identified. Different stakeholders and experts need to be involved. A high level approach can be taken as a first step with a small group, which will help identify other stakeholders and experts to be involved in the future;
- A pathway needs to be effective, i.e. able to tackle the risks that it has been conceived for) and flexible, i.e. capable of dealing with different circumstances over time;
- The effectiveness of an adaptation pathway needs to be evaluated not only with regard to its direct ability to prevent climatic impacts, but also to generate co-benefits that produce desirable outputs in cities, for example strengthening the social and economic fabric of a city, reducing health risks and strengthening the cultural identity of citizens;

There is no one-size-fits-all pathway. Instead, there are different packages of options that cities can choose from depending on their local risks and needs.

Figure 2 describes the steps of the RAMSES Pathway approach.

More information:
Cities in developing countries are key actors for tackling climate change

We should never forget that climate change is a global issue. It is not sufficient to focus on the developed world, as the positive effects achieved there could potentially be overshadowed by accelerated climate change and a rapid lifestyle change in cities in developing countries (Gudipudi et al. 2017). At present, consumption behavior is still very different in the developing world in comparison to OECD cities. Developing cities are often denser and cause fewer emissions per unit of GDP (Gudipudi et al. 2016), whereas the energy consumption of cities in OECD countries is directly proportional to their gross domestic product (GDP). This means that a doubling of the population in developed cities would double their energy usage as well. This can be explained through an infrastructure lock in, i.e. current infrastructure cannot reduce its emission intensity fast enough to compensate for demographic growth.

In cities located in developing countries however, a doubling of the population would not double energy consumption. Their emission intensity still increases with the income, but not at the same pace of mature cities in the OECD in the past. Therefore, developing cities offer an ideal test bed for decoupling economic growth from CO₂ production, and we shall leap at this opportunity in order to avoid recreating the same growth model, which developed cities are struggling to escape.

More information:
Conclusions: A new paradigm for future cities

The findings highlighted in this policy brief are only some of the many insights developed by RAMSES. What they clearly show is that to solve the climate problem, a new paradigm for future cities is needed. Short distances for both citizens and goods, horizontal and vertical green spaces, combined with new building materials are only some of the key solutions to create future resilient cities. Investments are being made, but more is needed in order to switch to a new paradigm. RAMSES contributed to create the awareness necessary to do so. Great challenges and great opportunities stand before us in the years to come.

More information:

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Who are the RAMSES Partners?

RAMSES is a European funded project currently consisting of 12 partners. These are the Postdam Institute for Climate Impact Research (PIK), the London School of Economics (LSE), University of Newcastle upon Tyne (UNEW), Vlaamse Instelling voor technologisch Onderzoek n.v (VITO), Université de Versailles Saint-Quentin (UVSQ), Fundación Tecnalia Research and Innovation (TECNALIA), Norges Teknisk-Naturvitenskapelige Universitet (NTNU), World Health Organization (WHO Euro), T6 Ecosystems S.R.L. (T6 Eco), Seneca Group S.P.R.L (SENECA), ICLEI – Local Governments for Sustainability, and The Climate Media Factory UG GmbH (CMF). The Institut Veolia Environnement Association (IVE) and Institut de Recherche pour le Développement Durable et les Relations Internationales (IDDRI) were previously partners in the project.