Scientific aspects

Content

1 Description of the research programme

1.1 Problem definition, aim and central research questions

It is an important challenge to define a coherent adaptation strategy and to develop adaptation measures that are well designed and flexible, and that meet various criteria such as efficiency (in spatial and temporal perspective), coherency (e.g. in integrating cross sectoral aspects), innovativeness (in terms of exploiting new technological options and new options provided by climate change) and effectiveness.

The problem definition of the program is to improve the tools for defining the adaptation challenges for the various sectors and areas in the Netherlands and to develop, to improve and apply tools for the development of a coherent *strategy for adaptation and implementation of practical adaptation measures,* and to improve the evaluation tools to further optimize the options and to select the best packages of adaptations options.

This results in the following research questions:

1. How can - in a dynamic context and given the uncertainties related to climate change- the targets be identified for adaptation in the various sectors and the various regions of the Netherlands and what will be the desired timing?
2. How can a consistent adaptation strategy and alternative and innovative adaptation options be generated, both in terms of changes in infrastructure and changes in behavior and society, in order to cope with climate change and to make the Netherlands climate proof?
3. How can assessment and evaluation tools be developed and applied for adaptation in the various regions in the Netherlands and for the various sectors and hotspots, including crosscutting issues?

For research question 1 this requires new scientific methods to consider uncertainty issues and climate change impacts and issues like the optimal timing of the various targets for adaptation (How much needs to be done and when?)

For research question 2 we want to identify in close collaboration with the stakeholders in the various hotspots of KvK what alternative options are available, ranging from technical to behavioral and institutional options and what are the most promising ones and how can this be integrated in a consistent adaptation strategy?

Under research question 3 we will focus on the urgent and remaining issues related to the costs and benefits of the options, in particular the optimal timing of the implementation, the cross sectoral issues, discounting and the flexibility in the timing of the various steps in the implementation of the strategy and the relevant adaptation options.

1.1 Programme outline and research approach

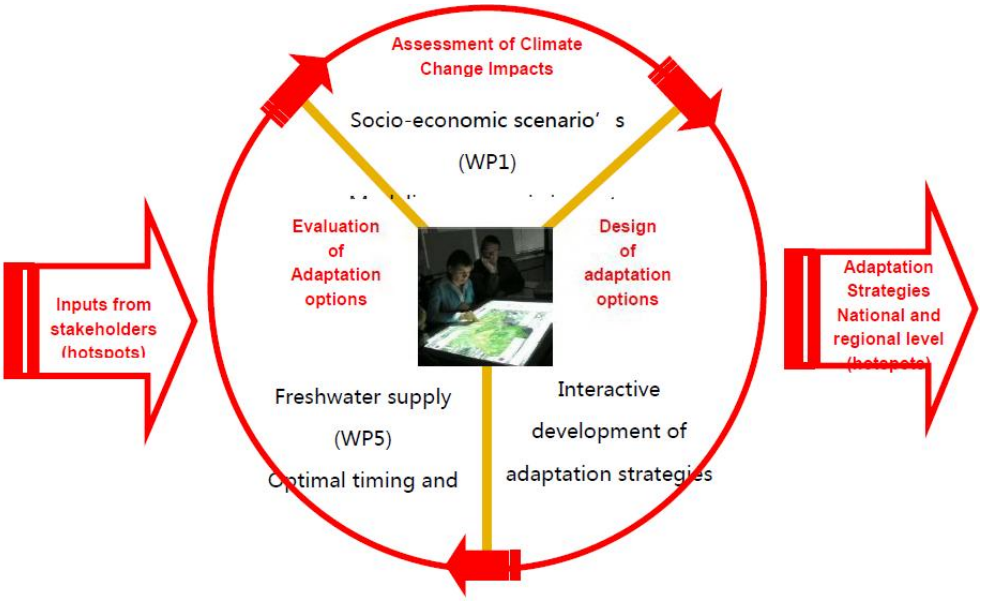

Figure 1. Outline of the program and research approach

Figure 1 shows the integrated nature of the program and the interactions between the three core domains and the WPs . In the top segment of *Assessment of climate change impacts* we focus on the assessment of climate change impacts by means of socioeconomic scenarios (**WP1**) and the modeling of flood risks (**WP2**). In the domain of *Design of adaptation options* we focus on interactive development of spatial adaptation strategies (**WP3**) and on visualization and communication of adaptation (**WP4**) in consultation with stakeholders and KvK hotspots, by means of innovative visualization techniques and interactive design interfaces. In the third domain of *Evaluation of adaptation options* we focus on the costs and benefits of the options and the selection of the best options based on the various criteria, such as efficiency, equity, spatial impacts, and timing. This is done by modeling the options for fresh water supply (**WP5**) and by studying assessment methods for developing a strategy and adaptation measures (**WP6)**, particularly focusing on

temporal aspects and optimal timing. By developing and selecting indicators the program contributes to efficient and effective monitoring of the implementation of adaptation in the Netherlands at various scale levels (**WP7**). Through regular consultation and exchange of information in the program board and in workshops the WPs will be coordinated and from the start of the program we focus on the integration of the insights obtained in the individual work packages. The topics of research are selected not to give coverage to all aspects of adaptation, but explicitly to cover a number of topics that urgently need additional attention in the context of KvK in order to serve the needs of the policymakers and the stakeholders.

Apart from contributing to WP1 and WP7, the Netherlands Environmental Assessment Agency (PBL) will take an effort in fine-tuning the program, ensuring that questions will be answered that are relevant for the preparation of the adaptation strategies in the Netherlands in the policy context and at the regional and local level. Much of the information for this will be generated in the PBL project “roadmap to a climate proof Netherlands”.

1.2 Innovative aspects and scientific output

Although many studies have focused on adaptation options, so far only rather general inventories and results have been obtained. With ongoing climatic change an urgent need exists to develop, to improve and to apply scientific methods and tools that can provide for an optimal temporal and spatial planning of adaptation options for the various sectors and regions in the Netherlands, with a potential to be used in various countries of the world. This means that the most suited scientific methods and the best tools need to be developed to clearly define the adaptation tasks; to identify alternative options; to assess these options and to select the best options for a systematic implementation by the various relevant stakeholders. The program contributes to research at the front of the disciplines involved in adaptation research by contributing to defining the adaptation challenges, based on a combination of socioeconomic and climate scenarios; given the uncertainties in both the climate scenarios and the economic development at the regional level this poses new questions to spatially explicit modeling of human activities and the impacts of climate change; in this context the Landuse Scanner Model will be improved and extended.

An important scientific issue is how to assess the economic damages of flooding. Although the direct damages can be relatively easily assessed, the secondary impacts are difficult to establish and need more attention. The program makes an innovative contribution by modeling the impacts of flood risks, in particular focusing on assessing secondary damages of flooding (an issue that is not yet satisfactorily dealt with sofar).

As adaptation involves almost all sectors and actors in the economy and in all regions, very specific knowledge is required on the impacts of climate changes on these specific sectors and regions. In order to make best use of the local knowledge of stakeholders, new methods for the iterative interaction with stakeholders will be developed to obtain the best information and best perspective on adaptation options. Visualization is used to inform stakeholders on the risks and opportunities of climate change at the regional level. Particularly innovative is the visualization of the hydrological impacts of heavy rain in polders under various circumstances through hydrological modeling directly linked to precipitation and the visualization of the impacts in a very detailed manner.

The risk of prolonged periods of drought asks for a complete revision of the strategies on fresh water allocation and storage in the Netherlands. This aspect has been stressed by the Delta Committee, which suggested to substantially raise the water level in Lake IJssel. Integrated hydro-economic modeling of fresh water resources demand and supply in the Netherlands, both at the national and regional river basin level is necessary to ensure cost-efficient solutions for future freshwater provision. The program will make innovative contributions in this domain by (i) integrating the hydrological and economic aspects of freshwater resources allocation under climate change in a joint approach, (ii) designing spatial (dis)aggregation procedures to analyze regional and national impacts simultaneously in a consistent and coherent way, and (iii) examining the possibilities of introducing water markets to deal with future freshwater allocation problems.

An important contribution of the program is the study on the optimal timing of adaptation and the issues related to discounting (this topic is still unsolved as stressed by the Stern report and related discussions and by the Deltacie, which did not elaborate on the timing of adaptation measures); The results of an improved understanding on the timing of the measures (related to fixed costs, irreversibilities, hyperbolic discounting and real option theory), will be made available for stakeholders in hotspots of KvK and for national, regional and local policymakers.

The monitoring of adaptation policies and the indicators to be used are new topics that hardly received scientific attention sofar. The program contributes to the definition and selection of appropriate indicators and their use in the implementation phase of adaption measures. This enables effective and efficient monitoring and identification of domains, sectors, categories of stakeholders or regions that will require additional attention in order to adapt to climate change. This issue is closely related to optimal timing of measures.

1.3 Relevance of the research programme in an international context

The relevance of the program at the international level is threefold:

Firstly the program produces new methods and results that are relevant for the international scientific community and that will be published in the international literature. For WP1 this includes the innovative approaches for landuse modeling; For WP2 the CGE modeling approach for assessing secondary impacts of flooding; For WP3 the stakeholder analysis based on several layers of GIS maps in an interactive manner. For WP4 the international relevance is the fundamental innovative approaches in visualization through integrated hydrological modeling and visualization in 3D, a method that can be used for assessing the impacts of heavy precipitation in many international case studies. For WP5 the fundamental innovation relevant to the international community is the integrated hydrological and economic approach for assessing fresh water allocation under different climate scenarios. The Dutch scientific expertise in this domain is highly relevant for other countries facing similar water resource allocation policy questions within and outside the EU. For WP6 the innovation is on the analysis of the optimal timing of measure for climate adaptation. So far little research has been explicitly focusing on the optimal timing under uncertainty and learning for adaptation. Most studies on optimal timing focused on mitigation. WP7 is very innovative

because monitoring of adaptation measures is just in its infancy and we still have to decide about what are appropriate indicators and how a good monitoring systems can be designed.

Secondly the program, by focusing in detail on the case studies in the Dutch contexts, provides examples and results of typical case studies that can be compared with results in other European or international case studies. Other researchers can then follow similar approaches or adjust the approach according to the local circumstances. Typical innovative case studies are the application of the GIS design table studies on the peat meadow area, the fresh water allocation in the Netherlands, and modeling of hydrology and visualization for polders in Hotspot Haaglanden.

Thirdly the results of the program can be integrated in meta analyses and integrated in European assessments of climate change impacts and adaptation options in the European context, in order to contribute to a European strategy for adaptation. Through publication in international journals, presentation at conferecens, international exchange and participation of several consortium members in EU programs such as Mediation the innovation can be shared with European partners.

1.4 International cooperation

We have international cooperation on adaptation through the EU project MEDIATION, which will run parallel to the KvK program and this guarantees up to date international cooperation and access to other disciplines within the international institutes IIASA , PIK, and JRC (see support letters). From the international research partners we would like to mention in particular the Potsdam Institute fur Klimaforschung (PIK), the International Institute for Systems Analysis (IIASA) in Laxenburg Austria and the Joint Research Center (JRC). These research institutes play a leading role in the research on climate change, bith for mitigation and adaptation and are involved in a variety of international projects on adaptation, such as the ADAM project and the EU funded project MEDIATION. These projects both focus on adaptation to climate change in Europe and apply the State of the Art methods to assess the various risks, the resilience and the best adaptation strategies. Another important related EU DG Research funded project is SIRRIMED: Sustainable Use of Irrigation Water in the Mediterranean Region, aiming to develop new models of water governance in Mediterranean countries facing climate change and increasing droughts. The WP5 leader is also the leader of the Water Governance work package in this new EU project that will start around May 2010.

The role of the institutes is particularly to exchange information on the most recent insights in the methods for assessing adaptation strategies at the local regional and national level and to integrate these insights in implications for EU policymaking. Based on the subsidiarity principle this also involves to reflect on the role that the various stakeholders play in adaptation to climate change.

Within Mediation IIASA focuses on

- identification of adaptation needs and on
- Inventory, review and critically examine methods and metrics for assessing impacts and vulnerability to slow and sudden onset climate change

- Identification of impact thresholds, key risk factors and potential adaptive responses in the form of stakeholder discussions in given sectors and regions,
- Suggest improvements of methods and metrics with a focus on a more coherent and integrated approach
- Apply available and improved methods & metrics for selected cases in key sectors at regional and European level.
- Analyse uncertainty in assessment of impacts and vulnerability and feedbacks to tools and methods as well as decisions studied

PIK focuses in particular on information and tools for assessing climate change impacts, vulnerability and adaptation options accessible for use at appropriate levels in Europe, including a GIS/ remote sensing based Decision Support System (DSS) as an early warning tool for the evaluation and strategic planning of adaptation measures, a query/database component of options and a training module.

JRC contributes to the following research activities

- Inventory, review and critically examine methods and metrics for assessing impacts and vulnerability to slow and sudden onset climate change
- Identification of impact thresholds, key risk factors and potential adaptive responses in the form of stakeholder discussions in given sectors and regions,
- Suggest improvements of methods and metrics with a focus on a more coherent and integrated approach
- Apply available and improved methods & metrics for selected cases in key sectors at regional and European level.
- Analyse uncertainty in assessment of impacts and vulnerability and feedbacks to tools and methods as well as decisions studied

In addition all partners made a reservation of funds to invite foreign experts to share their experience and perspectives on adaptation and we plan that researchers will visit foreign research institutes as well.

Wp4 has in project 1 close collaboration with the Collaborative for Advanced Landscape Planning (CALP) group at the University of British Columbia (prof. Stephen Sheppard). The PhD candidate will carry out part of the work at the CALP group. Project 2 collaborates with the RWTH Aachen Virtual Reality Group, headed by prof. Torsten Kuhlen. Part of the work in WP4 will be carried out by a postdoc researcher and a PhD student

1.5 Most important references

1. Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K.L. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007, Assessment of adaptation practices, options, constraints and capacity. In: Parry, M.L. Canziani, O.F., Palutikof, J.P., Hanson, C.E., van der Linden P.J., (eds.) Climate Change 2007.: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the

Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge, pp. 719-743.

2. Bacic, U., D. Rossiter, A. Bregt (2006) Using spatial information to improve collective understanding of shared environmental problems at watershed level; Landscape and Urban Planning 77 (2006) 54–66
3. Berkhout, F. Hertin, J. and Gann, D.M., Learning to adapt: Organisational Adaptation to Climate Change Impacts, Climatic Change, Volume 78, no 1, pp.135-156.
4. Berry, P.M.,M.D.A. Rounsevell, P.A. Harrison and E. Audsley, 2006, Assessing the vulnerability of agricultural land use and species to climate change and the role of policy in facilitating adaptation, Environmental Science & Policy, Volume 9, Issue 2, April 2006, pp. 189-204.
5. Brouwer, R. & Hofkes, M. (2008). Integrated hydro-economic modelling: Approaches, key issues and future research directions. Ecological Economics, 66(1), 16-22.
6. Brouwer, R., Akter, S., Brander, L. & Haque, E. (2009). Economic valuation of flood risk exposure and reduction in a severely flood prone developing country. Environment and Development Economics, 14(3), 397-417.
7. de Haan, G. (2009), Techniques and Architectures for 3D Interaction, PhD thesis, Delft University of Technology, September 2009
8. Fujita, M., P.R. Krugman and A.J. Venables (1999), The spatial economy: cities, regions and international trade, MIT Press, Cambridge, Mass.
9. Füssel, H-M. and Klein, R.J.T., 2006, Climate Change Vulnerability Assessments: An evolution of conceptual thinking, Climatic Change, Vol 75, no 3, pp. 301-329.
10. Geertman, S. and Stillwell, J. (Eds), 2008, Planning Support Systems: New Methods and Best Practice (New York: Springer).
11. Grothmann, T. and Patt, A. 2005, Adaptive capacity and human cognition: The process of individual adaptation to climate change, Global Environmental Change Part A Volume 15, Issue 3, October 2005, pp.199-213.
12. Harley, M., L. Horrocks, N. Hodgson and J. van Minnen, 2009. Climate change vulnerability and adaptation indicators. ETCACC Technical Paper 2008/9, EEA-ETC/ACC
13. Jansen, R., van Herwijnen, M., Stewart, T.J., and Aerts, J.C.J.H., 2008, Multiobjective decision support for land-use planning. Environment and Planning B: Planning and Design, 35, pp. 740-756.
14. Kabat, P., van Vierssen, W., Veraart, J., Vellinga, P. and Aerts, J. (17-11-2005) Climate proofing the Netherlands. Nature 438(7066): 283-284.
15. Mills, E., 2007, Synergisms between climate change mitigation and adaptation: an insurance perspective, Mitigation and Adaptation Strategies for Global Change, Volume 12, Number 5 / June, 2007, pp. 809-842.
16. Milly, P. C. D. , J. Betancourt, M. Falkenmark, R. M. Hirsch, Z.W. Kundzewicz, D. P. Lettenmaier,R. J. Stouffer, 2008, Stationarity Is Dead: Whither Water Management? , Science, 1 February 2008: Vol. 319. no. 5863, pp. 573 – 574.
17. Reilly, J. and Schimmelpfennig, D. , 2000, Irreversibility, Uncertainty, and Learning: Portraits of Adaptation to Long-Term Climate Change, Climatic Change, Volume 45, Number 1, pp. 253-278.

18. Smit, B, Burton, I. Klein, R.J.T. and Wandel, J. , 2000, An anatomy of adaptation to climate change variability, Climatic Change, 45: 223-251.
19. Stelling, G.S. and S.P.A. Duinmeyer (2003), A staggered conservative scheme for every Froude number in rapidly varied shallow water flows, Int. J. for Num. Meth. in Fluids, 43;1329-1354

2 Interdisciplinarity

The work packages are linked as is indicated in Figure 1. The team includes researchers with different disciplinary background including natural scientists focusing on hydrological modeling, spatial economists and landuse modelers and environmental economists. Also through the cooperation with the themes 1-5 of KvK the best disciplinary skills are available to the program. The interdisciplinary approach is based on profound knowledge and expertise in the individual disciplines and specific skills on interdisciplinary cooperation of the various leading researchers in the consortium. Disciplines involved are regional economics, environmental economics, spatial modeling, hydrology, transport planning and environmental policy analysis. All leading researchers have outstanding experience in interdisciplinary climate change research both at the national and international level as documented in the CVs and the track records of the participating institutes.

WP1 is strongly interdisciplinary in the integration of the climate scenarios and the economics scenarios at the regional level.
WP2 is based on integration of economic modeling, hydrology, hydraulics and risk assessment
WP3 includes GIS and visualization techniques, stakeholder analysis, planning
WP4 focuses on visualization techniques, meteorology, hydrology and programming
WP5 integrates economics, hydrology and water management
WP6 has a strong economic focus, and is directly linked to meteorology (Theme 6) and governance (Theme 7)
WP7 integrates aspects of climate science, governance and economics in defining the indicators and designing and efficient monitoring system.

Interdisciplinary approaches include integrated assessment modeling, visualization techniques and stakeholder analysis. Also in the design of indicators and monitoring in WP7 various disciplinary approaches will be brought together for the design of efficient indicators and monitoring system.

As it is not possible to include all disciplines in Theme 8 we will closely collaborate with Theme 7 on Governance to make sure that other social sciences, related to decision making, social behaviour and social psychology will be consistently be consulted and embedded in the activities. This is in particular possible because Theme 7 is also focusing on Haaglanden as a case study, which makes that the consortium leaders, jointly with leaders of Haaglanden can fine tune the activities and the budgets are available, both for Haaglanden, and the Themes 6 and 7. If necessary we will also involve and consult other social sciences, particularly outside the domain of economics.

We have contacted Prof. dr. R. Vonk, Hoogleraar Sociale Psychologie Sectie Sociale en Cultuurpsychologie Radboud Universiteit to discuss the issues of the Socio Psychological aspects and she has indicated to be willing to look into these issues and to give advice on who could further support the program in this respect.

3 Coherence between and synthesis of outcomes from the individual work packages

The coherence between the work packages has been explained under 2B2, where the structure of the program was explained. The program does not have the intention to cover all aspects of adaptation in a fully integrated manner. Instead we have identified the most pressing questions in the development of tools for improving adaptation strategies and measures, in the full iterative cycle of defining the adaptation challenges based on socio-economic and climate scenarios, the design of adaptation options and the assessment of the alternative options. Through mutual exchange of the insight obtained in each of the work packages we will work in a coherent program and contribute to consistent and new tools for adaption, that will be applied in a number of hotspots in KvK and that fill important gaps in current methods and knowledge. Through application of the socio economic and climate scenarios, the Land Use Scanner Model and the iterative procedure with stakeholders to generate and visualize adaptation strategies we will contribute to developing relevant adaptation strategies. These adaptation strategies can be assessed by means of up to date methods of cost benefit analysis and MCA. Within the hotspot Fen meadows and shallow lakes the Waterschap Noorderzijlvest, Wetterskip Fryslan, Hoogheemraadschap de Stichtse Rijnlanden, the Province of Utrecht and Friesland and Stowa have expressed interest to participate in the interactive design of adaptation strategies.

Finally, the work package on indicators and monitoring prepares for the successful implementation and the monitoring of the process of adaptation in the Netherlands, in the context of the challenges that the Netherlands are facing.

The synthesis of the outcomes of the individual work packages will be a continuous concern from the start of the project till the end. Although it will not be possible to integrate and synthesis all results within Theme 8, we intend to summarize at least the coherent results of the work packages and the related case studies in international journal articles or in a book or special issue of an international journal. We will in close cooperation with the stakeholders integrate and synthesize the results. In WP6 we will also integrate results in the context of the development of the adaptation strategy for Haaglanden in the Western part of the Netherlands. The integrated use of the various tools will particularly be relevant for the case study Haaglanden, where stakeholder analysis, visualization, cost benefit analysis and multicriteria analysis will be used in the development of the adaptation strategy. This also includes the visualization and modeling as done by TUDelft. Close cooperation between WP1, WP3, WP4 and WP6 will take place and the indicators and monitoring aspects will also be tested in the context of Haaglanden in WP7. If possible we will also use the results of WP5 on fresh water modeling in the assessment for the adaptation strategy. Theme 8 has decided to support the activities of Haaglanden with K Euro 40000 in order to support this intensive cooperation with the stakeholders.

Results will be integrated and be communicated in the scientific community and the policy domain outside the Netherlands, which makes that they can be applied at a global level. Jointly with the program bureau we will contribute to publications , such as books or special issues, that include the synthesis of the results.

4 (Expected) cooperation and coherence with other research themes

WP1 Scenarios, cooperation with Theme 6 for climate scenarios (in particular for linking the land use model with a hydrological model). For Theme 3 cooperation is envisaged as regards the sharing of scenario information and the application of the land-use model to a regional, rural case study.

WP2 provides essential decision support tools for assessing water safety investments dealing with flood risk at the national and regional scales (Theme 1:water safety at both the national and regional level). The long term effects appraisal allows for estimating reductions in flood risk due to safety investment, spatial planning (Theme 4: climate proofing urban ares)and insurance. Moreover, the indirect effects approach allows for assessing the effects of loss of production as well as infrastructure, providing input for infrastructure evaluation (Theme 5: infrastructure and networks). As wel, better ex ante estimation of total flood damage allows for improved projections and instruments for modeling (Theme 6).

WP3 Interactive development of spatial adaptation strategies, with theme 3 on Climate proofing rural areas and with theme 6.

WP4 Visualization of impacts and strategies has a relationship with theme 6 Climate scenarios. Visualization techniques will be used to express and communicate climate scenarios. These climate scenarios will be tailored according to end user requirements in theme 6 and the visualizations of WP4 will be developed accordingly. Within Theme 1 (water safety) there is a close link to WP4 at both the national and regional level.

Relevant output from theme 1 will be integrated in WP4 either via the Climate Effect Atlas or directly via project 1 of WP4. The same holds for Theme 3 (climate proofing of rural areas).

WP5 economic modeling and assessment of the impacts of climate change on freshwater resources, with Theme 3 on climate proofing rural areas and Theme 4 on climate proofing urban areas and Theme 7 on governance.

WP6 Optimal timing and cost benefit analysis with Theme 6 on climate scenarios and Theme 7 on governance, and also with Themes 3 and 4.

WP7 Monitoring and indicators with Themes 1-7, in particular with Theme 7 Governance and adaptation. WP7 Monitoring and indicators is willing to collaborate with all Themes 1-7 that express interest in evaluation and indicators, and in particular has established contacts with theme 6 (projections) for forward looking indicators, and with theme 7 (governance) for usage of indicators in governance processes.

The problem domains of water safety, freshwater supply, rural areas and urban areas will be central in our program. We will organize cooperation and improve coherence according the following routes:

Very strong cooperation with Theme 1 that is focusing on water safety issues in the Netherlands. The cooperation will mainly take place trough participation of Deltares.

Cooperation with Theme 7 Governance is also through Theme 2, WP6: Decision making under uncertainty: finding a robust and flexible fresh water. There will be a close cooperation with our WP 4 (dealing with controversies) and WP 5 (normative principles: legitimacy effectiveness and resilience); Theme 3, WP ….: Farmers' adaptation strategies. There will be a close cooperation with project 3.2 in theme 7 (Implementing climate adaptation policies: Public choices and private initiatives). Theme 6, WP on 'how to deal with uncertainties'. There will be close cooperation with project 4.2 in theme 7: (Science-policy arrangements at regional scale; how to warrant scientific requests and social robustness). Theme 7 WP on Interactive development of spatial adaptation strategies. There will be a close cooperation with project 4.1 (Dealing with climate adaptation frames).

The cooperation will be coordinated through the regular meetings of the Theme leaders, and if relevant also through the coordination in the hotspots. In addition there will be direct cooperation through the involved researchers. This will be relatively easy because a number of researchers from Theme 8 are also participating in other Themes or the leading researchers are working in the same building (for instance for Theme 7 Governance and Theme 8).

5 Connection to finalized and current projects in KfC and other research programmes

In general the program focuses on a number of unsolved issues that have arisen in other research programs and that need urgent attention. Relations with other programs are indicated for each work package:

WP1 The land-use modeling framework that was developed and applied in various projects in the preceding Climate Changes Spatial Planning program (e.g. Lands, attention to safety, ACER) will be improved based on the experiences in these projects. This concerns especially the proposed incorporation of multifunctional land use and densities in urban areas.

WP2 The concern for safety (Aandacht voor Veiligheid) project has urged the need for better scientific assessment of flood risk. For example, ex post flood estimations for the Katrina flood were 5 time ex ante flood projections for the New Orleans area. TNO and VU are involved in Waddenacademie, where they are planning to coordinate a work package on modeling of flood risk and regional economy for the North Netherlands Wadden region.

WP3 Exploring the link between climate, land use and water management to support design of adaptaion stragies has been explored within the project “Spatial decision support for management of Dutch fen meadows” funded by the BSIK programs “Climate changes Spatial Planning (KvR)” and “Living with Water

(LmW)". Results from these projects are the bases for the current research. The current proposal aims at method development. Results from the current project will be used to support case studies within a project funded as part of the Hotspot Fen meadows and shallow lakes. Methods developed in this work package will be used in the EU-KP7 project Knowseas to support design of marine reserves and other types of zoning.

WP4 Visualizations are in theory relevant to all of the KvK themes and research projects. The Bouwstenen NAS project is a KvK project which attempts to capture and disclose relevant knowledge form the various projects (within and outside the KvK programme). The Climate Effect atlas will play a central role in both work package 3 and 4 and will safeguard a close connection to ongoing KvK research. In WP4, project 1 is closely related to the currently running Building Blocks NAS project of KfC. This NAS project further develops a number of decision support tools such as the Climate Effect Atlas. The results of WP4 will provide a better scientific basis and improve the innovative character of the tools already being developed in the NAS project. The tools developed in NAS form the basis for the visualizations of project 1. The visualizations can be seen as 'add-ons' to the NAS tools to make them more effective. Parallel to project 2 and 3, a project Delft 3Di is being developed in cooperation with Hoogheemraadschap Delfland, Deltares, and Nelen & Schuurmans (a private consultancy firm in watermanagement). In this project emphasis will be on development of simulation and visualization tools for scenario exploration for decision support in water management.

WP5 Economic modeling and assessment of the impacts of climate change and adaptation strategies on freshwater resources builds upon the work carried out in the Leven met Water project "De Watereconomie van Nederland" where existing economic models were linked to existing hydrological models to assess the impacts of the implementation of the Water Framework Directive in terms of water quality improvements on the economy. Experiences in this project will be carried over to this project. An important step forwards in this new project will be the development of a combined modular-holistic hydro-economic model that allows addressing freshwater resource allocation issues under uncertainty given climate change. Furthermore, one of the unresolved key problems in the Leven met Water project was to consistently aggregate and disaggregate impacts at various levels (river basin to national and vice versa). This too will be explicitly picked up in WP5 of this underlying project, together with the introduction of (hypothetical) water markets in the developed economic model.

WP6 Optimal timing and cost benefit analysis is related to, but evidently completely distinct from the Routeplanner project on inventory of adaptation options and IC5 in the context of the program Climate change and spatial planning. Relations exist through mutual participation with Climate proofing the Netherlands, agricultural sector (PBL) and Bouwstenen NAS. Also participation in EU project Mediation in period 2010-2013. The special focus of the PhD project on optimal timing under uncertainty makes that the approach in KvK is unique and the analysis will be based on the best available approximation of probability density functions of KNMI, which will become available in the coming years, and which so far have not yet been available. This also implies that there is no overlap with previous research. In addition new contributions will be made to the development of the adaptation strategy for the hotspot Haaglanden,

partially based on the experience in the routeplanner project and in BSIK IC5. The project will clearly define the meaning of optimality in this context and will also focus on flexibility, resilience, robustness of the the policy measures and make sure that the measures remain fit-for purpose.

WP7.Monitoring and indicators will ensure collaboration with the KvK-project NAS Building Blocks, facilitated through personal overlaps. Through international, particularly European contacts, exchange of experiences and ideas will be organized with other emerging disucssions on monitoring and indicators, particularly in Germany and the European Union (EEA), e.g., through a personal overlap with the European Topic Centre on Air and Climate Change hosted by PBL.

For the longer term the consortium will investigate how after the completion of the program an organizational structure can be developed which guarantees that the developed methods and expertise remain available for further analysis and recommendations on adaptation to climate change, for instance in terms of a Center of Excellence, as mentioned by the Raad van Bestuur.