



Climate Proof Cities: an integrated research framework

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Climate Proof Cities consortium
Peter Bosch (TNO) *Editor*

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Auteur: Sonja Döpp (TNO)

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1 Introduction

Climate Proof Cities (CPC) is a large scale research programme that focuses on climate change adaptation in cities in the Netherlands. Until now most of the urban climate adaptation research has looked at different research topics related to urban climate and urban design, vulnerability, adaptation measures and governance in isolation. Therefore, it has been very difficult to determine and compare effectiveness of adaptation measures. The CPC programme is based on a systems approach, and aims to answer its research questions in an integrated way. As there are many interdependencies in adaptation to climate change in cities, the CPC research projects are strongly linked to each other. Researchers throughout the programme will cooperate in interdisciplinary teams, in case studies at specific locations on different scale levels. Close cooperation with various stakeholders has been established in order to link scientific research with the urban adaptation issues in practice. The intended end result of CPC is an integrated assessment of the need and possibilities of adaptation in Dutch cities.

The great diversity in science, institutes and people that an integrated approach like CPC involves, brings a lot of integration challenges with it. Aspects like speaking the same language, being able to use each others results and eventually providing results that can actually be used by stakeholders in developing their urban adaptation strategies are essential for a successful completion of CPC. The CPC programme is explicitly designed to deal with these challenges, and a separate work package on integration is included.

This paper is one of the deliverables of the Integration work package. Starting with theoretical background of transdisciplinary research and integration processes, we show how these concepts are applied in the CPC research approach. Based on first year research experiences and the current state of the programme we identify success factors and points to improvement, which provide valuable lessons in the continuation of CPC and integrated research on urban climate adaptation in general.

2 Integrated research: theoretical background

Integrated research is a popular term in science these days. The term is also being referred to in the full title of CPC programme “Climate change adaptation in the urban environment: an integrated and multi-scale approach”. In order to clarify the programmes’ view on integrated research two related concepts are discussed in section 2: *integration* and *transdisciplinary research*. Models and frameworks from literature that are described below will be used to clarify and analyze the CPC approach in section 4.

2.1 Integration

The term ‘integration’ is used a lot in scientific research over the last years but its concept is broad and often unclear. Generally, integration refers to “interrelating elements that were not related before” (Jahn et al. 2006) or “bringing disparate elements together into a more holistic entity” (Van Kerkhoff, 2005). In research these can be all kinds of elements, which can be

separated by various types of boundaries. Van Kerkhoff (2005) identified 12 thematic categories of integration in science and environmental policy contexts, which illustrate the wide scope of integrated research. These 12 categories imply integration across:

Science	<ol style="list-style-type: none"> 1. disciplines 2. research issues, such as water and land 3. research and teaching 4. data 5. research methods, such as empirical work and modelling 6. research organisations, such as universities, government agencies, and private laboratories
Beyond science	<ol style="list-style-type: none"> 7. worldviews 8. research and application activities such as policy implementation, product development and marketing 9. sectors, such as academia, industry and government 10. management/governance arrangements by scale, such as local, regional and national government 11. management/governance organisations by issue focus, such as departments or ministries of agriculture and environment 12. resources, such as funding

In defining an integrated approach for research, it is important to consider what kind of elements are supposed to be integrated and consequently what kind of barriers there are to overcome. A distinction can be made between integration within science and beyond science. The first six categories defined by Van Kerkhoff that are listed above refer to integration within the research sector and could all be related to *interdisciplinary research* (see next paragraph). The last five categories listed above refer to integration beyond science, i.e. integration between research and non-research organizations and people who apply research in various contexts. The seventh category, integration across different worldviews, can be relevant for all contexts. Based on the different types of integration, Van Kerkhoff developed a framework for analyzing integration (Figure 2-1). Besides the within/beyond science distinction (upper and lower half), this framework also includes a distinction between integration across activities or across institutional structures (left and right part).

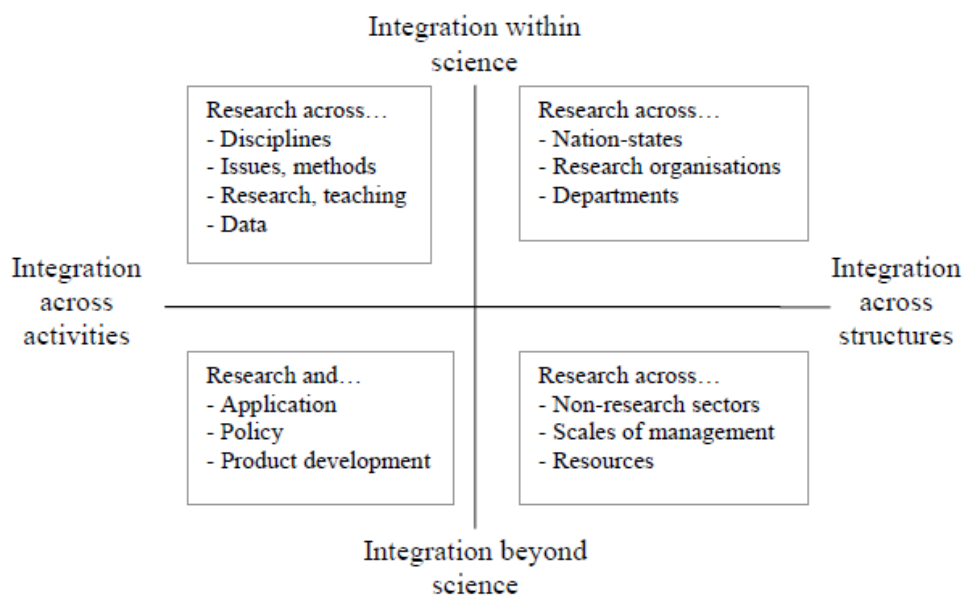


Figure 1 Framework for analyzing integration by Van Kerkhoff (2005)

The resulting four quadrants give insight in the different scopes and focus of the application of integration.

- Integration in the **top-left quadrant** involves the connection of activities of scientists in order to produce interdisciplinary, comprehensive research outputs for policy advice. Often, many disciplines are involved with their own methods and jargon for similar type of issues. Shared datasets and guidelines for specific research parts are examples to overcome these kinds of barriers.
- The **top-right quadrant** is about establishing connections between scientists of different organizational structures, i.e. the removal of administrative and organizational barriers. Research consortia in the field of science and environmental policy often involve research parties from different institutes and different countries. Clear agreements on data sharing and ‘intellectual property rights’ for example are very important to enable integration in this context.
- The **lower left quadrant** describes the interaction between scientists and research users that is required to produce useful results for practice, i.e. active stakeholder participation. Case studies can be very effective in establishing communication and connection between stakeholders and scientists in the research process, for example by jointly defining local research questions.
- The **lower right quadrant** focuses on integration across boundaries of non-research organisations (e.g. national and local governments) that might hinder effective cooperation in the research process. Temporary organizational structures that involve both research and non-research parties can be established to work with these kind of boundaries. An example of such a structure is Knowledge for Climate¹, the overarching research programme where Climate Proof Cities is a part of.

¹ <http://www.knowledgeforclimate.nl>

2.2 Transdisciplinary research

Integration is an important part of transdisciplinary research processes. Like for integration, there are various definitions of transdisciplinary research. In this type of research, a wide range of unrelated scientific disciplines work together on a common research goal. In contrast with 'interdisciplinary research', transdisciplinary research involves a participatory approach, i.e. (non-scientific) stakeholders can help to shape the research process. The aim of participatory research is not only to integrate life-world perspectives and interests, but also to solve complex problems with local knowledge, testing the relevance of outcomes and improving practice-oriented effectivity (Pohl and Hirsch Hadorn, 2007). According to Pohl and Hirsch Hadorn (2007) transdisciplinary research deals with problem fields in such a way that it "identifies, structures, analyses and deals with specific problems in such a way that it can: a) grasp the complexity of problems, b) take into account the diversity of life-world and scientific perceptions of problems, c) link abstract and case-specific knowledge, and d) develop knowledge and practices that promote what is perceived to be the common good." The Handbook of Transdisciplinary Research by Hirsch Hadorn et al. (2008) gives more clarification on the term and concept, and descriptions of various examples that illustrate the broad applicability of a transdisciplinary approach.

Based on a strategic sustainable urban mobility project, Bergmann & Jahn (2008) developed a universal model for transdisciplinary research processes (Figure 2-2). The model illustrates how science and practice are joined in integrated research projects, and how a distinction can be made again in the final outcome: results for practice and scientific results. It is important to consider this two-fold purpose and outcome: the joint research process has to target two very different groups and their questions and needs.

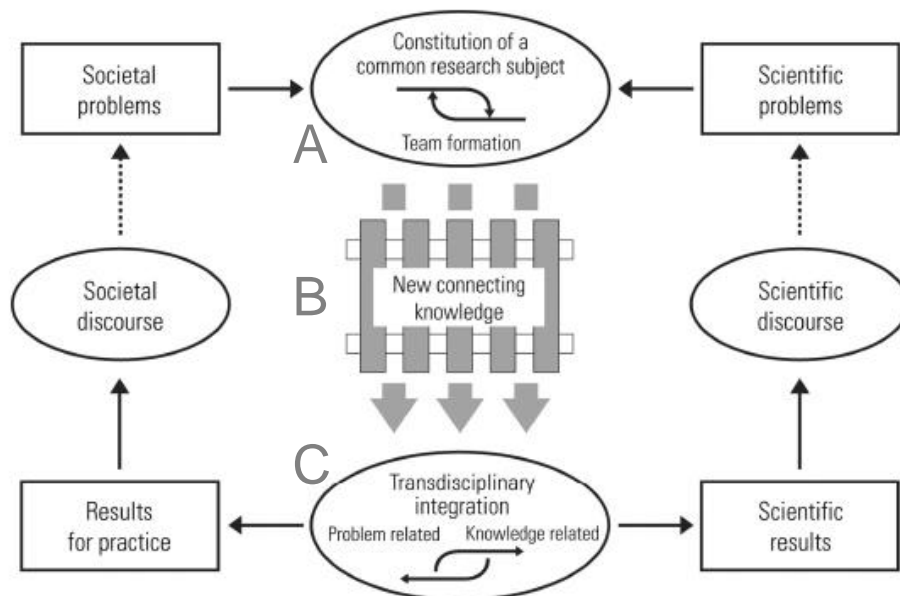


Figure 2 Model for transdisciplinary research processes by Bergmann & Jahn (2008)

Integration within and beyond science takes place in different ways and at different stages in the transdisciplinary research process. Bergmann & Jahn describe a sequence of three project phases in a typical transdisciplinary research project:

- *Phase A*: The first phase consists of the 'constitution of a common research subject'. Normative scientific knowledge needs to be integrated with social and/or political issues

of relevance. The resulting focus of research should be accepted by all participating disciplines and stakeholders. During this phase, the basic project structure is created including the team formation (proposal phase).

- *Phase B*: In the second phase of ‘new connecting knowledge’, the actual research and cooperation process in work packages takes place. Knowledge building, linking between disciplines, researchers and projects and mutual learning are important elements.
- *Phase C*: The third phase is referred to as ‘transdisciplinary integration’. Ideally, the generated and integrated knowledge should be incorporated into practical problem solving strategies as well as into new interdisciplinary knowledge. (Bergmann & Jahn, 2008)

3 CPC programme

3.1 Objective and results

The central goal of CPC is to increase the adaptive capacity and reduce the vulnerability of the urban system to climate change through the development of strategies and policy instruments for adapting cities at various scale levels. In order to reach this, a research consortium has been composed that brings together scientists with a wide variety of disciplines. Engineers, climate scientists and urban designers from technical universities, urban planners and urban managers from general universities, and a variety of other disciplines from the participating knowledge institutes will work together to achieve this goal. Since the aim of CPC is to develop knowledge for practice, stakeholders from several Dutch cities are involved as well. CPC is part of the Knowledge for Climate (KfC) research programme, co-financed by the Dutch Ministry of Infrastructure and Environment. The overall objective of KfC is to develop knowledge and services that make it possible to climate proof the Netherlands.

As mentioned before, CPC applies a transdisciplinary research approach; the model of Bergmann & Jahn applies very well. In the construction of the programme (*phase A*) cities played an important role; the programme design is based on questions from practice. Cities defined their main issues concerning climate adaptation including water and heat issues, questions on problem definition, adaptation measures and governance. These issues were translated into 5 main policy questions:

- How will climate change influence Dutch cities, and how and to which extent do cities influence the local climate themselves?
- How vulnerable are Dutch cities for climate change, and what will be the impacts?
- Which measures and strategies are available to improve the adaptive capacity of cities?
- How to implement these measures in urban areas?
- What will be the balance of urgency, costs and benefits?

The project structure including work packages and cases (described in the next paragraph) is based on these policy questions. Generating and connecting new knowledge through this structure corresponds with *phase B* in the transdisciplinary research model of Bergmann & Jahn.

Research in the cases in the participating cities generates knowledge on local issues that can be directly incorporated in practice. This can be considered as a part of the *results for practice*. However, the real challenge is to bring individual project and case results together

and build a quantitative knowledge base for developing urban climate adaptation strategies for Dutch cities in general. Knowledge that is generated by CPC should be applicable in urban areas in the Netherlands and not specifically for the participating cities only. The intermediate CPC outcomes for this larger context will be translated into policy relevant information in an integrative yearly report.

CPC is a scientific programme, hence achieving good *scientific results* is as important as results for practice. 12 PhD students will deliver their dissertations at the end of the programme period. In addition, results will be published in peer reviewed journals and at international conferences. Besides individual project results, the scientific outcome of CPC consists of transdisciplinary knowledge on urban adaptation; i.e. the scientific component of developing urban climate adaptation strategies.

For the overall synthesis of knowledge for developing urban climate adaptation strategies, both scientific and for policy makers, a separate work package has been designed (wp5: Integration). This work packages coincides with *phase C* of the Bergmann & Jahn model. Also in this phase, city stakeholders will be involved to ensure local applicability.

3.2 Program design

The CPC programme has been designed taking into consideration that urban adaptation cannot be studied in isolation, if the outcomes are to be useful for policy development. A larger system is considered that is governed by three boundary conditions: 1) the amount of global climate change we will face, 2) the environmental, social and economic dynamics and complexity of urban development and 3) urban governance (Figure 3-1). CPC aims to answer a number of questions on the urban climate, on its impacts and on possible responses, but it will always take the larger system into account.

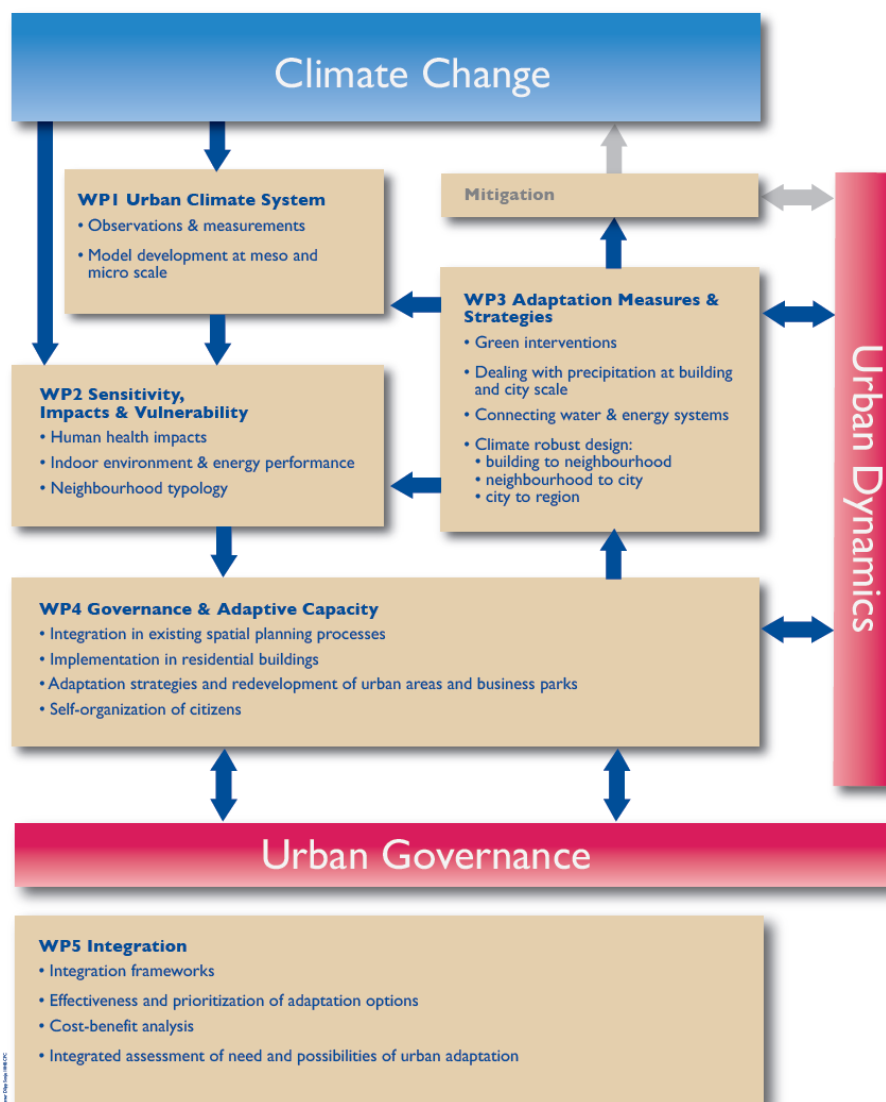


Figure 3 Research framework of Climate Proof Cities

Projects are organized in five work packages (Figure 3). A description of the research projects in each work package can be found at the CPC website² (see Box 1). The projects are linked to each other and build upon each others' results, even though most projects are executed in parallel. As data and information from each work package becomes available, they will be used in the other work packages to substantiate working assumptions and replace these for scientifically underpinned variables. In each of the work packages a multi-scale approach is used. Attention will be paid to issues at different scale levels: street and buildings (and people), neighbourhoods, cities and regions. In practice this will be realized by executing the research in a number of case studies, addressing issues (policy questions) on specific scale levels (Figure 4). Researchers from different projects work together on issues at a specific scale level, in close cooperation with stakeholders. Specific locations and precise topics have been selected during extensive discussions with the cities involved.

² www.knowledgeforclimate.nl/climateproofcities (see 'workpackages')

Box 1 Work packages in CPC

- **WP1:** Urban Climate System. To ensure that effective and coherent adaptation measures and strategies are being developed for the urban environment, a thorough understanding of processes of the Urban Climate System (UCS) is essential. This includes understanding of weather, air quality and climate phenomena from meso-scale to micro-scale. In addition, more quantitative information regarding the UCS is needed. The aim of WP1 is to provide this information, both from observations and model simulations.
- **WP2:** Sensitivity, Vulnerability and Impacts. The aim of WP2 is to analyse the sensitivity of buildings, neighbourhoods and people, and their vulnerability to the expected climate changes. This knowledge is used to answer the questions: What are the potential impacts of climate change, considering the important uncertainties involved, and when and where are adaptation measures needed? This work package is driven by the KNMI climate change scenarios and their supplements, and is especially intended as a supporting work package to WP3.
- **WP3:** Adaptation measures and strategies. The main research question in WP3 is: Which measures can be taken for climate robustness of cities, neighbourhoods and buildings, and what is their efficiency and effectiveness? The themes for this work package aim to cover the entire range of measures for climate robustness: green interventions, dealing with precipitation at the buildings and city level, the combined approach to water and energy, and spatial and technical design measures at various scales. Resulting measures imply climate adaptation, climate mitigation and an approach we could call climate pro-activation, i.e. utilizing climate characteristics optimally in the urban and building design.
- **WP4:** Governance and adaptive capacity in cities and metropolitan areas. The central aim of WP4 is to provide new insights in the way climate adaptation can be introduced into the existing spatial planning processes. Research is based on the knowledge that urban planning is in itself a highly complex process in which a lot of significant and (mostly) conflicting interests of different actors are competing, and that climate adaptation measures do not represent a so-called 'strong interest' whose integration into urban processes need no support.
- **WP5:** Integration. To be useful for policymaking, the results from work packages 1-4 and the different cases have to be combined and included in an integrated assessment of the need and possibilities of adaptation in cities. WP5 brings together information on a suite of policy questions: What is the impact of global and regional climate change scenarios on Dutch cities, in other words, "what would it cost if we would do nothing?"; what are appropriate policy responses in each of these scenarios, and how much would these cost; and what would be needed to implement adaptation strategies?

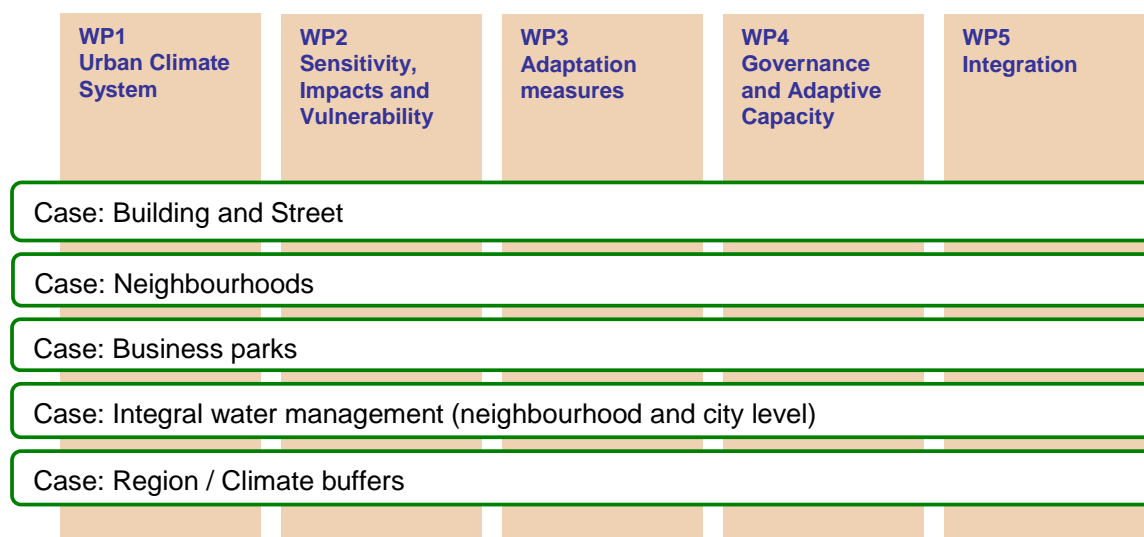


Figure 4 CPC cases at 5 scale levels. The case on Business parks is, as it stands, included in the Neighbourhood case.

4 Integration in CPC

The programme structure described above is the basis for the integrated approach in CPC. It brings people, knowledge and results from various disciplines and practices together, and forms the framework for integrating all different perspectives that are involved. However, as nicely illustrated by Jeanine Reutemann ‘integration’ does not necessarily ends once perspectives are merged (Figure 5). More and dedicated activities are needed to arrive at a true integrated assessment.

There are several ways by which integration is facilitated in CPC, both within as beyond science across the various aspects in the framework by Kerkhoff (Figure 1). In the sections below, we focus on the left quadrants of the framework: integration across activities.

Integration across structures (the right hand part of the framework in Figure 1) is, at least partly, studied in the programme itself. Projects in work package 4 on governance study “integration across structures” as part of research questions like: What are the dynamics of integration of climate adaptation in existing planning processes? What are the barriers and opportunities (e.g. financial, political, social)? Descriptions of projects in work package 4 are given on the CPC website² (under ‘work packages’).

4.1 Integration across activities within science

4.1.1 *Establishing contacts and communication*

As mentioned before, the CPC research projects largely build upon each others’ results. Therefore, it is crucial that researchers know each others work and share their knowledge and results. *Regular meetings and workshops* are organized at which researchers present their research plans and progress (see figure 6). These include CPC yearly events, at which stakeholders are invited as well. Summer (or spring) schools are organized in cooperation with the foreign research partners³ in order to share knowledge also internationally. An *internal web space* at the Knowledge for Climate intranet offers researchers means to share work plans, results, literature and other documentation. News from the case studies and the different work packages is being spread in the internal *newsletter*, published once every two or three months.

³ University of Manchester, University of Kassel and Freiburg University

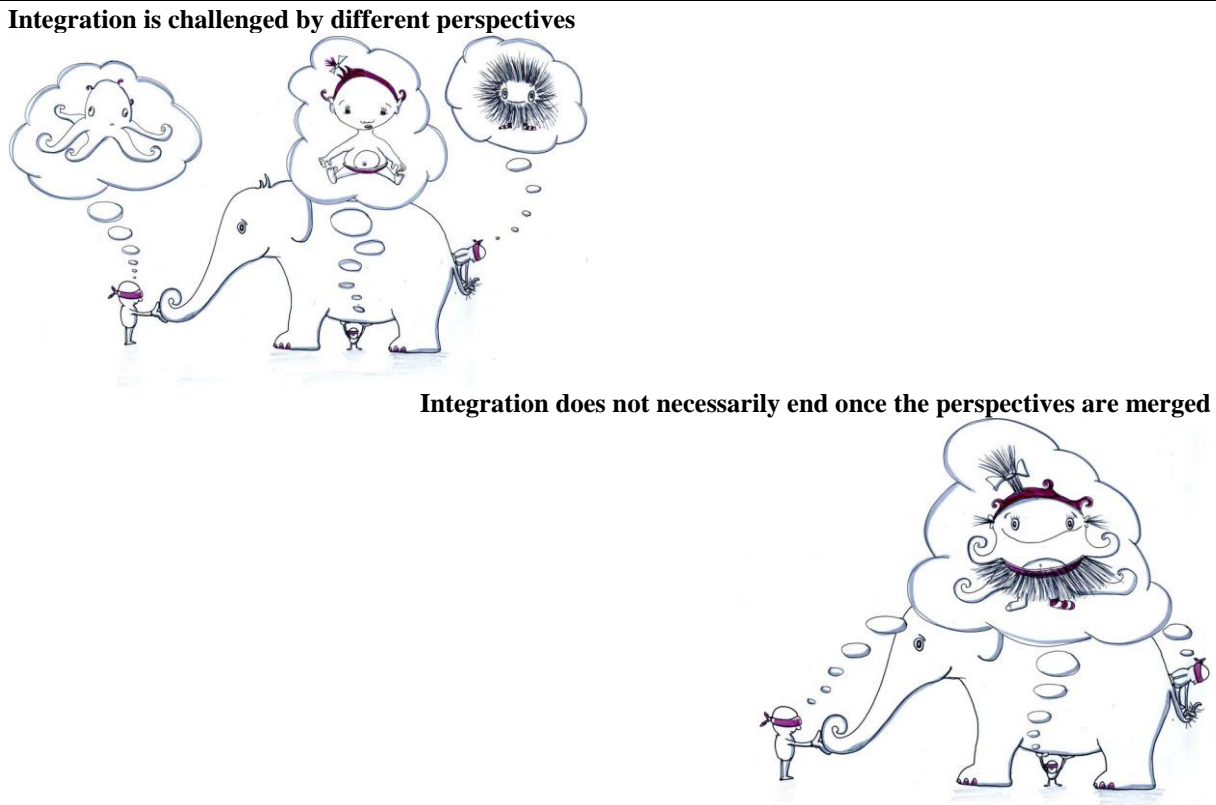


Figure 5 Illustration of Integration by Jeanine Reutemann (source: presentation Christian Pohl at td-conference Bern, 2008)

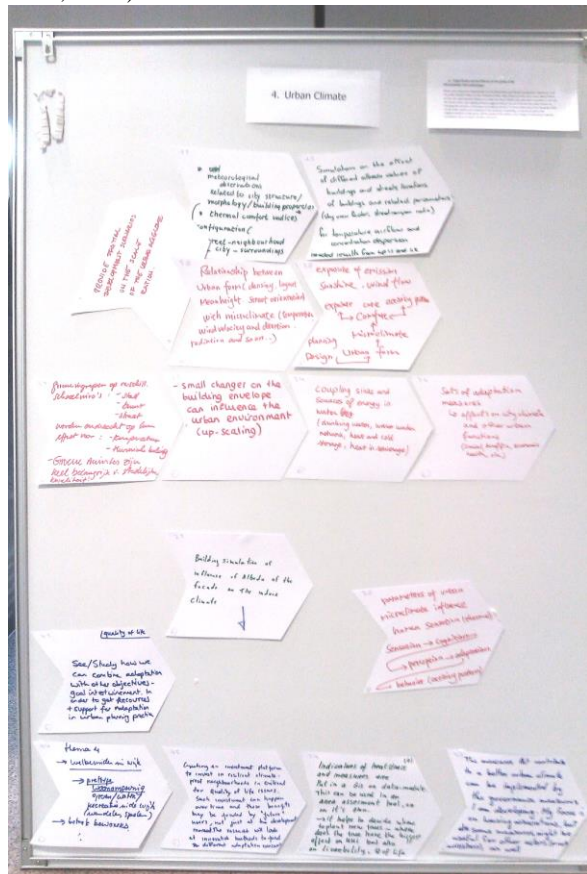


Figure 6 Results of a group activity to find out how research projects interrelate at the 2011 yearly CPC event (see also annex 1).

4.1.2 Providing guidelines to enable integration of results

Working with a large and diverse group of researchers towards a common outcome requires some *guidelines* to ensure everybody speaks the same language and all use the same concepts for reporting the outcomes. Guideline documents will be developed in 2011/2012 on the following topics:

- **Sensitivity, Vulnerability and Impact:** Definitions on the central concepts in climate adaptation strategies, and providing literature references to various views on these concepts.
- **Dealing with uncertainty:** Background on uncertainty in climate adaptation research, including examples of how to present various uncertainties in communication. The aim is to make policy makers using any CPC report aware of the uncertainties concerning adaptation options.
- **Effectiveness of adaptation measures:** Guidelines on reporting the effectiveness of adaptation measures with regard to water retention/buffering, effects on outdoor temperature and mitigation of climate change, including indicators and reporting units.
- **Costs of adaptation measures:** Summary of existing guidelines for cost of (abatement) measures (e.g. by EEA and IPCC) in a workable format for CPC.
- **Outline of the Yearly Report:** Annotated outline of the yearly report, to communicate to all researchers the framework in which their outcomes will be presented in the consecutive yearly reports.
- **Reporting on measures:** A checklist on all aspects of adaptation measures that ideally should be described, ranging from a description of measure, cost-effectiveness, to implementation issues.
- **List of relevant terms and definitions:** Growing document on frequently used terms in climate adaptation research.

4.1.3 Stimulating the integration process

Researchers are being stimulated to work together and share their data in the cases. The type of questions that are defined by stakeholders in the cases, which can be summarised in the 5 policy questions that were mentioned in section 3.1, also forces researchers to assemble their results in early stages of their research projects. The same holds for the outline of the yearly report, which is also based on the 5 policy questions.

4.2 Integration across activities beyond science

Stakeholder participation is crucial in CPC to ensure that relevant issues are being studied and the research output actually contributes to policy making, and is organized in various ways.

Case meetings are organized at least twice a year for each case study. This meeting is attended by researchers of the projects involved in the particular case and representatives of the cities and water boards. The first case meetings focused on elaborating research questions and identification of case locations. Future meetings will focus more on the implementation of research activities. Some research questions require specific local knowledge, so input from stakeholders is important in the case studies.

Besides active participation of selection of representatives from the cities, it is important to keep all stakeholder well informed about the progress of the programme. Therefore all stakeholders receive the internal newsletters and are invited to the CPC yearly events.

Participatory visioning of future developments and adaptation options will be organized with stakeholders in work package 5 (Integration). It is part of the integrated assessment of the effectiveness of proposed adaptation measures and strategies for different future projections for regional climate and socio-economic scenarios for urban development. In a participatory learning process, the experience and interests of urban planners will be integrated with knowledge of climate scientists.

Stakeholders will be involved in *shaping regular policy reporting* by consultations on list of contents and draft material. The CPC yearly report is intended for communicating the general findings of the programme and to support all stakeholders that are involved in developing adaptation strategies for cities.

Another way to ensure social relevance and applicability of results is by stimulating effective *knowledge dissemination* to stakeholders outside the CPC consortium. CPC is involved in existing strategic networks (e.g. CROW⁴, Future Cities⁵) to make knowledge accessible to local governments and other stakeholders in the built environment.

Also on the level of national government cooperation with stakeholders is established; CPC has a strong connection with of the sub-programmes of the Delta Programme New Urban Developments and Restructuring⁶ (by the Ministry of Infrastructure and the Environment). Regular contact is organized between the two programmes to align the knowledge that is being produced in CPC and knowledge that is required for policy development in the Delta Programme. If needed, the CPC consortium is able to conduct additional studies commissioned by the Delta Programme in order to support national policy development regarding urban climate adaptation, like the ‘Fysieke bouwstenen knelpuntenanalyse N&H’ and ‘Kennismontage Hitte en Klimaat in de Stad’⁷.

5 Conclusions and recommendations

Although the CPC consortium is still in the early stages of research, some conclusions on the integration processes throughout the programme can be drawn.

Within science

It is a challenge to keep researchers from focusing only on their own research projects only. Obviously, a well constructed scientific research plan in their own discipline is the fundamental starting point for the PhD projects. However, it remains crucial for them to stay aware of the fact they are part of a larger whole: CPC. Not only in order to deliver joint results, but also to benefit from each others knowledge and networks. Hence it is important to

⁴ National Information and Technology Platform for Transport, Infrastructure and Public space

⁵ EU – Interreg IVB-project “Future Cities – urban networks to face climate change” www.future-cities.eu

⁶ http://www.deltacommissaris.nl/english/topics/new_urban_developments_and_restructuring/

⁷ <http://kennisvoorklimaat.klimaatonderzoeknederland.nl/nieuws/projecten-nieuws/10719401/Kennismontage-Hitte-en-Klimaat-in-de-Stad>

stimulate communication and to strengthen connections between researchers (see Figure 6 and Annex 1). There is a role for the work package leaders in this.

In order to encourage researchers to share their knowledge, better use can be made of the existing internet facilities by Knowledge for Climate. Up to now, little literature and other documents have been uploaded on the joint internal webspace (intranet⁸). It would be worthwhile to examine whether the intranet is suitable enough or other facilities should be created to share information and results. The existing webspace is certainly not suitable to store and share large datasets like GIS maps. Therefore a central database will be developed to share maps and other data sets.

Joint products outside the original programme appeared to be effective means to bring researchers together. The ‘Kennismontage Hitte’ and ‘Fysieke bouwstenen knelpuntenanalyse N&H’ that were commissioned to CPC by the Delta Programme did not only result in useful products for the CPC research programme itself, but also made people work together in early stages of their research. It would be good to have more of these kinds of projects in the future.

Beyond science

Based on first reactions and involvement of most cities so far, the CPC consortium accomplished good relationships with its stakeholders. One of the most important success factors of CPC stakeholder participation is ‘listen to your stakeholder’. Regular meetings with stakeholders to discuss research questions, choice of case studies, ways of cooperation and first research outcomes have contributed to this achievement.

A challenge in stakeholder participation in CPC is to find the balance between involvement of stakeholders, but not overload them with meetings. Time is limited, specifically for stakeholders whose core business is not to be involved in research activities. Researchers will have to work efficiently in their contact with stakeholders. This also implies to not approach them individually on the same kind of questions. Coordination of contact moments is important, and is largely the responsibility of the case managers. For cities it is important to know the central contact persons.

Better use of internet facilities is important in stakeholder participation as well, in order to keep stakeholders better informed about what is happening where and by whom in the programme. Some stakeholders indicated they would like to learn from each other as well, not only from their specific case studies in their own cities but also from other cases.

Integration takes time

It took quite a long time to define the case studies together with the cities and other stakeholders. Sometimes several meetings were needed for the cities to understand the research programme, and for researchers to understand the state of development of adaptation thinking within the city administrations and their need for information. This stage clearly included an element of mutual learning with regard to the formulation of research questions and the identification of requirements for research locations: in early stages of the research it

⁸ Access via www.knowledgeforclimate.nl

is difficult to be precise, and one needs to acknowledge that the first research stages need to start from general notions and questions.

Outside reasons, such as changing contact persons, and uncertainty about funding and participation, have influenced the speed of the process in the CPC case as well.

Integration 'within science' through cooperation in workpackages and in cases is slowly taking off at the moment of writing. Meetings still play an important role in networking between researchers. For the success of the integrated research approach, it will be important to increase the interaction and cooperation between researchers through all possible means.

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Websites:

td-net: Network for Transdisciplinary Research
<http://www.transdisciplinarity.ch/e/Transdisciplinarity/>

Annex 1: main connections between CPC research projects

