STW Perspectief

Nieuwe technologie mogelijk maken in de topsectoren

RONDE 2012/2013

Number of the programme	**P12-14**
Title of the programme and acronym	RiverCare: towards self-sustaining multifunctional rivers
Programme leader	prof. dr. S.J.M.H. Hulscher, Water Engineering and Management, Faculty Engineering Technology, University of Twente
Participating organisations	**Applying research institutes**: - University of Twente, Water Engineering and Management (WEM, UT) - University of Twente, Laboratory of Design, Production and Management (DPM, UT) - Utrecht University, Physical Geography (PG, UU) - Radboud University Nijmegen, Institute for Water and Wetland Research (IWWR, RUN) - Radboud University Nijmegen, Institute for Science, Innovation and Society (ISIS, RUN) - Delft University of Technology, Environmental Fluid Mechanics (EFM, TUD) - Wageningen University, Hydrology and Quantitative Water Management (HWM, WU) - Wageningen University, Soil Geography and Landscape Group (SGL, WU) **Potential users**: - **Knowledge institutes:** Deltares, RIVM, Alterra - **Companies:** Arcadis, Bureau Waardenburg, CSO, HKV_consultants, Royal HaskoningDHV, Witteveen+Bos, Tygron, T-Xchange - **Other organisations:** Rijkswaterstaat, Province of Gelderland, DLG, Staatsbosbeheer, US Army Corps of Engineers, Bundesanstalt für Wasserbau, Topsector Water, Directoraat-Generaal Ruimte en Water
Duration of the programme	6 years
Budget Personnel positions: 13.5 PhD students 5.3 Postdocs (3 yr)	**Requested budget from STW (€)** - programmatic activities: 60,000 - personnel costs: 3,229,548 - travel and consumables: 734,413 - Materials: 45,000 - Field work: 550,000 - **Total**: € 4,618,961 **Contribution by users / other parties** - *in cash*: 1,248,500 - *in kind*: 1,013,328 - **Total**: € 2,261,828

Keywords:
River management, sediment dynamics, river morphology, flow resistance, ecosystem services, uncertainty

A. Description of the programme

1. Summaries

1.1 Summary of the programme objectives, focus and ambitions

Rivers *live*, i.e. rivers are inherently dynamic water systems involving complex interactions among hydrodynamics, morphology and ecology. In many deltas around the world lowland rivers are intensively managed to meet objectives like safety, navigation, hydropower and water supply. With the increasing pressure of growing population and climate change it will become even more challenging to reach or maintain these objectives and probably also more demanding from a management point of view. In the meantime there is a growing awareness that rivers are natural systems and that, rather than further regulation works, the dynamic natural processes should be better utilized (or restored) to reach the multifunctional objectives. Currently many integrated river management projects are initiated all over the world, in large rivers as well as streams. Examples of large scale projects in the Netherlands are 'Room for the River' (Rhine), the 'Maaswerken' (Meuse), the Deltaprogramme and projects originating from the European Water Framework Directive (WFD). These projects include innovative measures have been executed never before on this scale and include for example longitudinal training dams, side channels, removal of bank protection, re-meandering of streams, dredging/nourishment and floodplain rehabilitation. Although estimates have been made on the effects of these measures for many of the individual projects, the overall effects on the various management objectives remains uncertain, especially if all projects are considered in connection. For all stakeholders with vested interests in the river system it is important to know how that system evolves at intermediate and longer time scales (10 to 100 years) and what the consequences will be for the various river functions. If the total, integrated response of the system can be predicted, the system may be managed in a more effective way, making optimum use of natural processes. In this way, maintenance costs may be reduced, the system remains more natural and more self-sustaining and ecosystem services such as safety, navigability, biodiversity and climate buffering can be safeguarded or even enhanced.
The unprecedented extent of these interventions, together with comprehensive in-situ monitoring now offer an excellent opportunity to gain extensive knowledge about their intermediate and long term impacts.
The key objectives of the programme are therefore to get a better understanding of the fundamental processes that drive eco-morphological changes, predict the intermediate and long-term developments, make uncertainties explicit and reduce them where possible and develop best practices to reduce the maintenance costs and increase the benefits of interventions. The projects currently or soon to be carried out in the Netherlands provide a unique opportunity to achieve these objectives and use the results to develop or improve models, guidelines and tools that van be used for river management.

1.2 Summary of the applications and industrial and/or societal relevance

We come from a tradition of river training and engineering predominantly aimed at one single focus, namely safety, navigability or freshwater supply. Now there is a growing awareness that rivers are multifunctional and, indeed, inherently dynamic. River managers in the Netherlands and elsewhere are interested in combining and optimising river functions while cutting maintenance costs. To do so it is important to know how the river system naturally responds to interventions and to have an appropriate framework to monitor and evaluate the effects, such that better river management decisions can be made. This programme will contribute to this need. It will increase our understanding of the fundamental eco-morphological processes that determine the response to an intervention which will be used to develop or improve existing tools to better predict this response. To be able to evaluate various management options, a framework will be developed in this programme that identifies the benefits of the river developments for various river functions based on ecosystem services. The results of the programme will be made available via open-access data and knowledge bases and integrated into a serious game (Virtual River) that can be used to create a setting in which river managers, stakeholders and other users together can take more educated decisions on the management of the river system. All products will be developed in close collaboration with the end users making use of (inter)national experience and case studies to ensure practical relevance and usability. In the programme we included the showcase Wealty Waal (dutch: Waalweelde) in which most of the interventions are carried out. This will illustrate the potential of the RiverCare concepts and help consultancies in advertising it abroad. The RiverCare programme will lead to more optimal management of the river system that fulfils the objectives better, require less maintenance and hence will save money to society. The improved knowledge, evaluation framework and serious game will be excellent export products for public organisations, knowledge institutes and consultancies, in national and international perspective.

2. Main scientific challenges and research lines

Now, large changes in the river system are created so that the systems is forced well away from its current state. This give an unique scientific opportunity to study the reaction of the system and combine this with the current knowledge to create (improved) models, tools and guidelines. As in most natural systems the adaption behaves as a decreasing e-curve, we expect to get sufficient information in a 3-5 year time period to describe the longer term behaviour. This will assist river managers and other stakeholders to take educated decisions on future interventions, and to embed the results of this programme in the daily practice of the end users. To tackle these challenges interdisciplinary research is necessary related to the following aspects:

River morphodynamics: Many human interventions currently taken in rivers and streams, such as longitudinal training dams, construction of side cannels, removal of bank protection, re-meandering of streams, dredging and nourishment and floodplain rehabilitation, initiate morphological changes that may ultimately hamper various river functions. Since most of these measures have not, or not at the current scale, been implemented before, it is unknown from experience what the morphologic evolution will be and how this will impact river functions. Therefore, knowledge of the morphologic effects of these interventions is crucial for a cost-effective management.

River ecology: Ecological processes will also be affected by these measures. To understand and predict the ecological development after their implementation, knowledge of biotic and abiotic processes needs to be integrated. The current scientific understanding of the dynamic interactions and feedback mechanisms between these processes is still limited, especially at the quantitative level and when it comes to establishing predictive models. There is also a need for a generic classification system of ecosystem units that is interpretable by and useful for stakeholders with various interests.

Ecosystem services: An integrated way to evaluate the societal effect of human interventions in river systems is by quantifying ecosystem services. River systems provide valuable ecosystem services such as safety, navigability, biodiversity and spatial quality, among others. Suitable approaches, indicators and standards need to be developed to quantify these ecosystem services and evaluate the societal impact of human interventions.

Uncertainty: Management decisions rely on predictions of future developments in the river system. These predictions usually involve large uncertainties which tend to be overestimated, thus forcing managers to overly conservative choices. Quantifying and where possible reducing the uncertainties in the prediction of future developments will help managers to take more robust and cost-efficient measures.

River governance: Implementing measures in river systems involves many stakeholders with varying perspectives and perceptions. A better understanding of these frames and the way stakeholders interact may open ways to a new and innovative governance model for river management.

Communication tools: For valorisation of the knowledge, models, tools and guidelines developed in this programme, these products need to be communicated effectively to the end users. This will be done by (1) involving the end users in the development of these products, and (2) develop specific tools, also with strong involvement of the end users, that aim at translating specialist knowledge to accessible and practically useful and usable information. Examples of the latter are a low-threshold data-access system, a knowledge base (Wiki), tools for visualisation of the programme results integrated in a serious game environment for collaborative decision-making.

Application: The ‘Waalweelde’ will act as a showcase in order to show the potential of the intervention measures, Virtual River and maintenance tools. This will help in advertising the Dutch river management abroad.

Figure 2 Realisation of a side channel in the Vreugdenrijkerwaard along the IJssel River in 2003 (left, photo: B. Boekhoven, Rijkswaterstaat) and sediment accretion in a side channel near Gameren along the Waal (right, photo: G.W. Geerling, Deltares).

Table 1 presents the results of the latest research assessment on a scale 1 (poor) to 5 (excellent). Table 2 gives for each research group the principle investigator (PI), his/her publication record and a selection of positions in the scientific arena.

Table 1 Results of research assessment of research groups.

Group	Quality	Productivity	Relevance	prospect	Expertise	Lead in project
WEM, UT	4	5	4	5	Management and physics of rivers and coastal seas	F,G
DPG, UT	4	3	4	3	Development of user centred design methods & tools	
EFM, TUD	5	5	5	5	Shallow environmental flows and river morphodynamics	B
IWWR/ISIS*, RUN	4	4	4	4	Ecological risk assessment of environmental stressors in river systems / Sustainable use and management of river basins	E,H
PG, UU	4	4	4	5	River and floodplain hydro-morphology and management	D
HWM/SGL, WU	4½	4	4	5	Spatial and temporal variability in fluvial dynamics	A,C

* young institute, first research assessment June 2013

Table 2 Scientific performance (from Web of Scienc) of principle investigators (PI) of research groups.

Group	PI	Publications	Citations/ Publications	H-index	Position in scientific arena
WEM, UT	Hulscher	78	10	16	VICI laureate; Alumnus KNAW-DJA; chair of conferences MARID (2004) and RCEM (2007); associate editor of JGR-Earth Surface (2004-2005); member committee restoration Afsluitdijk and Hedwigepolder; PI of several STW/ALW-projects.
DPG, UT	Van der Voort	20	9	4	PI of national programme IOP-IPCR Synthetic Environments and of sub-programs of IOP-IPCR Design for Usability, REPAR and PID Teleflex. PI of industry funded PhD projects (Ford).
EFM, TUD	Uijttewaal	46	12	14	IAHR Fluid Mechanics leadership team; chair of several conferences e.g. Euromech 523 Ecohydraulics (2011); PI of several STW, NWO-DfG funded projects; Head of Env. Fluid Mechanics Laboratory at TUDelft.
PG, UU	Middelkoop	56	13	15	PI of several (inter)national programmes (IRMA-SPONGE, NWO-LOICZ, NWO-STW Biesbosch); Member of the Netherlands Commission for Environmental Assessment.
IWWR, RUN	Leuven	96	13	22	PI of several (inter)national programs such as EU interreg IRMA SPONGE & Urban Water, NWO-LOICZ & SSEO; Member of the Netherlands Commission for Environmental Assessment.
ISIS, RUN	Smits	74	14	19	PI of several (inter)national programmes such as EU, FP7 interreg programmes (A,B and C) and NWO-LOICZ & SSEO and NWO VERDUS.
SGL, WU	Wallinga	54	25	20	VENI & VIDI laureate; Director of Netherlands Centre for Luminescence dating; PI of STW project.
HWM, WU	Hoitink	25	7	9	PI of PhD projects funded by NWO-ALW, NWO-Wotro, KNAW and Stowa; Head of the Kraijenhoff van de Leur Laboratory for Water and Sediment Dynamics at Wageningen University.

3. Application perspective at the programme level

Economic and societal relevance: RiverCare will contribute to sustainable river management by reducing lifecycle costs and increasing benefits from ecosystem services. The individual projects, the Virtual River tool and the 'Waalweelde' application will serve as showcases to bolster the forerunner position of Dutch delta technology.

Application perspective: Using the planned and ongoing Dutch interventions as a unique large-scale experiment allows us to generate new knowledge and tools to optimize future river management strategies. This will yield direct economical and societal benefits. In addition, the close cooperation with users in each project will increase the worldwide applicability of the Dutch expertise in river management.
Demand orientation: RiverCare is based on important questions put forward by users.
User commitment: See letters of support.
Technical objectives: Most projects aim at innovative technological solutions toward more sustainable river management and better monitoring. RiverCare will advance the scientific knowledge and technological knowhow needed to forecast the effects of measures in river systems. All projects have their own scientific output and will also contribute to the serious-gaming tool Virtual River, the Wiki and the data-base.
Expected results: This programme brings many relevant scientists and end users in the field of rivers together and we expect that this collaboration will result in a better transfer of knowledge and questions from end users and lead to scientifically sound and practical tools that will be applied in daily practice to manage the rivers towards a more self-sustaining, multifunctional system with increased benefits worldwide. Each project may contribute to the development of new or improved models, tools or guidelines. We also envision a user-friendly, open-access database and Wiki containing all collected data and all results generated by RiverCare. The Wiki will be continued from the Wiki of the EU-project REFORM. We will develop the Virtual River tool, which will be tested together with Dutch river managers and consultancy firms, and also become available for educational purposes. On the scientific side we expect fourteen PhD theses and a large number of scientific and professional publications. Finally, this programme will provide highly valuable training for PhD, MSc and BSc students, ready to be employed in the water sector.
Contribution to public-private partnerships (PPP): Nationally and internationally, public as well as private stakeholders are involved in water management. The programme's close collaboration with both types of end user will strengthen existing partnerships and likely foster new ones. Also, Rijkswaterstaat is currently experimenting with Design-Build-Finance-Maintain (DBFM) contracts, a new type of long-term contract that includes not only the design and implementation of an intervention but also its financing and maintenance. This will lead to an entirely different relationship between government and private sector. The knowledge resulting from RiverCare will help river managers, consultants and contractors to prepare for DBFM contracts.
Utilisation plan: Most scientific partners of the RiverCare programme participate in the Netherlands Centre for River Studies (NCR), and this collective research programme will strengthen the network among scientists as well as between scientists and users. To enhance the team spirit, we envisage to start with a three-day field trip with users, researchers and supervisors visiting typical projects in the Netherlands and abroad.
We will use the NCR website to keep each other informed about all RiverCare activities and to make the programme's products available. We plan to have an annual full-day meeting with all users and researchers. Researchers will present brief progress reports, to be followed by workshops in which users interact with researchers discussing applications to foreign rivers and new validation possibilities (e.g., Mississippi delta (US), the Danube basin (Romania) and river systems in Colombia and Indonesia), also covered in project H. This day can be linked to the annual NCR days.
Next, we plan to organise at least two two-days courses, with a basic part (for young engineers and scientist from other scientific/engineering areas) and an advanced part discussing the latest insights from the RiverCare programme. These courses will be open for people inside as well as outside RiverCare.
Furthermore, due to the discussions in the RiverCare workshops and the strong involvement of the users in the projects, we expect that RiverCare will spark off many MSc and BSc projects. This is already quite common in our research field, and the high visibility of RiverCare will motivate students even more to formulate projects within this context. This will also lead to more academics to meet the increasing demand for highly qualified river specialists in the government, the private sector, the knowledge institutes and academia.
Exchange of knowledge will also occur through the mobility of everyone working on RiverCare, and through joint supervision of the projects. The researchers will be on user locations part of the time, facilitated by employees of users that hold part-time positions at universities.
The creation of the end products of RiverCare is planned in Project F (knowledge base, communication and virtual river. The users play a central role in stating their wishes in the first phase of the Programme and giving feedback on these products during the Programme. The Virtual River tool will also be of use for educational purposes (secondary schools, colleges and universities) and may help increasing public awareness that rivers have a behaviour of their own that would better be respected. We are also considering launching a computer game called 'Train the river'.
Market perspectives: The growing awareness of the value of rivers, the increasing exploitation of rivers and the potential impact of climate change worldwide makes multidisciplinary knowledge of the behaviour of

rivers and associated management issues a valuable commodity. Delta technology is foreseen as an important field for export of Dutch expertise. This programme will boost Dutch expertise on river restoration and management which can be applied in deltas around the world. We include an application to the 'Waalweelde' so that this can act as a showcase and facilitates using the RiverCare knowledge, models, tools and guidelines in other projects in the Netherlands and abroad, as many of them are involved in national and international river management projects.
Users community: Most of the relevant stakeholders in Dutch river management are involved in the programme, varying from national and regional authorities, knowledge institutes, consultancies, NGOs to local field managers. In addition some international partners have shown interest in the programme. This variety of end users represents a large range of different expertise from which the programme can benefit and vice versa.

4. Strategic relevance of the programme
Added value: The proposed programme provides the opportunity to collaborate in a large consortium of researchers and end users with a large variety of different expertise. So far, many bilateral projects between researchers and end users have been performed, often on mono-disciplinary topics. This programme should be able to bring river research and its practical application to a level that could not be reached in smaller research groups.
Sense of urgency and importance of programmatic approach: Projects such as 'Room for the River' (Rhine) and 'Maaswerken' (Meuse) and numerous stream restoration projects have been designed without much attention for the large-scale response of the river system. The fact that they are currently being carried out presents not only a unique opportunity, but also a must to evaluate the effects of these projects. River management of national and regional waterways has become a complex matter involving multiple disciplines and stakeholders. It can only be addressed properly by integrating these disciplines and actively involving all end users. The fact that for the Netherlands Government has passed a law for the Deltaprogramme, which includes the definition of a long term (2050 and 2100) strategy for river maintenance, only underlines the necessity of RiverCare.
Refreshment of the network: The consortium builds on the Netherlands Centre for River Studies (NCR), a platform in which the involved universities, Rijkswaterstaat, Deltares and Alterra exchange information on ongoing research and projects. This programme provides the opportunity to actually collaborate in research projects with different cross links. In addition, the network is extended by several other end users that enrich the network with their perspectives on the matter.
Long-term perspectives: The Wiki will be hosted by Deltares after the end of RiverCare. The Virtual River game will be applied in the Netherlands at 'Waalweelde' (showcase) and the valorisation abroad will be explored further in project H. In this way we create experience how this instrument can help in exporting the 'Room for the River' and 'Maaswerken' concepts, starting with the Deltaprogramme.
Opportunity to excel: Lowland rivers are important economic drivers in deltas all around the world. They provide fresh water for irrigation, industry and domestic use, can be used for shipping, carry sediment downstream to feed the coast and are important ecological corridors. Cut-off or excessive use of these resources leads to major problems in many of these areas. Sustainable river management is a vital component of economically and environmentally relevant delta technology. Bundling the river research capacity in the Netherlands in RiverCare will enhance our position as experts in delta technology.
Practical embedding: Strong involvement and commitment of the end users as expressed in the letters of support will warrant the practical embedding of the programme results.

5. Structure and organisation of the programme
The programme consist of 8 projects:
A. Optimizing longitudinal training dam design (WU-Hoitink)
B. Side channels and erosion of natural banks (TUD-Uijttewaal)
C. Regional river systems: implications of novel stream restoration approaches (WU-Wallinga)
D. Sediment nourishment and floodplain monitoring (UU-Middelkoop)
E. Ecosystem services and floodplain rehabilitation (RUN-Leuven)
F. River governance: uncertainties, participation and collaboration (UT-Hulscher)
G. Communicating programme outcome: knowledge base, visualisation and Virtual River (UT-Hulscher)
H. Self-supporting hydrosystems and valorisation (RUN-Smits)

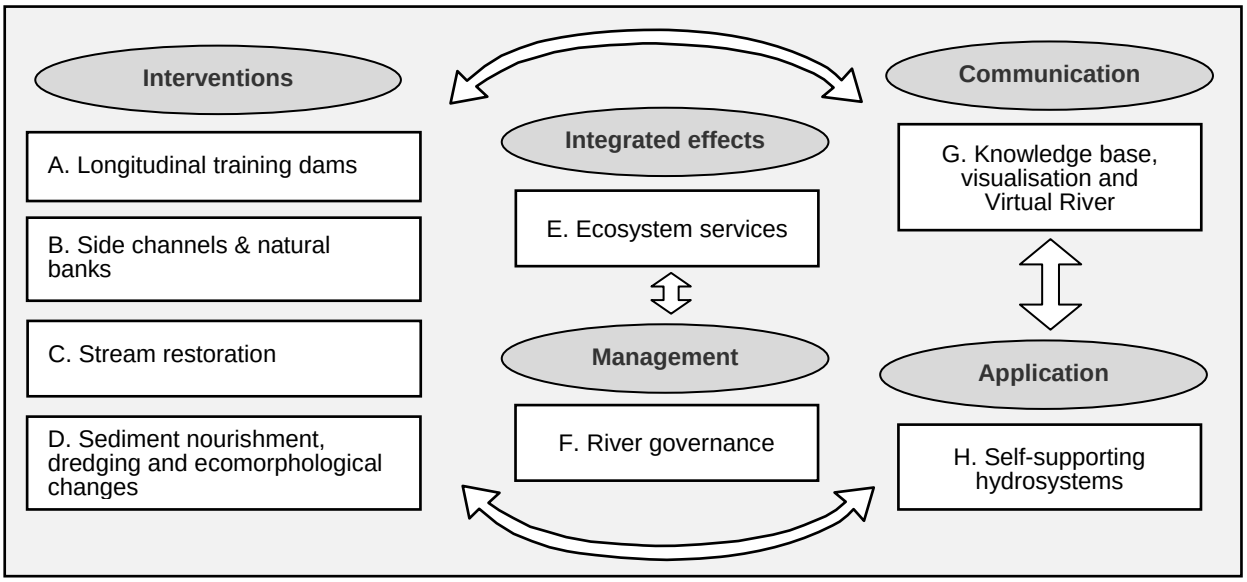

Figure 1 Scheme of projects in the programme.

Projects A-D focus on increasing the fundamental knowledge of the ecomorphological changes after a specific intervention and are coupled to existing monitoring plans that give insight in the first response of the river or stream to the intervention. In project E the most relevant ecosystem services will be quantified and used to develop an integrated assessment framework that is able to evaluate the societal benefits of interventions and management strategies. Project F tries to quantify and reduce the uncertainties inherently involved in the prediction of the river's response to management decisions and looks for optimal ways of stakeholder participation and collaboration in decision-making processes. Both, project E and F will make use of the knowledge generated in projects A-D. In project G the data and knowledge generated in the programme will be made accessible by a low-threshold data-access system and knowledge base (Wiki). Spatial and temporal developments predicted based on the knowledge generated in the programme will be visualised and integrated in a serious game (Virtual River) to facilitate collaborative decision-making. Export opportunities and the showcase 'Waalweelde' are addressed in H. Each project is described in more detail in part B.

Coherence: Coherence in the programme is achieved at three levels: subproject (PhD-trajectory) level, project level and programme level. In each subproject the supervision team consists at least of two scientific groups and one user. This will support the interaction of research groups and end users and warrants that the results are in line with the practical needs of the end users. Because each project consists of at least two subprojects, researchers, supervisors and end users also interact in user meetings at project level. Because supervisors and end users are often involved in more projects this will stimulate coherence among projects. At the programme level a steering committee will guard the objectives of the overall programme.

Programme coordination:

Programme level: Steering committee consists of all project leaders and representatives of the main funding organisations (RWS, RWS-ON, Deltares, STOWA)

We propose to have every 3 months a RiverCare information day. All project teams together (scientists and in-kind contributing users) meet in a one-day meeting rotate between the universities and having roughly the following structure:

- Lectures provided by the host university
- Presentations of the scientists reporting their progress
- Game and/or site visit and/or lab visit or social activity

During this day the steering committee meets parallel to the meeting of the scientist e.g. during the lectures.

Project level: The scientist and in-kind contributing users in projects will have meetings every 3 months to provide in-depth discussions.

PhD-trajectory level: managed by the home university, meetings at least bi-weekly with the daily supervisor and bi-monthly with the whole supervising team.

Table 3 Schematic overview of the programme.

Projects	Subprojects	Applying research groups	Potential users
A Optimizing longitudinal training dam (LTD) design	A1 Hydraulics of LTDs (PhD)	a. Wageningen University-HWM: Dr. Hoitink b. Delft University of Technology-EFM: Prof. Uijttewaal	Rijkswaterstaat, Deltares, Witteveen+Bos, HKV
	A2 Ecology of LTDs (PhD)	a. Radboud University Nijmegen-IWWR: Dr. Leuven b. Wageningen University-HWM: Dr. Hoitink	Rijkswaterstaat, Deltares, Witteveen+Bos, HKV
B Side channels and erosion of natural banks	B1 Side channels (PhD)	a. University of Twente-WEM: Dr. Schielen b. Delft University of Technology-EFM: Dr. Blom	Rijkswaterstaat, HKV, CSO, RoyalHaskoningDHV
	B2 Natural banks (PhD)	a. Delft University of Technology-EFM: Prof. Uijttewaal b. Utrecht University: Dr. Kleinhans	Rijkswaterstaat, Waterboards, RoyalHaskoningDHV
C Regional River systems	C1 Morphodynamics (PhD)	a. Wageningen University-SGL: Prof. Wallinga b. Utrecht University-PG: Dr. Kleinhans	STOWA, Rijkswaterstaat, Alterra, Witteveen+Bos, Waterboards
	C2 Hydrology (Postdoc)	a. Wageningen University-HWM: Dr. Hoitink b. Wageningen University-SGL: Prof. Wallinga	STOWA, Rijkswaterstaat, Alterra, Witteveen+Bos, Waterboards
D. Sediment nourishment and floodplain monitoring	D1 Nourishment (Postdoc)	a. Delft University of Technology-EFM: Dr. Blom b. University of Twente-WEM: Prof. Hulscher	Rijkswaterstaat, Witteveen+Bos
	D2 Dredging (PhD)	a. Delft University of Technology-EFM: Dr. Blom b. University of Twente-WEM: Prof. Hulscher	Rijkswaterstaat, Witteveen+Bos
	D3 Floodplain monitoring (PhD)	a. University of Utrecht-PG: Prof. Middelkoop b. University of Twente-WEM: Dr. Augustijn	Rijkswaterstaat, HKV, Witteveen+Bos
E Ecosystem services and floodplain rehabilitation	E1 Floodplain rehabilitation (PhD)	a. University of Twente-WEM: Dr. Augustijn b. Radboud University Nijmegen-ISIS: Dr. Leuven	Rijkswaterstaat, Deltares, Arcadis, DLG
	E2 Ecosystem services (PhD)	a. Radboud University Nijmegen-ISIS: Dr. Leuven b. University of Twente-WEM: Dr. Augustijn	Rijkswaterstaat , RIVM, Deltares, Bureau Waardenburg, Arcadis, DLG
F River governance: uncertainties, participation and collaboration	F1 Uncertainty (PhD)	a. University of Twente-WEM: Prof. Hulscher b. Wageningen University-HWM: Dr. Hoitink	Rijkswaterstaat, HKV,
	F2 Participation (Postdoc)	a. Radboud University Nijmegen-ISIS: Prof. Smits b. University of Twente-WEM: Prof. Hulscher	Rijkswaterstaat , Witteveen+Bos
	F3 Collaboration (0.5 PhD)	a. Radboud University Nijmegen-ISIS: Prof. Smits b. University of Twente-WEM: Prof. Hulscher	Rijkswaterstaat, Province of Gelderland, Witteveen+Bos
G Communicating programme outcome: knowledge base, visualisation and Virtual River	G1 Virtual River/serious game (PhD)	a. University of Twente-DPG: Dr. van der Voort b. University of Twente-WEM: Prof. Hulscher	Rijkswaterstaat, Deltares, Tygron, T-Xchange, consultancies
	G2 Knowledge base & communication (Postdoc)	a. University of Twente-WEM: Prof. Hulscher b. University of Twente-DPG: Dr. van der Voort	Rijkswaterstaat, Deltares, Tygron, T-Xchange, consultancies
	G3 Knowledge base & communication (Postdoc)	a. University of Twente-WEM: Prof. Hulscher b. University of Twente-DPG: Dr. van der Voort	Rijkswaterstaat, Deltares, Tygron, T-Xchange, consultancies
H Self-Supporting Hydrosystems and Valorisation	H1 Wealthy Waal: Morphodynamics (PhD)	a. Utrecht University-PG: Dr. Kleinhans b. Radboud University Nijmegen-ISIS: Prof. Smits	Province of Gelderland, Rijkswaterstaat
	H2 Wealthy Waal: Environment and valorisation (PhD)	a. Radboud University Nijmegen-ISIS: Prof . Smits b. Radboud University Nijmegen-IWWR: Dr. Leuven	Province of Gelderland, Rijkswaterstaat
	H3 Export possibilities(0.33 Postdoc)	a. Radboud University Nijmegen-ISIS: Prof. Smits b. University of Twente WEM: Prof. Hulscher	Province of Gelderland, Rijkswaterstaat, consultancies

Planning:

Table 4 Schematic representation of the research planning

Project	Subproject	0-6 month	6-12	12-18	18-24	24-30	30-36	36-42	42-48	48-54	54-60	60-66	66-72
A	A1 PhD												
	A2 PhD												
B	B1 PhD												
	B2 PhD												
C	C1 PhD												
	C2 PD												
D	D1 PD												
	D2 PhD												
	D3 PhD												
E	E1 PhD												
	E2 PhD												
F	F1 PhD												
	F2 PD												
	F3 0.5 PhD												
G	G1 PhD												
	G2 PD												
	G3 PD												
H	H1 PhD												
	H2 PhD												
	H3 PD												

6. Financial planning

Project	Requested from STW		Cofunding	
A	2 PhDs	€ 362,446	**In cash**	
	Travel & Consumables	€ 47,554	Rijkswaterstaat	€ 55,000
	Field Work	€ 90,000	Deltares	€ 75,000
			In kind	
			Rijkswaterstaat	€ 29,520
			Deltares	€ 40,000
			Witteveen+Bos	€ 7,500
			HKV_consultants	€ 38,080
B	2 PhDs	€ 362,446	**In cash**	
	Travel & Consumables	€ 47,554	Rijkswaterstaat	€ 125,500
	Field Work	€ 90,000	**In kind**	
			Rijkswaterstaat	€ 81,500
			CSO	€ 45,000
			Royal HaskoningDHV	€ 38,080
			HKV_consultants	€ 38,080
C	1 PhD	€ 181,223	**In cash**	
	1 Postdoc	€ 180,840	STOWA	€ 101,000
	Travel & Consumables	€ 91,937	Alterra	€ 15,000
	Field Work	€ 30,000	Rijkswaterstaat	€ 5,000
			In kind	
			STOWA	€ 62,000
			Alterra	€ 26,180
			Witteveen+Bos	€ 7,500
D	2 PhDs	€ 362,446	**In cash**	
	1 Postdoc	€ 180,840	Rijkswaterstaat	€ 235,000
	Travel & Consumables	€ 116,714	**In kind**	
	Fieldwork	€ 190,000	Rijkswaterstaat	€ 102,000
			HKV_consultants	€ 26,656
			Witteveen+Bos	€ 7,500
E	2 PhDs	€ 362,446	**In cash**	
	Travel & Consumables	€ 47,554	Rijkswaterstaat	€ 58,000
	Fieldwork	€ 90,000	RIVM	€ 70,000
			Bureau Waardenburg	€ 10,000
			In kind	
			Deltares	€ 40,000
			RIVM	€ 22,848
			Bureau Waardenburg	€ 22,848
			Arcadis	€ 22,500
F	1.5 PhD	€ 271,835	**In cash**	
	1 Postdoc	€ 180,840	Rijkswaterstaat	€ 155,250
	Travel & Consumables	€ 109,465	**In kind**	
			Rijkswaterstaat	€ 69,400
			HKV_consultants	€ 38,080
			Witteveen+Bos	€ 7,500
G	1 PhD	€ 181,223	**In cash**	
	1 Postdoc	€ 180,840	Rijkswaterstaat	€ 93,750
	Travel & Consumables	€ 252,937	Deltares	€ 75,000
	Materials	€ 45,000	Arcadis	€ 8,000
			Royal HaskoningDHV	€ 5,000
			Witteveen+Bos	€ 2,000
			In kind	
			Deltares	€ 84,000
			T-Exchange	€ 72,500
			Tygron	€ 45,132
			HKV_consultants	€ 11,424
H	2 PhDs	€ 362,446	**In cash**	
	0.33 Postdoc	€ 59,677	Province of Gelderland	€ 150,000
	Travel & Consumables	€ 20,698	Rijkswaterstaat	€ 10,000
	Fieldwork	€ 60,000	In kind	
			Rijkswaterstaat	€ 25,000
			Arcadis	€ 2,500
	Programmatic activities	€ 60,000		
	Total	€ 4,618,961	**Total**	€ 2,261,828
			In Cash	€ 1,248,500
			In Kind	€ 1,013,328

B. Description of the projects in the programme

Nieuwe technologie mogelijk maken

Project number: A
Project title: Optimizing Longitudinal Training Dam Design

Project leader: Dr. A.J.F. Hoitink, Wageningen University

Requested research positions: 2 PhDs

Budget:
Requested from STW: k€ 500
Contribution by users: k€ 130 (*in cash*) & k€ 115.1 (*in kind*)
Non-eligible support (laboratory experiments): k€ 80 (*in cash*)

I. Scientific description of the project

Longitudinal training dams (LTDs, Figure 1) serve to constrict the flow in the navigable part of a river during low flows, and to increase the discharge capacity during flood conditions (Vermeulen et al., 2013). In The Netherlands, the replacement of series of river groynes by LTDs is considered to be a key measure to prepare the Dutch rivers for the next century and beyond. The flexibility to create gaps in the dam potentially offers the opportunity to control unwanted morphological effects in the main and side channel. Training dams are also expected to exert a favourable influence on habitat diversity and ecological conditions. At present, aquatic-terrestrial zones along rivers regulated by groynes and rip rap banks are highly dynamic and characterized by low shoreline complexity. River banks typically represent harsh environmental conditions, due to high disturbance by impacts from navigation, which causes shipping waves, water displacement and bank erosion. These environmental conditions result in low biodiversity and dominance of invasive exotic species (Nienhuis et al., 2002; Buijse et al., 2002; Leuven et al., 2009). LTDs may create shallow and sheltered lotic habitats and gentle slopes subject to intermediate hydro-morphological disturbance and supporting high biodiversity values. The objective of this project is to develop the scientific knowledge needed to optimize the design and management of longitudinal training dams in terms of navigation, flood protection and ecological rehabilitation of regulated rivers.

The design of an LTD and its openings should be such that the exchange of water and sediment can be controlled at low and high water stages. At low water stages, the penetration of ship-induced waves and flow should be reduced such that the disturbing influence of navigation is minimized without disconnecting the side channel completely. At high water stages, sediment transport over the LTD and through the openings will affect the bathymetry of the main channel and the side channel, depending on the local flow direction and level of turbulence. In view of erosion and aggradation of sediment, a proper lay-out of the LTD, regarding height, shape and orientation as well as the locations and shape of the openings is of paramount importance for the LTDs to meet multiple criteria. It is therefore important to achieve a thorough understanding of the transport processes associated with an LTD, and using this knowledge, to optimize the design regarding the hydro-physical and ecological consequences. The prospective project aims to understand the interactive effect of design parameters, by means of field monitoring, laboratory experiments, and modelling.

Figure A1 A: Longitudinal training dam separating the fairway (left) from a shallow side channel (right), B: flow across a gap in the dam, C: top view illustrating exchange.

This project requires expertise in the fields of hydraulics and ecology and is therefore composed of two PhD studies (Table 1). Subproject A1 aims at a physics-based optimization strategy in the geometrical design of LTDs, for which the following research questions are formulated:

1. Which are the local physical processes governing the exchange of water and sediment within a LTD gap, for alternative geometries of the gap?
2. How do alternative planform schematizations of the LTD affect the regional hydrodynamics and morphological developments?
3. Which effects can be expected from variation in design parameters, and do these interact?
4. What is the best design strategy to let the hydrophysical system meet multiple criteria, after calibration of the gap geometry?

Subproject A2 aims at a generic LTD design and management strategy for ecological rehabilitation of regulated rivers, by answering the following research questions:

1. To what extent do LTDs improve ecological conditions in regulated rivers, compared to traditional river training (i.e. river groynes and rip rap banks)?
2. What are the temporal developments of river ecotopes protected by LTDs?
3. Do LTDs yield similar habitat diversity and quality as side channels constructed in floodplains?
4. Which are the controlling factors available to improve design and management of LTDs for ecological quality?

Each subproject aims to result in a PhD thesis composed of 7 chapters, of which 5 are planned to result in a paper. Guidelines for LTD design will be published as a joint (A1/A2) scientific paper.

Table A1 Layout, time planning and products of the two PhD projects

Project / phase	Year 1				Year 2				Year 3				Year 4				Goal or deliverable
A1 Hydraulics of LTDs																	Physics-based optimization strategy in the geometrical design of gaps in LTDs
1. Research design																	Research questions, methods and planning; scope & outline of thesis (Ch1)
2. Literature review and initial modeling																	Desk study 2D/3D schematization of training dams with multiple gaps in Delft3D (Ch2)
3. Laboratory experiments																	3D flow structure and sediment transport in LTD gaps from laboratory experiments (Ch3)
4. Field monitoring, and data analysis																	Establish 3D flow, sediment transport and morphology in the River Waal field pilot (Ch4)
5. Numerical modeling in Delft3D																	Modeling strategy to represent LTDs in Delft3D, using new parameterizations (Ch5)
6. Development optimization strategy																	Strategy to optimize the LTD design in terms of navigation, flood risk and ecology (Ch6)
7. Application to the pilot case																	Advice to adjust gaps in the field pilot based on research results throughout the PhD study
8. Synthesis		1						2				3	4	5	6	7	PhD-thesis (Ch1-7), joint paper on guidelines
A2 Ecology of LTDs																	LTD design and management strategy for ecological rehabilitation of regulated rivers
1. Research design																	Research questions, methods and planning; scope & outline of thesis (Ch1)
2. Literature review and data mining																	Species sensitivity distribution modeling to assess ecological benefits of LTDs (Ch2)
3. Field monitoring, and data analysis																	Initial development of shoreline complexity and habitat diversity behind LTDs (Ch3)
4. Modeling habitat suitability																	Implementation of biodiversity indicators in HABITAT model (Ch4)
5. Evaluation of ecological benefits																	Assessment of ecological succession behind LTDs using results of BACI-monitoring (Ch5)
6. Management and design optimization																	Ecological optimization of design and management criteria for LTDs (Ch6)
7. Application																	Workshop with users on options to improve/ manage LTDs; user training HABITAT-model
8. Synthesis		1			2					3		4		5	6	7	PhD-thesis (Ch1-7), joint paper on guidelines

II. Utilisation plan

A comprehensive 6-year pilot project for the River Waal has been initiated by Rijkswaterstaat, which has reached the phase of implementation. Two training dams are being constructed in serial inner bends of the river, covering a total length of about 10 km. The two side channels, on opposite banks of the river, are interrupted by 7 gaps in total. All information generated within the RiverCare project, including intensive field monitoring, laboratory experiments, numerical simulations and habitat modeling is shared and used for optimizing the implementation in the pilot project in the River Waal, as well as for deriving generic guidelines for future LTD designs. Thus, a unique opportunity is created to maximize the benefits for all parties involved. Both subprojects will have a practical case where from day one data can be collected to monitor the effects of this major interference with the river. At the same time, state of the art monitoring techniques are used that provide detailed information needed to optimize the LTD in the field. The deliverables are expected in the following arrangements.

Extensive data sets will be built from continuous monitoring, repeated field surveys and laboratory experiments using a physical scale model. In the River Waal pilot, permanent surface level gauges will be employed to monitor mean level and ship waves. Horizontal acoustic Doppler current profilers (HADCPs) will yield horizontal profiles of flow velocity, turbulence quantities and acoustic backscatter, which is a surrogate for suspended sediment concentration (Sassi et al, 2012). The HADCPs will be moored on top of the training dams to collect profile measurements across the openings, into the side channel, and along the crest of a training dam. Repeated boat surveys will consist of multi-beam echo sounding and ADCP measurements with a high spatial coverage. Bed sediment will be sampled once every year to investigate sediment sorting processes. A bottom lander will be place in the dam opening under study, deployed with coupled ADCPs to capture detailed information about the 3D flow and turbulence structure (Vermeulen et al., 2011). Ecological surveys concerning habitat availability, ecological succession and relevant environmental factors will be made on a regular basis to monitor the variations throughout the seasons, as well as the evolution over the years after implementation of the LTDs. Vegetation coverage and biodiversity will be determined on the basis of target species, and comparisons will be made with historical data and reference locations without LTDs. The **laboratory experiments** aim to reveal local flow processes and initial morphological developments for alternative gap designs, adopting a similar approach as in Vermeulen et al. (2013).

Modelling tools that are used by Deltares for hydrodynamic and morphological simulations (Delft3D), and for ecological simulations of habitats for individual or groups of species (HABITAT), will be improved to allow for appropriate modeling and optimization of LTDs. Delft3D improvements will aim to capture 3D effects in processes of flow and sediment transport in a 2D horizontal model, by developing suitable parameterizations. Both for long-term Delft3D computations, needed to predict morphodynamic developments, and for HABITAT simulations, a method will be developed to derive representative boundary conditions. The utilization of the improvements realized in Delft3D and in HABITAT will readily reach beyond the application to the River Waal pilot study, since these simulation packages have a worldwide users group supported by Deltares. Based on the findings of this study **design guidelines** will be developed that integrate the hydraulic, morphodynamic en ecological performance of LTDs. This will be done in close collaboration with Rijkswaterstaat. To facilitate the utilisation process, regular meetings will be organized with all researchers and users involved, in order to evaluate the observations and to value the interpretations for adaptations of the design. This holds for the design of the pilot project but also, in a more generic sense for the design of future LTD.

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Nieuwe technologie mogelijk maken

Project number: B
Project title: Side channels and erosion of natural banks

Project leader: Prof.dr.ir. W.S.J. Uijttewaal, Delft University of Technology

Requested research positions: 2 PhDs

Budget: **Requested from STW:** k€ 500
Contribution by users: k€ 125.5 (*in cash*) & k€ 202.66 (*in kind*)

I. Scientific description of the project

The biogeomorphodynamics of trained rivers can be enhanced by leaving the banks unprotected and by creating side channels. Both measures increase spatial substrate variability due to the larger cross-sectional variation in flow and sediment transport which improves ecological diversity. At the same time conveyance capacity and navigability should be guaranteed, and maintenance efforts should be manageable and cost-effective. Proper understanding and predictability of the morphodynamics are therefore of key importance in the design of river restoration projects. Two research challenges are identified and described below in detail. First the stability of the side channels, which should neither fill in rapidly nor erode and attract discharge. Both problems would require expensive maintenance. Second, the local processes governing the rate of bank erosion require attention as they determine the planform changes in the main and side channels with freely erodible vegetated banks.

Subproject B1: Side channels

In this subproject, we focus on the morphodynamics of unequal bifurcation of side channels. Side channels are a popular measure which regains some natural river behaviour between otherwise fixed levees, but they often have infilling, which is unwanted for ecological purposes, or degradation and increasing discharge, which endangers navigability. We will both study the Dutch situation and evaluate cases abroad. Current developments in the larger scheme of Room for the River in the Netherlands enable us to monitor the behaviour of side channels from the construction phase onwards.
The overall objective of this project is to develop a procedure for the design of a side channel (or system of side channels) that minimizes maintenance.

Research questions

1. What are the effects of bifurcation shape on flow and sediment partitioning?
2. What are the relative contributions of bedload and suspended load in various configurations to aggradation or degradation of the side and main channels? How does sediment sorting affect these contributions?
3. What are the optimal and adaptive bifurcation shapes that lead to stable side channels?
4. What are effective methods (such as flushing and construction of bottom vanes) to maintain a side channel if it, despite its original design, silts up or experiences extensive erosion?

Research approach

On the basis of previous studies (Kleinhans et al., 2013) the important processes that determine the partitioning of flow and sediment at bifurcations will be identified. Also the role of vegetation on flow and sedimentation will be included. After validation, a three-dimensional flow and sediment transport model will be used to evaluate typical side channel scenarios inspired by the Dutch Rhine and Meuse river cases. These will be confronted with field observations of Dutch cases. In addition to that a comparison will be made with international experiences concerning the design of side channels (USA, France). On the basis of field observations and modelling results optimal and adaptive bifurcation shapes will be devised. In addition to extensive (field) data-sets and improved modelling tools, one of the results of the current project will be a document of best practices for the design of side channels and methods to modify bifurcation shape afterwards.

Subproject B2: Natural banks

In flows with a curvature the outer bank erosion determines for an important part the migration rate of channels (Parker et al., 2011, Van Dijk et al., 2012). Undercutting of the bank is determined by the near-

bank turbulence which, until now, has been oversimplified. Following bank failure, slump blocks and vegetation residue at the bank toe have poorly understood effects. On the one hand these materials may protect the bank toe or delay further toe erosion (Parker et al., 2011), but on the other hand turbulence is enhanced (Ottevanger, 2013). Moreover, in smaller rivers this material can form the substrate for new vegetation. For these processes the composition of the bank material is important as well as the type of vegetation.
The objective is to improve understanding of processes related to the bank toe and employ this to propose means of manipulation of bank toe erosion rates that are acceptable from a practical and ecological point of view. To this end we will combine our strengths in geotechnical bank stability modelling, detailed turbulence modelling and morphodynamics experiments to complement field
site study and modelling.

Research questions

1. What is the effect of slump blocks and vegetation at bank toes on local flow turbulence?
2. How is bank toe erosion affected by this?
3. Which techniques or bio-engineering approach (stimulating or removing certain species) can be developed to enhance or decrease the rate of bank erosion processes?
4. How should the findings (literature, (field)experiments, field observations, analyses) from this study be included in numerical models that can be used for engineering purposes and long-term predictions of scour and deposition?

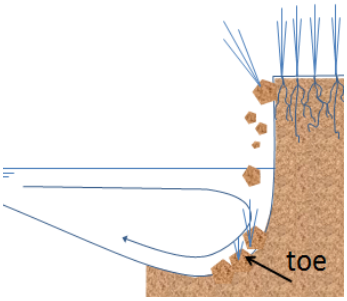

Figure B1 Sketch of outer bank erosion process

Research approach

On the basis of existing literature and previous experiments a simple model will be set up which serves as a basic tool for practical applications (see Langendoen & Simon, 2008). This model will require input parameters regarding geotechnical information (cohesiveness and erodibility of the toe) as well as hydrodynamic processes (shear stresses and turbulence in bends; Blanckaert et al., 2012). Field observations on dynamic streams will be made and existing data sets will be used (e.g., Slingebeek, Overijsselse Vecht and Meuse) to identify the relevant erosion processes and conditions. The observations concern mainly characterisations of morphology and vegetation patterns and will be made on a regular basis during the course of the project. Further refinement of modelling tools will be realized using laboratory experiments dedicated to bank toe scour using different material properties. We will test erosion of different bank (toe) compositions for a relevant range of configurations and conditions in large-scale (5x50m^2) morphological flume at DelftUT at near-prototype conditions. Detailed numerical modelling approaches (Ottevanger, 2013) will allow, after validation, for the parameterisation of the physical processes for conditions bracketing freely eroding bank scenarios in small streams to medium-sized rivers.

Table B1 Layout, time planning and products of the two PhD projects

Project/Phase	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Goals/Deliverables**
B1 Side Channels																	
1. Literature study																	review report (paper)
2. Analysis bifurcations																	inventory of functionality
3. Field surveys																	data set with interpretation (paper)
4. Morphological modelling																	improved model formulation (paper)
5. Prevention silting up																	effective measures, best practices
6. Synthesis and thesis																	thesis (paper)
B2 Natural Banks																	
1. Literature study																	review report (paper)
2. Conceptual model, revisions																	simple tool wit parameterisations (paper)
3. Field surveys																	data set with interpretation
4. Laboratory tests																	physics of erosion (paper)
5. 3D-modelling																	improved model formulations (paper)
6. Parameterisation																	design guidelines
7. Synthesis and thesis																	thesis (paper)

II. Utilisation plan

The two subprojects will be executed at Delft University of Technology and University of Twente, respectively. Supervision will be jointly executed between Delft University of Technology, University of Twente and Utrecht University, and with a strong the involvement of Rijkswaterstaat (large rivers, Meuse and Rhine) and local water authorities (smaller streams). Thus we combine our complementary expertise and the inspiration from observations in the ongoing field case projects. Research output will be validated by the practical cases and after dissemination aid further optimization and maintenance of Room-for-the-River measures and other restoration projects like Natural Banks for the Meuse. Finally the accumulation and integration of knowledge in the RiverCare programme provides the platform for dissemination in the form of an integral design concept for river restoration at the reach scale.

Utilisation is achieved at different levels of detail. At the most integral level, guidelines will be developed in consultation with users, for design, implementation, and maintenance of side channels and natural banks. These guidelines will be supported by simple (spread-sheet type) tools. At this level the strongest link is found with applications and thus with the case studies in the field. First versions of these guidelines will become available to project partners and selected end users and will be further refined and expanded towards the end of the project for broader dissemination. To ensure general applicability, physics based modelling tools (such as Delft3D) will be further developed using improved erosion and transport formulations validated by dedicated field and laboratory measurements. These tools should also allow for estimating the sedimentation patterns that could develop in and downstream of a restored river reach, for example to assess the risk of hindrance for navigation.

Deliverables:

- Guidelines for the design of side channels and bifurcation shape.
- Guidelines for the design of natural, dynamic river banks.
- Model formulations that allow for the prediction of large-scale (time and space) morphological behaviour of unprotected banks and dynamic side channels with inclusion of effects of vegetation.
- Tools for assessing the consequences of renaturalisation of rivers with inclusion of manageability.
- New data sets of monitored bathymetry changes in the winter bed as well as a further analysed and interpreted existing ones (such as the Meuse surveys 2008-2017).

Biannual meetings will be organized where progress of both subprojects is presented to the users and contributors of the projects. In addition to that workshops and courses will be organized within the framework of RiverCare for further dissemination of knowledge and best practices.

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Project number: C
Project title: Regional river systems: implications of novel stream restoration approaches

Project leader: Prof.Dr. J. Wallinga, Wageningen University

Requested research positions: 1 PhD, 1 Postdoc (3 years)

Budget: **Requested from STW:** k€ 484
Contribution by users: k€ 121 (*in cash*) & k€ 95.68 (*in kind*)

I. Scientific description of the project

Over the past centuries, regional rivers and streams in lowland regions such as The Netherlands have been modified and trained, resulting in rapid drainage of the catchments. Drainage has been further accelerated by changes in land-use, where once forested areas were increasingly transformed into farmland or urbanized areas. In recent decades, realization has grown that rapid drainage has considerable drawbacks: 1) it results in a lowered groundwater table, increasing the need for artificial watering of crops and affecting ecosystem functioning; 2) high discharge peaks after precipitation events can cause floods. Expected climatic changes (e.g. IPCC ,2007) will worsen these problems, with extended dry periods and more extreme precipitation events. In response to these prospects, water boards have drastically changed their views on management of regional river systems. Novel management strategies aim at self-sufficient systems, where water is stored within the catchment and discharge peaks are dampened. Many of the measures within these management plans also aim to enhance the ecological status of the regional river system. In many respects, promising measures aim at restoring the regional river system to a semi-natural state, inspired by historic data on the systems (Fig. C1), but constrained by future boundary conditions.

Figure C1 Historical map of the Regge (left) and stream restoration project on the Regge (right). (Photo: Waterschap Regge en Dinkel)

Current understanding of regional river system functioning is insufficient to design cost-efficient measures towards self-sufficiency. Although historic maps provide inspiration for stream restoration measures, little is known about the hydrology and morphodynamic functioning of the systems in historic times (e.g., Walter & Merrits, 2008). Hence, it is not clear whether the historic situation can indeed serve as an appropriate reference for a self-sufficient system. Focussing on the ability to manipulate the hydrological system, little is known about which measures are most effective, where these measures should be taken, and how the regional river system will respond to a combination of measures. Moreover, there is a concern that the measures aiming at self-sufficiency, will cause the drainage peak of the regional systems to coincide with the discharge peak in the main river.

Subproject C1: Morphodynamic functioning of regional river systems (1 PhD)
The main goals of project C1 are to understand and predict morphodynamic system responses to measures aiming at self-sufficiency, and to support the design of highly efficient strategies that fit the system functioning. Towards these goals, the following research questions will be answered using a

combination of fieldwork, luminescence dating (Wallinga et al., 2010), field measurements and data analysis:

1. What were the hydrological and morphodynamic characteristics of historic regional river systems and how do these depend on subsurface, relief and groundwater?
2. What are the morphological and sediment dynamic responses to stream restoration measures?
3. How does the response to stream restoration measures relate to the functioning of the historic systems?
4. Which self-sufficiency measures make effective use of natural functioning of the system?

Subproject C2: Hydrological functioning of regional river systems (1 Postdoc)
The main goal of project C2 is to develop effective strategies for self-sufficiency of regional hydrological systems, without negative impact on flood risks in downstream areas. Towards this goal, the following research questions will be answered using a combination of hydrological models (e.g. MODFLOW, SOBEK), and data-analysis:

1. How effective are existing approaches for water retention in headwaters and target levels of the groundwater table, and which are the causes of failure or success of those measures?
2. How do existing stream restoration measures, such as remeandering, construction of a two-phase stream profile and insertion of woody debris, affect water retention?
3. Does the current practice of water retention in lowland streams negatively impact flood risk in the main Dutch rivers?

Research approach
In this project we will adopt an integrative approach with the central aim to design efficient self-sufficient regional river systems using 'building with nature' concepts. The project requires expertise in the fields of hydrology and geomorphology and will be carried out by a PhD and a postdoc (Table C1) and supported by the foundation for applied water research (STOWA) and Alterra to secure utilisation of results. Our study will use existing case studies consisting of a variety of measures taken in headwaters, inside the channel, and at the downstream boundary by various water boards. For these case studies, the hydrological and morphodynamic effects will be analysed, explained and evaluated. The resulting meta-analysis of the hydrology and morphodynamics of regional lowland systems will offer a solid scientific basis for future efforts towards self-sufficiency without negative impact on flood risks in downstream areas. In addition, the quantitative functioning of historical systems will be reconstructed, to evaluate how these can be used as inspiration for 'building with nature' approaches.

Table C1 Layout, time planning and products of the PhD and postdoc

Phase	Year 1				Year 2				Year 3				Year 4				Goals / deliverables
C1 Morphodynamics of regional systems (PhD)																	
1. Research design & literature review																	Research questions, methods and planning; scope & outline of thesis
2. Integrative stream assessment (with C2)																	Assessment of sources and sinks for water and sediment
3. Morphodynamics of 'natural' systems																	Reconstructions based on fieldwork and optical dating of sediments
4. Morphologic responses to measures																	Inventarisation based on monitoring data and airborne images
5. Success assessment of measures																	Combining results of 2-4 to identify successful methods
6. Synthesis and thesis				1		2		3			4			5	6	7	Papers & thesis chapters (1-7), joint paper on guidelines (with C2)
C2 Hydraulics of regional systems (PD)																	
1. Selection of case studies and data gathering																	Coherent dataset based on which measures towards self-sufficiency can be evaluated
2. Hydrological effects of measures of self-sufficiency																	Effectiveness assessment; paper 1: measures in headwaters; paper 2: measures by means of channel design
3. Analysis of river-tributary interactions																	Paper 3: timing of peak water levels in rivers and tributaries; paper 4: effect of river management on regional systems
4. Integration																	Joint paper on guidelines (C1/C2)

II. Utilisation plan

A wide range of measures aiming at self-sufficiency of regional river systems have been executed during the past decade, and many more are planned for the near future. The measures are commonly designed and carried out by individual water boards, who therefore are the ultimate end users of the knowledge generated in this project. The Foundation for Applied Water Research (STOWA), in which the water boards are represented, Rijkswaterstaat and Alterra, will guarantee dissemination of gained knowledge through existing networks, including the '*Community of Practice Remeandering'* and the '*Deltaproof*' and '*Water Mosaic'* knowledge programs. Alterra is involved in many stream restoration projects as an independent consultancy institution for applied knowledge in ecotechnical design and spatial planning, and as such acts to connect fundamental research to practical issues in the field (e.g. Wolfert et al., 2009).

The proposed project will produce tools, guidelines and models towards self-sufficiency of regional water systems, based on an evaluation of the effects of current practices in stream restoration in relation to natural functioning of the system. The ultimate benefits of the envisaged end-products for society are: (1) increased effectiveness and cost-efficiency of self-sufficiency measures, (2) reduced maintenance costs of regional river systems, (3) increased ecological and landscape values, (4) prevention of increased flood risks in rivers.

STOWA will integrate the proposed project with other planned and on-going research on regional river systems. The in-kind contribution of STOWA (€ 62,000) is made available through involvement of senior STOWA and water board employees, who will spend at least 534 working hours to support the project by: (1) coordinating contributions of the water boards (selection of case studies, supply of data); (2) encouraging and coordinating collaboration with other research projects on regional river systems, (3) communicating the project and its results to water boards and Rijkswaterstaat.

Alterra will co-develop and apply the products of the project by integrating newly gained insights in its advisory and consultancy projects. The in-kind contribution of Alterra (€ 26,180) represents 220 working hours of Dr. A. Makaske, which will be spent on: (1) distributing the project deliverables within Alterra and encouraging application in relevant projects, (2) advising the project team in practical issues, (3) communicating about the project and its results in stakeholder communities, most importantly the Community of Practice on stream restoration (CoP 'Hermeanderen') in which STOWA is also represented.

Deliverables

- Quantitative insight in the hydrological and morphodynamic functioning of historical regional river systems, as a function of their environmental setting (C1&C2 - month 24);
- A generic model to quantify changes in river discharge regime and groundwater levels as a function of a wide range of potential measures aiming at self-sufficiency (C1&C2 - month 36);
- An assessment of interaction of discharge characteristics of regional river systems and main rivers, that allows the assessment of potential increases in flood risks due to coinciding peak discharges (C2 - month 36);
- A set of sample sheets ('staalkaarten') providing reference cases for successful stream restoration measures (C1 - month 36);
- A generic model to forecast morphodynamic response to a wide range of stream restoration measures as a function of environmental setting (C1 - month 48).

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Project number: D
Project title: Nourishment, dredging and floodplain monitoring

Project leader: Prof.dr. H. Middelkoop, Utrecht University

Requested research positions: 2 PhDs + 1 PD

Budget: **Requested from STW:** k€ 850
Contribution by users: k€ 235 (*in cash*) & k€ 136.156 (*in kind*)

I. Scientific description of the projects

Subprojects D1 Nourishment (1PD) and D2 Dredging (1 PhD)

For rivers that are prone to aggradation or degradation, sediment management measures such as nourishment and dredging have become increasingly popular worldwide, as they are flexible, ecologically sound, and cost-effective. Sediment nourishment has the potential to restore the natural morphodynamic behaviour of a river system (e.g., Ebro river, Spain), reduce or halt bed degradation (e.g., the German Rhine), increase habitat diversity (e.g., Spree river, Germany), and temporarily arrest the erosion of river banks or dikes to await more permanent constructions (e.g., Cauca river, Colombia). It is still difficult, however, to predict the effects of such sediment management measures, as the effects of bedforms, sediment sorting, and porosity changes on riverbed topography are not well accounted for. The objective is to improve predictions of channel response to nourishment (subproject D1) and dredging (subproject D2) in sand-gravel rivers such as the Dutch Rhine, and to provide tools for effective design of nourishment and dredging measures. In 2015 Rijkswaterstaat will start with a large-scale nourishment field experiment in the Dutch Rhine (costs 5 to 10 M€) to study how nourishment can counteract the degradation of up to 2 cm/yr. This ongoing bed degradation is mainly due to a shortage of sediment supply from upstream (Mosselman et al., 2004) and is characteristic of many rivers, e.g. the German Rhine, Elbe, Danube, and Mississippi. This nourishment experiment will provide a unique opportunity to collect field data for validation of mathematical tools.

Research questions

1. How does augmented sediment supply (nourishment) affect the morphodynamic pattern? How can nourishment be optimized for its effect (subproject D1)?
2. How does dredging affect morphodynamics? How can dredging be optimized (subproject D2)?
3. How can insights concerning bedform evolution, porosity changes, and sediment conservation be incorporated in a numerical model to improve predictions of channel response (D1&D2)?

Research approach

Subprojects D1 and D2 comprise the following steps: literature study; analysis of data of the Rhine nourishment experiment to be conducted by Rijkswaterstaat in 2015 (D1); analysis of data of dredging measures conducted by Rijkswaterstaat (D2); implementation of modeling insights for bedform formation (e.g, Van der Mark et al., 2008), porosity (Frings et al., 2008) and sorting (e.g., Blom, 2008) into one of the world's leading open-source software systems for river engineering applications, Delft3D; evaluation and further development of the above submodels; validation of the Delft3D model by application to the field data; development of strategies for effective nourishment and dredging.

Subproject D3: Floodplain monitoring (1PhD)

Floodplain intervention measures lead to changed floodplain morphology and vegetation patterns. A key issue is to create abiotic conditions so that these will provide sustainable habitats to ecologically relevant species (EU-WFD, Natura 2000) and also fulfil flood protection demands and other services. However, after completion of the intervention, morphology and vegetation patterns will change over a range of temporal and spatial scales. This depends on morphological processes and vegetation colonization, growth/succession and management (e.g. cutting, grazing). To assess the longer-term success of floodplain restoration measures, adequate monitoring of their effects is essential.
In the Netherlands the concept of ‘ecotopes’ is used to map habitat patterns and floodplain hydraulic roughness. Ecotopes are characterized by specific morphology, hydrology and management, and allow adequate communication among different disciplines involved in floodplain management. However, the

current ecotope typology involves major disadvantages: their mapping still occurs by manually digitizing aerial photographs (laborious and to some extent arbitrary), they are assumed to be internally homogeneous (which is not always true), they do not give conditions of floodplain backwaters, they are not easily transferable across scales, and cannot directly be applied to large rivers abroad. PhD D3 will develop more innovative techniques to document and analyse floodplain vegetation, habitat patterns and backwaters.
The objective of this project is to establish innovative methods for documenting and evaluation of (1) floodplain elevation and hydraulic roughness associated with 3D vegetation structure, (2) floodplain habitat patterns (including 3D structures), and their (potential) value in terms of biodiversity and food-webs, and (3) a-biotic characteristics of floodplain backwaters.

Research questions

1. How can we integrate ecological knowledge and remote-sensing (RS) data to document 3D floodplain (ecotope-type) habitat patterns across a range of scales?
2. To what extent can we use 'standard' LIDAR products (e.g., AHN-2) to quantify floodplain topography and hydraulic roughness; can we quantify within-ecotope roughness?
3. How can we document ecotope succession stages, and their essential aspects (e.g., patch size, connectivity, distances) for ecosystem services?
4. What are critical floodplain backwater characteristics for various target species, and how do we monitor these using labour-extensive instruments?

Research approach

We analyze the terrestrial parts of the floodplain together with PhD B1 and PhD E1 and make a conceptual-empirical model that contains a 'demand-driven' rule base for environmental conditions and habitat characteristics (Straatsma et al., 2013), and Markov-type 'transition matrices' representing typical morphological and ecological succession stages, in combination with of GIS-layers of floodplain information. The model will be fed with existing and new field data, RS spectral information, hi-res imagery from a remotely-controlled 'drone-type' Swinglet and laser scanning data (Straatsma & Middelkoop, 2006). Image classification will be done using novel Object-based image analysis (OBIA; Addink et al., 2012). This will provide a more explicit description of the classification criteria, and allows quantitative documenting internal variability within the units mapped. By analysing time-series, changes will be quantified and evaluated. A-biotic characteristics of floodplain backwaters will be monitored by field sampling and automated multi-parameter instrumental set-ups and RS analyses. This allows for monitoring and evaluation of day-to-day to seasonal variation.

Table D1 Layout, time planning and products of the two PhDs and postdoc

Subproject/Phase	**Year 1**				**Year 2**				**Year 3**				**Year 4**				**Goals/Deliverables**
D1 Nourishment (PD)																	
Analysis Rhine exp.																	Paper
Implementation																	Adapted Delft3D software system
Evaluation																	
Validation																	Guideline for implementation in engineering software, paper
Strategies																	Guideline for design of nourishment measures, paper
D2 Dredging (PhD)																	
Analysis dredging data																	Paper
Implementation																	Adapted Delft3D software system
Improvement submodels																	
Validation																	Adapted model formulations, paper
Strategies																	Guideline for design of dredging measures, paper, thesis
D3 Monitoring (PhD)																	
Floodplain topography and roughness																	Method for monitoring at different scales, paper
Floodplain ecotopes																	Tools and guideline for evaluation 3D ecotope patterns, paper
Floodplain backwaters																	Tools for monitoring, paper
Synthesis																	Thesis

II. Utilisation plan

PhD D1 and PD D2 at Delft University of Technology will closely collaborate with RWS (RWS-WVL: Sieben, and RWS-ON: Havinga) and Deltares (Sloff, Mosselman). Data from nourishment experiments in the Dutch Rhine to be conducted by RWS in 2015, as well as data from dredging measures conducted by RWS, provide a unique basis for validation of the tools developed within this project. Examples of questions from RWS that will be addressed are: How does the supplied sediment affect bedform geometry and flood water levels? How do nourishments interfere with navigation and floods? How do nourishments affect the water and sediment distribution over the Pannerden bifurcation? How do we design nourishment and dredging measures? How and how fast do bedforms reform after dredging measures? The open-source Delft3D code that will be extended by PhD D1 will aid the design of nourishment measures undertaken to combat bed degradation of the upstream Dutch Rhine, as well as the design of dredging measures undertaken to guarantee a minimum navigation depth. Furthermore, we will contribute to implementing the mathematical tools resulting from this project in engineering software such as iRIC (http://www.i-ric.org/, Prof. Shimizu, Hokkaido University, Japan & USGS). Next to river managers (e.g., RWS, Bundesanstalt für Gewässerkunde, Koblenz), the resulting mathematical tools may help (inter)national consultants acting in the field of river morphodynamics. Deliverables are:

- Guidelines for the design of nourishment and dredging measures;
- Guideline for the implementation of new model formulations in engineering software;
- Model formulations that allow for the prediction of the effects of dredging and nourishment measures.

PhD D3 will closely collaborate with RWS (RWS-ON and RWS-CIV). A key issue in river restoration is to create a-biotic conditions in such a way that these will provide sustainable habitat to ecologically relevant species, and fulfil the demands of flood safety and other ecosystem services. Evaluation of the success of interventions asks adequate, efficient and innovative monitoring of successional stages of floodplain ecotopes and whether these meet the specified demands of the targeted services. PhD D3 will explore integration of different RS data types and field surveys to identify floodplain state and development over a range of spatial and temporal scales. Key questions are:

- What survey types are most adequate for monitoring requirements of different floodplain services?
- How can we efficiently monitor post-intervention changes in floodplain elevation and hydraulic roughness, in view of increased flood water levels?
- Are the emerging vegetation pattern and resulting a-biotic conditions of backwaters ecologically ‘sound’: is the ‘house’ developed adequate for (return of) target species?

In RiverCare, PhD D3 will closely cooperate with Projects B, E. The project yields a methodology that will be developed, tested and applied within the Netherlands in floodplains where projects are currently being implemented. Site selection will be undertaken with RWS-ON. Together with RWS-CIV we will provide innovative techniques and methods for their new floodplain monitoring programme. Also, the developed approach will contribute internationally, e.g. to EU-project REFORM. Selection of river cases abroad will be undertaken together with end users. Deliverables are:

- Innovative techniques and methods for documenting and analysis of floodplain topography and hydraulic roughness, 3D ecotope patterns and backwater a-biotic conditions;
- Methods for assessment of changes in ecosystem services from ecotope succession schemes;
- Guidelines for operational application and exporting developed methods.

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Nieuwe technologie mogelijk maken

Project number: E
Project title: Ecosystem services of floodplain rehabilitation

Project leader: Dr. R.S.E.M. Leuven, Radboud University Nijmegen

Requested research positions: 2 PhDs

Budget: **Requested from STW:** k€ 500
Contribution by users: k€ 138 (*in cash*) & k€ 108.196 (*in kind*)

I. Scientific description of the project

Project E develops tools to 1) predict the spatial and temporal dynamics of river-floodplain ecosystems and its services under different natural and anthropogenic forcings, and 2) assess the effects of rehabilitation measures and management strategies on ecosystem services delivered by river-floodplain systems. These tools will be useful in reducing the long-term management costs, create more self-sustaining rivers with beneficial ecosystem services and design interventions smartly.

An integrated way to evaluate societal effects of rehabilitation measures is to quantify ecosystem services (Breure et al., 2012). River-floodplain systems provide valuable ecosystem services such as safety, shipping, biodiversity, spatial quality, recreation, biomass production, CO_2 sequestration, nutrient retention and self-purifying capacity. The ecosystem services concept contributes to an integrated framework for a socio-economic assessment of the (lifecycle) costs and ecological benefits of physical reconstruction plans and management strategies for river-floodplain systems. As measures are most successful when they integrate with riverine processes (Ward et al., 2002), implementing ecosystem services in integrated environmental assessments of river-floodplain management requires a user friendly tool that allows 1) compatibility with models for ecomorphological development of river-floodplains, and 2) scientific sound and transparent assessments of the benefits humans derive from ecosystems. Various types of indicators and approaches for quantification of ecosystem services are emerging (e.g., Rutgers et al., 2012; Van Wijnen et al., 2012). However, according to our knowledge, a user friendly and compatible tool that incorporates ecosystem services in integrated environmental assessments for sustainable river basin management is lacking.

The scientific objectives of this project are to improve our understanding of the ecomorphological changes in river floodplains upon various forcings and translate these changes into the consequences for ecosystem services. This knowledge will be used to develop a generic landscape classification system linking patterns to processes at various scales and tools to predict the dynamic evolution of the riverine ecosystem and its services that assists end users to develop sustainable physical reconstruction plans and management strategies for river floodplains. These objectives will be achieved by two PhD studies (E1 and E2) that address the following research questions:

Subproject E1: Floodplain rehabilitation: linking processes to landscape patterns
1. What processes determine the development of river-floodplain landscape patterns?
2. What is a suitable generic classification of river-floodplain landscape units that integrate processes and patterns at several spatial and temporal scales?
3. How well can the development of these landscape units and patterns be predicted?

Subproject E2: Ecosystem services: assessing ecological assets and liabilities of river systems
1. What are sound indicators to assess ecosystem services of river-floodplain systems at various spatial and temporal scales?
2. How can these indictors be linked to river landscape processes and pattern?
3. What are sound approaches to quantify and valuate these indictors in relation to rehabilitation measures and management strategies of river-floodplain systems?

Research approach
Subproject E1 starts with the identification of the processes (natural and anthropogenic) that steer the floodplain landscape pattern based on literature, expert knowledge and retrospective analysis of executed floodplain restoration projects or natural systems. Building on existing classification systems, a generic

hierarchical process-based classification of river-floodplain landscape units will be developed. The link between processes, landscape units and patterns will be quantified in probabilistic knowledge rules. Using land management information of stakeholders and knowledge of hydromorphodynamic and ecological processes (e.g. from models like Delft3D and HABITAT), the spatial distribution of the different processes can be determined and used to predict the development of different landscape units and patterns in time and space. The predictions will be validated on data from previous studies and data collected in other RiverCare projects. If necessary knowledge rules will be adapted or refined. The final phase will be done in conjunction with E2 where the developments in river-floodplain landscape units and patterns will be linked to indicators of ecosystem services in order to develop a user-friendly tool that predicts the dynamic evolution of ecosystem services in floodplains under natural conditions and different management strategies (interventions).

PhD E2 starts with an explorative study on available indicators and approaches to quantify ecosystem services in integrated environmental assessments within the context of sustainable river basin management. A set of selection criteria will be formulated to select an appropriate approach to quantify ecosystem services that will capture ecological complexity and temporal dynamics of river-floodplain systems at various spatial scales. The spatial variability and temporal development of ecosystem services will be quantified for river-floodplain systems under natural conditions and different management strategies. Input-output relations with other RiverCare projects will be facilitated by mutual attuning of landscape classification units. Next, we develop a tool to link indicators, landscape units and rehabilitation measures at various levels of scale and to valuate ecosystem services. For this purpose the ecosystem services tool will be implemented as a module in BIO-SAFE, an innovative model that assesses the effects of river management on biodiversity and habitats (Lenders et al., 2001; De Nooij et al., 2004; Wozniak et al., 2009). Quantification and valuation of ecosystem services will be carried out in several case studies on sustainable river-floodplain management, using data and expertise of RiverCare projects (A, E1 and H) and cases suggested by involved users. The final phase focuses on model improvements using results of case studies and delivery of an optimized ecosystem services tool in BIO-SAFE (stand-alone version, including users guide), training of (potential) users and discussing outreach, synthesis of results and finalization of the PhD-thesis.

Table E1 Layout, time planning and products of the two PhDs

Phase	Year 1				Year 2				Year 3				Year 4				Goals / deliverables
E1 Floodplain rehabilitation																	
1. Identification steering processes																	Overview of driving forces
2. Landscape classification system																	Classification system
3. Model development																	Knowledge rules linking processes to the development of landscape units and patterns
4. Model validation (case studies)								W									Maps of spatial and temporal distribution of landscape units and patterns
5. Optimization, utilization and outreach (with E2)															W		Model tool, users guide, workshop utilization / training users / outreach
6. Synthesis				1	2			3		4		5		6		7	Thesis (Chapters 1-7)
E2 Ecosystem services																	
1. Exploration and research design																	Overview of indicators and approaches
2. Selection of an appropriate method and indicators																	Approach to quantify river ecosystem services
3. Model development: spatial links, dynamics and valuation approach																	Model of ecosystem services
4. Application in case studies on river rehabilitation								W									Benefits of rehabilitation measures
5. Optimization, utilization and outreach (with E1)															W		Model tool, users guide, workshop utilization, training users, strategy for outreach
6. Synthesis			1		2			3		4		5		6		7	Thesis (Chapters 1-7)

II. Utilisation plan

For river managers (like Rijkswaterstaat) and other stakeholders (e.g., Provinces, consultancies, DLG, Staatsbosbeheer) it is very important to know how the river floodplains develop under certain conditions to make a suitable and cost-effective management and maintenance plan. Deltares has a vast experience in river rehabilitation projects and is willing to share this expertise in this project. Currently they are involved in a European programme on restoring river ecosystems (REFORM) on which this project will build. Deltares will provide advice on the classification system and process-modelling, data and working space. In addition, experts from Rijkswaterstaat and the other stakeholders listed above will contribute to the development of the extended ecotope system, the knowledge rules that will be used to predict the developments in floodplains and advice on the applicability of the developed tool. This will be done in user group meetings, but also in separate workshops and individual sessions.

Implementation of an ecosystem services module in the predictive model BIO-SAFE will contribute to the feasibility of the project and will guarantee utilization of this tool by users. BIO-SAFE has already been successfully applied in several environmental impact assessments (e.g., Lenders et al., 2001; De Nooij et al., 2004; Wozniak et al., 2009) and in scenario studies on effects of climate and land use change in river basins (e.g., Straatsma et al., 2019). By linking BIO-SAFE to GIS-based decision support systems, such as the Map-Table or ‘Wealthy Waal Dashboard’, the model can already be used to calculate the effects of hydrological measures on biodiversity values. Therefore, BIO-SAFE is also expected to be a useful model approach for analysing effects of river rehabilitation measures on a broad variety of ecosystem services potentially provided by river-floodplain systems.

Case studies for both E1 and E2 will be focused on the river Waal in order to support decision making in large scale river-floodplain rehabilitation. Analyses of representative case studies from contributing users and RiverCare projects (e.g. project A and H), and will elucidate added values of integrated environmental assessments based on quantification of process dynamics and associated ecosystem services. Successful results of cases will strongly promote applications of such a tool.

RIVM’s interest in the project lies in the use of the results in their advice to national and European governments on sustainable use and management of ecosystem services. Deltares and the involved consultancy firms (Bureau Waardenburg and Arcadis) are particularly interested in applying the ecosystem services tool in their national and international river projects. The experience and results of our case studies will offer them front runner positions and unique selling points for acquisition of projects on integrated environmental impact assessments of river management.

Future utilization will be facilitated by 1) Incorporation of the ecosystem services module in a proven and frequently applied model such as BIO-SAFE, 2) development of a standalone version with a user’s guide, and 3) a training programme for staff of contributing partners (RIVM, Deltares, consultancy firms). Finally, a workshop with all project partners will be organized to identify opportunities for utilization and to develop a joint strategy for outreach.

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Project number: F
Project title: River Governance: uncertainties, participation and collaboration

Project leader: Prof. Dr. S.J.M.H. Hulscher , University of Twente (WEM)

Requested research positions: 1,5 PhD, 1 Postdoc (3 year)

Budget: **Requested from STW:** k€ 562.14
Contribution by users: k€ 155.250 (*in cash*) & k€ 114.98 (*in kind*)

I. Scientific description of the project

Governance relates to consistent management, cohesive policies, guidance, processes and decision-rights for a given area of responsibility. In contemporary river governance there are three key issues that play a pivotal role: (1) uncertainties of hydrodynamic models that form the basis of management strategies and related engineering interventions, (2) participation and civic engagement in monitoring and evaluation of (engineering) interventions and (3) collaboration between societal stakeholders to identify and apply management strategies. This project has the objective to understand, assess and improve these three key issues of contemporary river governance.

Subproject F1: Uncertainties of hydrodynamic models
Hydrodynamic models that predict water levels are currently calibrated on the situation before the realization of interventions. This leads to significant uncertainties in predicted water levels (Warmink et al., 2012), which are often not included in decision making and lead to less robust designs with over-dimensioning and higher maintenance costs. In this project we account for the uncertainties inherently associated with these interventions. Recently developed Monte Carlo (MC) based methods are available for combined calibration and uncertainty quantification, but are time-consuming. The objective of this subproject is to develop a novel time-efficient method for combined calibration and uncertainty quantification and apply it to determine the most robust design of river interventions in cooperation with stakeholders.

Research questions (RQ)
1. What MC-based method is applicable for combined calibration and uncertainty quantification and what is the most optimal parameter set including its uncertainties?
2. How well do artificial neural networks perform for calibration and uncertainty quantification?
3. What is the most robust intervention design given the uncertainties due to natural evolution and climate change?

Research approach
The hydrodynamic model Delft3D will be used, which has a large international user base and is applied to numerous cases in the Netherlands and abroad as well as in other RiverCare projects. Warmink et al. (2012) already studied the parameters to include in the calibration and uncertainty analysis. Firstly, a state-of-the-art MC-based method is applied (RQ1), such as inverse modelling or the novel MCMC method DREAM (Vrugt et al., 2009) to initially quantify the uncertainties. Subsequently, a time-efficient artificial neural network (ANN) model is defined to predict these uncertainties (RQ2). If ANN proves successful, it will be applied for fast uncertainty quantification as input for RQ3, otherwise, MC-based methods will be used. For RQ3, scenarios of interventions and criteria for design and maintenance are defined in a workshop with stakeholders and input from projects A, B, D, E and F2. The combination of user criteria and scenarios given their uncertainty will lead to the selection of the optimal robust design. Combining calibration, uncertainty quantification and scenario analysis for assessing robustness is highly innovative.

Subproject F2: Participation and civic engagement in monitoring and evaluation of innovative (engineering) interventions
The Waal river (main Rhine branch in The Netherlands) is the most intense used fairway of Europe. In order to increase the water discharge capacity (flood protection measure) and improve the fairway dimensions, the regional river manager will carry out a pilot engineering intervention (2013-2015). This

intervention comprises a substitution of the traditional groynes by a 10 km longitudinal dam near the city of Tiel (see also project A; Huthoff, 2011). This intervention will change the features and appearances of the fluvial landscape dramatically. Therefore, the regional river manager considers an active involvement of stakeholders in monitoring and evaluation of this pilot which is important before an up-scaling of this intervention is contemplated.

Research questions
1. What is the level of awareness of local stakeholders with respect to the effects of longitudinal dams on the fluvial landscape?
2. How and to what extent can local societal stakeholders be involved in monitoring, evaluation and (possibly) improvement of longitudinal dams?

Research approach
A Participatory Monitoring & Evaluation (PM&E) research (Estrella et al. 2000) will be conducted to answer these questions. Conventionally, monitoring and evaluation has involved outside experts coming in to measure performance against pre-set indicators, using standardized procedures and tools. PM&E differs from more conventional approaches in that it seeks to engage key project stakeholders more actively in reflecting and assessing the progress of their project and in particular the achievement of results. Firstly, through a series of interviews, questionnaires and workshops with primary stakeholders, awareness and perception of landscape changes induced by the intervention will be assessed. Subsequently, through intensive interaction between the regional river manager and primary societal stakeholders corrective actions to improve performance and outcomes of the application of longitudinal dams will be jointly formulated.

Subproject F3: Collaboration between stakeholders to realize innovative management strategies
Since the near-floods of 1993 and 1995, spontaneous vegetation development in the floodplains of the Netherlands river system is restricted (decrease of water discharge capacity). From that moment on the so-called ‘nature-safety’ dilemma was born. One group of stakeholders assigned with the realization of nature rehabilitation goals strives towards self-regulating, dynamic processes; the other group of stakeholders involved in flood protection strives towards a limited and static implementation of nature restoration and biodiversity goals. However, both stakeholder groups strive towards an improved efficiency of floodplain management (reduced costs, adaptive management and valorization of ecosystem services). The results of a 2 year NWO research project named ‘Urban Regions in the Delta; Delta East’ demonstrated that mutual understanding, trust and framing of nature and safety goals by stakeholders are crucial in this process. Based on these results we would like to add two additional research questions that will be addressed in this RiverCare subproject:

Research questions
1. What are the framing perspectives of the involved stakeholders in relation to ecological rehabilitation and safety (e.g. flood protection) goals?
2. Can (and to what extent) re-framing of safety and nature values of engaged stakeholders in floodplain management contribute to improve the efficiency of sustainable floodplain management?

Research approach
In the context of the ‘URD Delta East’ project a lot of preliminary work (PhD student J. Fliervoet) has already been carried out. Hence, representatives of stakeholder groups, which are engaged in floodplain management along the Waal river are identified, approached and have agreed to work on this issue for the coming years (‘Taskforce Floodplain Management Waal’). Conducting the research activities will take two years and for practical reasons we suggest that the PhD student J. Fliervoet will be in charge of this research. Firstly, the cognitive representations (frames) will be identified through a series of interviews. The results will show a variety of conflicting and/or shared frames regarding floodplain management. Additionally, this study analyses how stakeholders negotiate meaning in interactions (interactional framing) based on the theory of Dewulf et al. [6]. Finally, a Q-sort method is used to measure the degree of re-framing in collaboration activities.

Table F1 Layout, time planning and products of the PhDs and postdoc

Project / Phase	Year 1				Year 2				Year 3				Year 4				Goals / Deliverables
F1 Uncertainties (PhD)																	
1. Research design																	Detailed research proposal
2. Literature/sensitivity analysis																	Uncertainties in river interventions (paper)
3. Calibration using MC method																	Uncertainty analysis (paper)
4. Application ANN																	Uncertainty prediction using ANN (paper)
5. Define cases/criteria with users																	Requirements on intervention design (paper)
6. Select robust design for cases																	Paper, writing and finalizing thesis
F2 Participation (Postdoc)																	
1. Research design																	Detailed research proposal
2. Field survey																	Collecting data
3. Perceptions of training dams																	Level of awareness (paper)
4. Monitoring and evaluation																	Involvement of stakeholders (paper)
5. Synthesis subproject F																	Guidelines for innovative governance (paper)
F3 Collaboration (0.5 PhD)																	
1. Frames and framing																	Conflicting and/or shared frames (paper)
2. Re-framing and collaboration																	Analysis by using Q-sort (paper)

II. Utilisation plan

The presented knowledge gaps and research questions presented in this project emerged from the running programmes of Rijkswaterstaat (pilot longitudinal dams), Province of Gelderland (Wealthy Waal programme) and Deltaprogramme. This explains the substantial cash contributions of RWS (125 k€) to this project. We foresee an application of our findings in development of a fast calibration an uncertainty quantification strategy for new and scheduled engineering interventions, which can be operational for robust design after additional testing in 1 or 2 years.

The results of the Participatory Monitoring & Evaluation (PM&E) research will be immediately used by RWS to monitor and evaluate the longitudinal dam pilot along the Waal river (2015-2018). Additionally, the results of subproject F3 will be used by the Administrative Platform of the Wealthy Waal project of which RWS and the Deltaprogramme are partners. The Administrative Platform “Wealthy Waal” is highly interested in a pilot innovative governance model for floodplain management called ‘Waardschap’. This resembles the British ‘stewardship’ but in ‘Waardschap’ also valorization of ecosystem services and a management strategy with respect to nature restoration goals in time and space are included. Based on the findings of F2 and F3 this subproject will address the social-cultural and institutional aspects of a ‘Waardschap’ and formulate the organizational structure and operational aspects of a pilot Waardschap along the Waal river which can be applied in 2014-2015.

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Project number: G
Project title: Communicating programme outcome: Knowledge base, visualisations and Virtual River

Project leader: Prof. Dr. S.J.M.H. Hulscher , University of Twente

Requested research positions: 1 PhD, 2 Postdocs (3 year)

Budget: **Requested from STW:** k€ 660
Contribution by users: k€ 183.75 (*in cash*) & k€ 213.056 (*in kind*)

I. Scientific description of the project

This project ensures the dissemination and accessibility of the outcome of all RiverCare projects. Firstly, it comprises the RiverCare project outcomes in a knowledge base containing all data and models. Secondly, data and knowledge will be made more accessible by developing interactive and intuitive visualisations. Thirdly, an interactive serious gaming environment will be developed to support collaborative decision making. Successful application of all three forms of output dissemination will result in effective, efficient and satisfactory support for informed decision making by the end users.

Task G.1: Use cases, scenarios and requirements
This task will elucidate the use cases, scenarios and group decision-making context within which the stakeholders of the RiverCare programme will use the programme outcome. These use cases and scenarios will be elicited through direct and intense involvement of the end users. User-centred design techniques as usability research, interviews, focus groups and participatory design workshops will be deployed to this purpose as well as to obtain reliable requirements regarding the knowledge base, visualisations and serious games to be developed in the other tasks. This task will be executed jointly by the Postdoc and PhD, whereas Deltares will devote its network to support end user involvement.

Task G.2a +2b: Open-access Knowledge and Data Storage system for river management
Based on the identified requirements (Task G.1) this project will continue the Wiki which is set up in the EU-project REFORM. The Wiki will be a communication tool within and outside the project. After the project, the resulting Wiki will be managed by Deltares. Furthermore this task will review consisting field data-storage systems (e.g., Open Earth, CARDS). To determine which way of data-storage satisfies the intended data users best, the review outcome is matched with identified users' wishes. Special attention will be paid to so-called meta-data information and trapped accessibility for different types of users, including initial and long-term use. The final product will be that all data will be accessible via a low-threshold data-access system. During the project we will select the best partner who can sustain this base (a university, Deltares or RWS).

Task G.3: Interactive and Intuitive Visualisations
Visualizations allow diverse groups of users to easily understand and interpret the data obtained in all other RiverCare projects. To realize visualisations that meet user needs, the visualization engine of Tygron will serve as the platform and simulations based on the interactive D-Flow Flexible Mesh model engine of Deltares as input. The resulting interactive and intuitive visualizations will be integrated in a serious gaming environment (Task G.4).

Task G.4: Serious games for collaborative decision-making
This task comprises research and development of a serious gaming environment that serves as interactive instrument to support collaborative decision-making among the diverse groups of stakeholders of the RiverCare programme outcome. The challenge in serious gaming is to find the sweet spot between governance, visualization, simulations and gaming. The PhD will conduct research on serious gaming techniques to build consensus on decisions at the right abstraction level at the right moment in time within the specific context of the RiverCare program, i.e. decision-making processes regarding issues that have a broad, wide-spread, non-transparent and frequently politically sensitive impact on a large and diverse

group of stakeholders. To focus the game environment development, the 'Waalweelde' case is selected. The research will build on the state of the art work on game design, game mechanics, story, aesthetic and technology models tailored for collaborative decision-making. It borrows from knowledge on individual judgment and decision making (Kahneman, 2011), social decision making, group dynamics and problem solving as addressed in Visual Analytics literature (Thomas & Cook, 2004). The gaming environment will be based on the CODE game suite provided by T-Xchange. Use-integration of the developed visualisations (G.3) will be realised.

Task G.5: Deployment of serious games and evaluation
This task organizes and facilitates that the serious games (G.4) supported by visualizations (G.3) are being played with the dedicated end users. To assess the impact of the decision environment, a decision room will be realized within the high-end, immersive visualization facilities available at the University of Twente. However the games are also made available for desktop use. Deployment of the serious games within a series of use cases (as defined in G.1) allows for the assessment of the effect of the serious games on the collaborative decision-making process. An iterative development and evaluation approach will be pursued to ensure end user involvement as well as to allow for refinement of end user requirements through-out the games development.

Task G.6: Communication within RiverCare
This task will ensure communication within the project. The Postdocs will be the intermediate between the specialist projects and the Virtual River PhD and help the PhD to obtain required information. Also, the Postdocs will be the intermediate between the Virtual River PhD and the Valorisation Project H. Next, the Postdocs will set up trainings and knowledge exchange sessions for both the PhD's and users, in order to have optimal exchange of knowledge among scientists in the programme as well as between the scientists and the end users.

Table G1 Layout, time planning and products of the PhD and two postdocs

Project / Phase	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Goals/Deliverables
G1 Virtual River (PhD)							
G.1 Use cases, scenarios and requirements							Identification use cases, scenarios and user centred requirements for visualisation and serious game (paper)
G.3 Interactive visualisation							Iterative development of visualisations
G.4 Serious gaming environment							Iterative development of gaming environment (3 papers)
G.5 Game evaluation							Deployment and evaluation of serious games and visualisations
G2 Knowledge base and communication (Postdoc)							
G.1 Use cases, scenarios and requirements							Identification of use cases, scenarios relevant to RiverCare
							user-centred requirements for data and knowledge base
G.2a Knowledge base							Review and adapt REFORM Wiki
							Explain to RiverCare community
							Maintenance and delivery final Wiki
G.2b Data storage							Selection data base platform
							Development and delivery final data base
G.6 Communication							Training for PhDs, scientists and users
G3 Knowledge base and communication (Postdoc)							
G.2a Knowledge base							Maintenance and delivery final Wiki, transfer to Deltares
G.2b Data storage							Development and delivery final data base, transfer to selected partner
G.6 Communication							Training for PhDs, scientists and users

Please note that Postdoc G2 will be employed from the start of the project. Postdoc G3 will start after 30 months, so that an overlap of 6 months is foreseen between the postdocs in order to guarantee a smooth transition. The PhD will start in the 2nd year of the project to be able to build on the outcome of the other RiverCare projects.

II. Utilisation plan

The key objective of the RiverCare programme is to increase the predictive understanding of the intermediate and long-term developments of river systems after human interventions. This understanding will be input to decision-making processes by a wide, diverse range of stakeholders. These stakeholders have to make decisions on multidisciplinary issues based on complex and large amounts of data. Successful dissemination from a governance view of the project outcome is realized when all involved stakeholders are able to correctly assess the consequences of the decisions-to-make.

The knowledge base, visualisations and serious game environment that will be developed in this project will empower stakeholders to make informed decisions in the realization of self-sustaining multifunctional rivers by allowing a highly usable and accessible interaction with the models and data generated in the RiverCare projects. Presenting the proposed interventions in the actual environmental context enables stakeholders to anticipate the consequences for their specific situation.

The interactive visualisations and the serious gaming environment realised in this project allow users to change interventions and show/predict the resulting data over a period of time. This gives decision makers a virtual environment where they can safely try out new strategies that can lead to innovative and sustainable solutions. Such approach will shorten the time-span of intervention decision and selection processes and thereby significantly reduce costs. Moreover, the outcome of these processes will often lead to better solutions as well as decisions that are supported by all involved stakeholders.

In the dissemination of project outcomes, the project is supported by three industrial partners, i.e. Deltares, Tygron and T-Xchange. As an applied research institute, the success of Deltares can be measured in the extent to which their expert knowledge can be used in and for society. Deltares develops simulation models and serious games with a range of aims: for the preparation of strategic decisions, to support operational activities or to raise awareness of sustainable options. Deltares will make available the D-Flow Flexible Mesh model that simulates the physical processes that are relevant in the context of a river (as open-source software). Training will be provided to allow D-Flow Flexible Mesh to be used in a gaming environment (20 days senior researcher, €18,560). Deltares will organize user involvement (5 days senior researcher, 5 days junior researcher, €7,880), participate in the effect studies (5 days senior researcher, 10 days junior researcher, €11,120) and participate in brainstorm sessions with the PhD and postdocs on data/models, visualization and gaming (twice a year, senior researcher, €22,272).

Tygron develops software to support decision making in spatial development and water management. The Tygron Game Engine allows to interactively manipulate the multiplicity of issues surrounding these domains and will be used to realise the visualisations of the outcome of the RiverCare programme. Since Tygron is aiming for scientific foundations of these next generation decisions support systems in Water Management, Tygron will support this project in two ways. Firstly, the in-kind support will consist of training of the PhD and two postdocs in the use and capabilities of the Tygron Game Engine. For this purpose, 150 hours of training by a senior trainer (costs: 17.850€) will be supplied. Secondly, the PhD student will be supported in the realisation of the visualisations by developers of Tygron (80 hours of senior developer (9.520€) and 214 hours of junior developer (17.762€)).This allows the PhD to focus on the content and interaction of the visualisation and less on the actual realisation.

T-Xchange, a joint venture between Thales Netherlands and University of Twente, designs and develops serious games for public and private organizations. Their interest in the project is how serious gaming can extend and compliment the decision-making process regarding planning and intervention techniques by bringing in the human in the loop. They will facilitate the PhD student with their serious gaming knowledge and tooling through active participation towards realisation of the serious game system. This in kind support comprises 400 hours by a senior researcher and 300 hours by a junior researcher (72,500€). In addition, T-Xchange will supply a license for their CODE game engine to be used for the duration of the project free of charge to ensure project involvement.

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Nieuwe technologie mogelijk maken

Project number: H
Project title: Self-supporting hydrosystems & Valorisation

Project leader: Prof. Dr. A.J.M. Smits, Radboud University Nijmegen

Requested research positions: 2 PhDs, 1 Postdoc (1 year)

Budget: **Requested from STW:** k€ 502.82
Contribution by users: k€ 160 (*in cash*) & k€ 27.5 (*in kind*)

I. Scientific description of the project

The Netherlands is the safest delta on earth and has a great international reputation in finding ways to balance economic, societal and ecological interests. During the last decades major investments have been made in developing new strategies and related technologies to update and maintain this reputation. One of the unique selling points of Dutch water management strategies is that it is based on an ecosystem based approach with concepts like Building with Nature, Room for the River, Cyclic Floodplain Rejuvenation. In summary, problems are addressed making use of, and guide, natural dynamics instead of eliminating them. Despite the fact that great progress has been made in elaborating and applying these concept locally, there are still important knowledge questions to be answered before we can successfully upscale and strengthen the export perspectives of the 'Dutch approach'. In this context, the present-day ambition in river management is to make better use of the self-regulating processes in river management and to promote a self-supportive system (i.e. making use of the fluvial ecosystem services and cost-efficient management at a river stretch scale). In this project we have selected the Rhine-Waal river section (Lobith-Gorinchem; ca. 80 km) named 'Wealthy Waal' (Waalweelde), to analyse and elaborate this ambition. The Wealty Waal is subject to many interventions the coming years. The most challenging and urgent questions are related to design (among which land use of floodplains) and maintenance. Design and maintenance strategies need to meet the policy and legislation conditions related to flood protection, navigation and (European) biodiversity goals. Moreover, these strategies need to be robust so that they can cope with natural dynamics (changes in water discharge, morphology, vegetation succession) and be very cost efficient (low maintenance costs, making use of ecosystem services). This project is split in three parts. PhD H1 and PhD H2 focus on the application of the morphological and environmental knowledge questions, respectively. PD H3 with representatives of the Dutch water will explore management entrepreneurs and consultancy scene, if and how the export possibilities of the 'Dutch approach' in river management can be enhanced with the 'self-supportive hydrosystems' concept (and related tools).

Subproject H1: 'Wealthy Waal': focus on morphodynamics
Research questions

1. What are the spatial and temporal dynamics of balances of floodplain forming sediments (from fine to course) induced by combined engineering interventions, nature restoration measures and floodplain vegetation succession along the Wealthy Waal river section?
2. Can we translate the modelled hydro-morphological dynamics in functional units along the Wealthy Waal river section?

Research approach
Mapping mass balances: previous work on the balance of sediments in the Waal (Hobo et al. (in prep.) for floodplain sediment, Frings and Kleinhans (2008) for channel sediment) will be collected, integrated and specified in terms of sources and sinks associated to the shipping fairway, groyne fields and floodplain elements, and discretised along the river, aided by the Delft3D model of the Rhine branches.
Information propagation: time scales of spatial propagation and spatial scales of the decay of information will be derived for all elements of the mass balances. The comparison of these time-dependent profiles, to be visualised in a first step as multi-coloured time-stacks (i.e. river-km and time as dimensions), will show where and when effects of measures and natural development coincide, cancel out and amplify.

Subproject H2: 'Wealthy Waal': focus on environment and valorisation

Research questions

1. How are the hydromorphological functional units (see H1) related to the Dutch 'river ecotope system' and to biodiversity?
2. The fluvial system provides a number of services that can be monetized, such as leisure, biomass (green energy, biobased compounds) and the minerals (sand, clay, gravel). To what extent, where and when can these ecosystem services be "harvested" along the selected river section without violating the policy guidelines with respect to safety, economy and ecology?
3. How can we achieve and strategically manage an optimal balance of various policy interests (flood protection, biodiversity, economy) in the floodplains of the 'Wealthy Waal' river section?

Research approach

Firstly, the research context needs elaboration: the concept of self-supporting hydrosystems based on a review of existing river management concepts and eco-hydrological-morphological perceptions (Ward and Tockner, 2002). The ecosystem tool (project E) is extended to encompass the costs and benefits connected to ecosystem services (leisure, biomass, minerals) and management costs for shipping and flood safety to be able to validate the self-supporting potential of the river system. The existing floodplain project designs in the Rhine/Waal River are collected, imported in a Geographical Information System (GIS) and in co-operation with stakeholders and end users (including RWD Division East Netherlands and the Province of Gelderland) several base design scenarios are elaborated, including options for management for the next 30 years. To evaluate a management strategy, both the spatial and temporal placement of the measures and management options can be assessed using the tools developed by subproject H1 and the tools of project E. We will use models and tools as Delft3D, HABITAT, GIS, and other preferably open-source modelling software.

Subproject H3: Exploring and enhancing export possibilities of self-supporting hydrosystem concept

Although the Dutch expertise in water management is internationally recognised, export products frequently are confined to selective tools (such as models and specific engineering techniques). Unfortunately, individual tools can only solve part of the problem or only address the symptoms of the problem instead of the cause of the problem. Within this context we hypothesize that promoting tools and technologies being part of a holistic and coherent vision on self-supporting and sustainable river management will be more successful. Additionally, when stakeholders participate in an awareness process (the rules of the natural system) and learn to collaborate with other stakeholders in a 'safe' environment (the rules of the socio-cultural system) we hypothesize that more potential clients will experience the economic, sociological and environmental benefits of the (Dutch) self-supporting hydrosystem concept.

Research questions

1. What exactly hinders the current application of the new Dutch river concepts abroad?
2. How can the virtual river be used in international perspective?
3. How can the lessons of the showcase 'Wealthy Waal' be exploited further?
4. Which further actions can be identified to strengthen the export perspectives of this knowledge and tools to other countries.

Research approach

Making use of the serious game of the Virtual River (Project G) (foreign) stakeholders experience the consequences of various river management scenarios. We will take Wealthy Waal as a showcase. By varying rules and conditions of the game and observing how stakeholders react and respond to these changes relevant information can be collected how potential clients frame 'the Dutch concept' of sustainable and self-supporting hydrosystems. Next, through individual questionnaires and structured interviews relevant information will be obtained than can improve the export possibilities of sustainable and self-supporting river management concepts and related tools. The serious game will be conducted with stakeholders of the Upper Citarum river basin (Indonesia) and a group of stakeholders of a (not yet identified) South American river basin. Through the entire process representatives of Dutch consultants and water management entrepreneurs will be involved and consulted.

Table H1 Layout, time planning and products of the PhD and two postdocs

Project / Phase	Year 1	Year 2	Year 3	Year 4	Goal / Deliverables
PhD 1 (UU)					
Review: characteristic scales, mass balances, scenarios					preparation to connect existing bodies of literature
Mass balance of channel sediment (data + Delft3D)					updated spatially detailed mass balance channel and groyes
Select model framework (box/GIS/Sobek/Delft3D)					setup of framework in which to model and visualise time stacks
Object-wise mass balances of floodplain sediment (data)					mass balances for typical floodplain components and projects
Length and time scale mapping					derive and plot characteristic length and time scales of adaptation
Connect to functional units					extend model with ecological input from project E
Integrate elements in spatio-temporal information					synthesis: find patterns and potential management problems
Finished model and application support (input to phd2)					Contribute to model application in PhD2
(Syn)thesis and papers					guess what
PhD 2 (RU)					
Concept self-supporting hydrosystems					prepare the context of the research
Cost / Benefit of ES and management					elaborate cost estimates for ES and magement interventions
Building design and management scenarios					create real world model testground for the management strategy
Management strategy development					use the testground with tools PhD H1 and ES tool (project E2)
Self-supporting capacity assessment					evaluate the self-supporting capacity based on cost - benefit
Finalising thesis					
PostDoc (1 yr) Valorisation RiverCare					
1. consulting representatives of consultancies & entrepreneurs					Overview experiences in Dutch export possibilities water management
2. elaboration and composing of management scenario's					components of serious game
3. making a serious game					linking scenario's to data Wealthy Waal by using Virtual River
4. Playing serious game with Indonesian and S-American stakeholders					insight in application of Dutch concept in different socio-cultural settings
5. web based interactive showcase					low cost and interactive showcase and matchmaking tool

II. Utilisation plan

Huge investments are being made in floodplain design (nature restoration, side channels, dike relocations) and shipping fairway (longitudinal dams). Because many of these interventions are innovative, the morphological and ecological effects are poorly understood. Lack of this knowledge hinders the development of a cost-efficient management strategy that meets the policy demands with respect to safety, economy and environment. The results of this project will provide a better understanding of the morphological and ecological interactions enabling an efficient floodplain management strategy at a river section level. Moreover, insight in ecosystem services that can be monetized opens the door to cost reduction. It is estimated that we can develop a self-supportive management strategy for the 'Wealthy Waal' project within a period of 3 years. The Administrative Board of the 'Wealthy Waal' programme has indicated to be interested to apply this strategy to the Rhine-Waal river section. This H delivers a management strategy with generic rules and thus can be easily upscaled and applied elsewhere.

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C. Letters of support

Letters of support with in cash and in kind commitment

Organisation	Type	In cash	In kind	Project
Ministry of Infrastructure and the Environment (Rijkswaterstaat)	Government	€737,500	€307,420	A,B,C,D,E,F,G,H (all projects)
Deltares	Knowledge institute	€150,000	€164,000	A,E,G
STOWA	Government	€101,000	€62,000	C
RIVM	Knowledge institute	€70,000	€22,848	E
Alterra	Knowledge institute	€15,000	€26,180	C
Bureau Waardenburg	Private	€10,000	€22,848	E
Arcadis	Private	€8,000	€25,000	E,G,H
RoyalHaskoningDHV	Private	€5,000	€38,080	B,G
Witteveen+Bos	Private	€2,000	€30,000	A,C,D,F,G

Letters of support with in cash commitment

Organisation	Type	In cash	In kind	Project
Province of Gelderland		€150,000	-	H

Letters of support with in kind commitment

Organisation	Type	In cash	In kind	Project
HKV	Private	-	€152,320	A,B,D,F,G
Thales (T-Xchange)	Private	-	€72,500	G
Tygron	Private	-	€45,132	G
CSO	Private	-	€45,000	B

Letters of general support

Organisation	Type
Bundesanstalt für Wasserbau (Germany)	Government
US Army Corps of Engineers	Government
Dienst Landelijk Gebied (DLG)	Government
Staatsbosbeheer	Government
Directoraat-Generaal Ruimte en Water	Government
KernTeam Deltatechnology, Topsector Water	Government

Rijkswaterstaat
Ministry of Infrastructure and the Environment

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Our reference

Date 3 June 2013
Subject Support Letter RiverCare

Dear Prof. Hulscher

With this letter we support the intentions of the project RiverCare which is going to be submitted within the 'Perspectiefprogramma' of Technology Foundation STW.

Rijkswaterstaat is responsible for (among other things) the maintenance of the main water system of the Netherlands which consists of the major rivers (Rhine branches, Meuse, Scheldt en Eems), parts of the North Sea and Lake IJssel and some important channels. Apart from the regular maintenance, Rijkswaterstaat is also responsible for predictions of water levels in times of high discharges and for the determination of the design water levels which are at the base of the height and strength of our main defence system: the dikes and dunes. To keep that system up to date, Rijkswaterstaat carries out large construction programs like Room for the River and the Meuse Works. In order to be prepared for the long term (the year 2050 and 2100) the Ministry of Infrastructure and the Environment has initiated the Deltaprogram. Rijkswaterstaat participates in this by supplying expert knowledge and initiating projects. In many of those activities, there is a close cooperation with provinces, water boards, local communities and other stakeholders.

Rijkswaterstaat uses state of the art hydraulic and morphological models for maintenance and predictions. However, it is also generally recognised that there are still a lot of sources of uncertainty in the models. That is why these models are constantly being improved by applying the latest research of knowledge institutes like Deltares and the Universities. This is particularly important because the programs Room for the River and the Meuse Works have as second goal (apart from restoring the safety), which is improving the spatial quality of the river area. The measures that are considered to achieve these goals, are constructing side channels, excavating floodplains and removing bank protection (among other measures). But in doing this, we essentially change the system to an extent which our models barely can analyse at this moment. In 2017, the last projects in these large construction-programs will be finished. The works carried out in these programs offer a unique possibility to monitor the various changes in processes due to the measures (from the point of view of ecology, morphology and hydraulics, as well as the interaction between these three fields), gather the relevant data and use that knowledge and data for the improvement of the

models. Monitoring is a vital step in this procedure. Using the data and the results of the research that is foreseen in RiverCare, most probably gaps in the knowledge needed for day-to-day maintenance, as well as for long term predictions will be bridged and this will lead to better, more efficient and possibly also cheaper maintenance.

Date
3 June 2013

Rijkswaterstaat is also very enthusiastic about the overall delivery: the virtual river. This tool can be used to explain the difficult river-system to a broader public (layman as well as technical educated), may act as an export product for the Netherlands Water Sector and can contribute to the sometimes very complicated process of stakeholder interaction (in river management situations).

Finally, Rijkswaterstaat is willing to supply all necessary data (existing, or coming from future initiatives in the framework of Room for the River, Meuse works and the Deltaprogram) that is needed for the various projects in RiverCare.

To summarize, Rijkswaterstaat supports RiverCare by delivering data (from previous projects, but also in contributing to new monitoring programs, monitoring methods and tools), in kind support (by delivering expert knowledge, which can be used to define the project, and evaluate results as the projects move along) and cash support. The main reason is that the results of RiverCare most probably will contribute directly to the improvement of the goals that Rijkswaterstaat has with respect to general maintenance of the major rivers in the Netherlands. This aim is reflected sufficiently in the research theme of RiverCare.

In the annex, the support of Rijkswaterstaat is is given in detail.

Rijkswaterstaat is aware of STW Intellectual Property Rights (IPR) and is in principle prepared to accept these but wishes to discuss with STW and the project coordinator the sensibleness and fairness of these general IPR in the light of the scope and the ambition of this research program.

I'm looking forward to the results of this multidisciplinary project and wish you success in the preparation and execution of RiverCare!

Yours sincerely

Dr. R. Allewijn,
Rijkswaterstaat Water, Traffic and Social Environment,
Director Safety and Water Use

Annex

Due to mutual interests, Rijkswaterstaat has decided to support RiverCare with a financial support, as well as an in kind support. RiverCare is an integrated project and various parts of Rijkswaterstaat are willing to participate. In this annex, the cash and in kind support of Rijkswaterstaat is summarised.

Project A: Optimizing longitudinal training dam design
This project is related to the pilot-project of Rijkswaterstaat with respect to the construction of longitudinal dams. Important part of this project is the monitoring before and after the actual construction of the dams to gain more insight in the consequences. Rijkswaterstaat East Netherlands supports this project in cash, as well as in kind.
Another important aspect of this project is the awareness and experience of longitudinal dams to the general public. Video interviews provide important data for this project and will be brought in as in kind support This also results in an in kind support of project F.
In cash support is related to the project which is known by the code P.000739 in the Rijkswaterstaat-administration.

Project B: Side channels and erosion of natural banks
As side channels are one of the key elements within several of the projects of Room for the River, Meuse Works and the Water Framework Directive, it is important to know the dynamics of side channels with respect to hydrodynamic, ecological and morphological aspects. This is closely related to the behaviour of unprotected, natural banks. Worthwhile mentioning is a project which aims at monitoring the consequences of making the Meuse banks more natural by removing the bank protection. Consequences for ecology and shipping are important monitoring-aspects which will be brought in as cash and in kind support for RiverCare in project B.
In cash support is related to the project which is known by the code L.1892 and S.3817.13 in the Rijkswaterstaat-administration.

Project C: Stream Restoration
The main part of the cash and in kind support for this project comes from a different organisation. Rijkswaterstaat contributes to this project with a limited cash support.
In cash support is related to the project which is known by the code L.1892 in the Rijkswaterstaat-administration.

Project D: Sediment nourishment and floodplain monitoring
Bed degradation is one of the key problems in rivers in developed countries such as the Dutch Rhine. This is often due to a lack of sediment transported by the river from upstream due to, for instance, the construction of dams in the past. A potential measure to halt this long-term bed erosion is the supply of additional sediment to the river. At this moment, a major field experiment (5-10 MEUR) is going to be carried out by Rijkswaterstaat to study how sediment nourishment can combat longterm bed degradation. Rijkswaterstaat supports this project on Nourishment and Dredging both in cash and in kind. Part of this project deals with gaining more insight in the ecomorphological changes within river floodplains and this subproject is supported in additional cash. The in kind support is part of the monitoring program (approx. 1000 k€) which is going to be carried out within the RWS-project. Part of the budget (less than 10%) is used as in kind support.

Another part of the cash support (€150.000 in project D) is funded through a RWS-research program which contributes directly to the maintenance responsibility of the rivers which Rijkswaterstaat has, and which is carried out by Deltares. At Rijkswaterstaat, this is known as the KPP-project.
Additional in cash support is related to the project which is known by the code S.2562 in the Rijkswaterstaat-administration and by the project which is known by the code L.1892 in the Rijkswaterstaat-administration.

Project E: Ecosystem services and floodplain rehabilitation
Rijkswaterstaat wants to know more about the interaction between hydraulics, ecology and morphodynamics as this is an important factor in ecosystem-services.
In cash support is related to the project which is known by the code L.1892 in the Rijkswaterstaat-administration.

Project F: River governance: uncertainties and perceptions
See the information at Project A.
In cash support is related to the project which is known by the code P.000739 in the Rijkswaterstaat-administration.

Project G:The Communicating programme outcome: knowledge base, visualisation and Virtual River
Rijkswaterstaat is very enthusiastic about the overall delivery: the virtual river. This tool can be used to explain the difficult river-system to a broader public (layman as well as technical educated), may act as an export product for the Netherlands Water Sector and used in a serious game, can contribute to the sometimes very complicated process of stakeholder interaction (in river management situations).
In cash support is related to the project which is known by the code L.1892 in the Rijkswaterstaat-administration.

Project H: Self Supporting Hydrosystems and Valorisation
For Rijkswaterstaat, it is important that the knowledge, which is going to be developed within RiverCare, is used by Rijkswaterstaat itself, as well as the consultancy firms which collaborate with Rijkswaterstaat. Hence, valorisation is an important aspect and that is why Rijkswaterstaat wants to be involved in Project G. Rijkswaterstaat offers exert knowledge as in kind support.
In cash support is related to the project which is known by the code L.1892 in the Rijkswaterstaat-administration.

General in kind support:

Dr. R. Schielen, who is employed by Rijkswaterstaat, is co-chair of RiverCare and he is an expert in water management (hydraulics and morphology, and safety and governance aspects). In this role, he contributes by applying his expert view in project B. Besides, Rijkswaterstaat recognizes the importance of the overall product 'The Virtual River' and in that respects, wants to contribute to that product in delivering expert knowledge to that project (project G and H). This will also be done by Dr. R. Schielen. Rijkswaterstaat is willing to allow Dr. Schielen to spend 4 hours/week (for 40 weeks/year over a period of 6 years) on RiverCare in order to be able to perform his position as co-chair and as expert in the various projects.

To summarize, Rijkswaterstaat supports RiverCare in the following way (in k€):

	By	Cash	In kind	Source of In kind
A	RWS-O	55	29,52	80 hours (senior) and 20 k€ in data
B	RWS-Z	48	41,5	500 hours (junior)
B	RWS-WVL	77,5	40	335 hours (senior)
C	RWS-WVL	5		
D	RWS-WVL	175	17	144 hours (senior)
D	RWS-O	60	85	144 hours (senior) and 68k€ in data
E	RWS-WVL	58		
F	RWS-O	125	21,9	100 hours (senior) an 10k€ data
F	RWS-WVL	30,25	47,5	400 hours (senior)
G	RWS-WVL	93,75		
H	RWS-WVL	10	25	210 hours (senior)
TOTAL		737,5	307,42	

Summary (in k€)

	Cash	In kind
RWS-WVL	449,5	129,5
RWS-O	240	136,42
RWS-Z	48	41,5
TOTAL	737,5	307,42

RWS-O: Rijkswaterstaat East Netherlands
RWS-Z: Rijkswaterstaat South Netherlands
RWS-WVL: Rijkswaterstaat Water, Traffic and Social Environment

Deltares

Enabling Delta Life

Universiteit Twente
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P.O. Box 217
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Date	Our reference	Number of pages
31 May 2013	1208213-000-ZWS-0001	3
From	**Direct line**	**E-mail**
Tom Buijse	+31 (0)88 33 57 116	tom.buijse@deltares.nl

Subject
Letter of support STW Perspectief proposal "RiverCare"

Dear Mrs Hulscher,

Densely populated large rivers and deltas worldwide suffer from increasing flood risks and deteriorating environmental quality. The recent assessment of the state of European and pressures made by the European Environment Agency highlighted approaches such as 'Room for Rivers' towards more integral and sustainable water management. The private sector, governmental bodies and research organization in the Netherlands have in long tradition in this respect and can be considered frontrunners to manage such low-lying and flood sensitive areas. The innovative "building with nature" approach to which Deltares intensively contributed and promotes to continue is an excellent example to tune the diverse interests from various perspectives.

Deltares research strategy amongst others aims to learn from large interventions to manage large rivers, lakes, estuaries and coastal waters. Our role in 'Building with Nature' and the key roles in FP7 projects such as 'REFORM' and 'FLOODSITE' are excellent examples in this respect. It is our strong belief that interventions such as "Room for Rivers, Maaswerken and nourish and dredging activities in large rivers should be accompanied by the appropriate research programs to plan such measures and evaluate their long-term development. This to increase our understanding and to develop new approaches and technologies to better forecast and reduce uncertainties aiming to increase the benefits for flood risk management and environmental quality and to reduce the maintenance costs. Furthermore it is our view that such approaches could be applied elsewhere in and outside Europe to manage rivers in a more integrated and sustainable way.

The STW Perspectief proposal "RiverCare" has the ambition to develop such new knowledge and transfer this into new tools for delta technology as well as the required interdisciplinary consortium of partners to address the present and upcoming research questions to manage large lowland rivers. The outcome will be made available for the Dutch water sector strengthening their international position.

Deltares therefore wishes to express its support to the RiverCare project. In fact all the components of RiverCare are connected to the scope of Deltares. We wish, however, to concentrate our contribution to the proposed projects A 'longitudinal training dams', E 'floodplain & ecosystem and G 'Data & Virtual River' and specify our contribution to each project hereafter.

REFORM - RiverCare

Deltares coordinates the EU funded FP7 project REFORM 'REstoring rivers FOR effective catchment Management'. This 4-yr project (Nov 2011 – Oct 2015) yields relevant results for RiverCare on various aspects. All deliverables of REFORM will become open-access available at the website www.reformrivers.eu. This website will be online until 3 years after the end of the project (2018).

A – Longitudinal Training Dams

Longitudinal training dams (LTDs) are an important and innovative adaptation of the original Room for the Rivers programme. The aim is that LTDs support multiple river functions (flood protection, navigation, ecology), but it is yet unsure how effective they are. The large 10 km pilot in the River Waal offers an excellent opportunity to evaluate this. Deltares wishes to support this with a cash contribution of € 75,000 and an in-kind contribution of € 40,000. The in-kind contribution comprises the use, training and support of the HABITAT software, specialist advice on ecological rehabilitation of large rivers in particular regarding habitat requirements of vegetation and fish and the supply of ecological data to assess the ecological benefits of LTDs.

E – Floodplain and Ecosystem

Large rivers fulfil multiple functions. In several parts of the world, management over the past decades already moved from sectorial towards more integral approaches while elsewhere it still is very single function oriented. Even in Europe management needs to improve the balance between land and water uses, environmental legislation (Water Framework Directive, Habitats Directive), flood protection and water supply.
Especially floodplains fulfil multiple ecosystem services, but the supply of these services in the light of floodplain succession and management is insufficiently understood. Deltares is highly interested in expertise on the benefits of floodplains in various phases of succession and under different management scenarios. Deltares wishes to support this with an in-kind contribution of € 40,000. The in-kind contribution comprises the use, training and support of the HABITAT software, specialist advice on ecotope classification and floodplain rejuvenation and succession.

G – Data & Virtual River

The knowledge of the multidisciplinary research on river-floodplain systems is captured in data, models and tools. Providing this knowledge in a form that is digestible by end-users is essential for transforming knowledge into policy. Deltares is highly interested in the integration of data, models and tools. Integrating data, tools and models into a serious gaming environment is one of the ways to make the results comprehensible by end users and to study the way the information is used. The gaming environment requires the models to interact with the end-users in real-time. Deltares is active in the international communities that standardize communication between models, which can also be applied to communicate with the gaming environment.

Deltares wishes to support this with a cash contribution of €75,000 and an in-kind contribution of €60,000. Deltares contributes towards integrating the next generation hydro software with a serious gaming experience. The in-kind contribution comprises of making available the D-Flow FM software as open source, the effort couple the software to the game engine (training and changes to the code), organizing user involvement, participation in the effect studies and brainstorm sessions on data, visualization and gaming.

Besides, REFORM has also developed a special GEOWIKI to allow the dissemination of case studies, knowledge and tools (wiki.reformrivers.eu). Deltares hosts this GEOWIKI and offers the RiverCare programme the opportunity to use this portal to give public access to its results. The yearly costs for hosting are € 4,000 and is guaranteed for the period 2014 – 2019 totalling € 24,000.

Intellectual Proper Rights

We are aware of STW Intellectual Property Rights and are in principle prepared to accept those, but wish to discuss with STW and the project coordinator the sensibleness and fairness of these general IPR in the light of the scope and ambition of this research programme. Deltares supports a strong open-access policy and is strongly urged to do so by both the Ministry of Economic Affairs and the Ministry of Infrastructure and Environment. In our view the research within Rivercare is in the pre-competitive domain and should make its outcome open access available.

Yours sincerely,

Ir. G. Blom
Director Inland Water Systems

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t.a.v. Prof. Dr. S.J.M.H. Hulsscher
Faculty of Engineering Technology
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ONDERWERP Letter of commitment
DATUM Amersfoort, 03 juni 2013
ONS KENMERK 2013-0245-RR/MT-446722
UW KENMERK

Dear Prof. Hulscher,

The Foundation for Applied Water Research / STOWA would like to express its commitment to support the project 'Regional River Systems – implications of novel stream restoration approaches' with cash and in-kind contributions. The 'Regional River Systems' project is part of the Rivercare programme which is envisaged to become part of the Technology Foundation STW Perspective scheme.

The research goals of the project 'Regional River Systems' are directly relevant to the STOWA projects 'Deltaproof' and 'Watermozaiek', focussing on challenges with regards to water quantity, and challenges with regard to ecosystem functioning in regional river systems, respectively.

The STOWA will support the project with a contribution amounting to 101.000 € in cash, made available to STW by transferring six tranches of 16.833 € equally distributed over the 6-year duration of the project. In addition, STOWA and participating water boards will support the project in kind with efforts adding up to 62.000 €.

Research questions that are addressed in the project, and that are of specific interest to STOWA and participating water boards are:

- How can the self-sufficiency of regional river systems be enhanced; which measures are effective to retain water and to reduce peak discharges under changing climate conditions? The whole catchment area is taken in account.
- What is the effect of management strategies aiming at self-sufficiency of the region on the main river systems, and how do measures taken in the main river systems affect the regional systems?
- Which expectations should we have regarding changes to sediment dynamics and morphodynamics of regional river systems in response to stream restoration measures aiming at self-sufficiency?

stowa

STOWA is keen to enhance integration of the project with other planned and on-going research on regional river systems, and will encourage and coordinate collaboration of the participating research teams. The in-kind contribution of the STOWA (62.000 €) is made available through involvement of senior STOWA and water board employees, who will spend at least 534 hours to support the project. The capitalization, against standard STW tariffs, of hours only represents a nominal value of hours STOWA will spend on the project. The resulting amount is not claimable as a cash contribution. Activities performed by STOWA and water board employees as in-kind contribution to the project include:

1. Coordinating contributions of the water boards, regarding selected case studies and relevant data.
2. Coordination of the collaboration between the RiverCare project and other planned and ongoing research projects on regional river systems.
3. Communication the project and its results to water boards.

The STOWA is looking forward to collaborating with the research team to pursue the goals of the project.

The STOWA agrees to publishing project results in open-access publications and open-source software.

Sincerely yours,

Drs. B. van der Wal

Director STOWA

Rijksinstituut voor Volksgezondheid
en Milieu
*Ministerie van Volksgezondheid,
Welzijn en Sport*

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Ons kenmerk
0084/2013 M&V/MvR/BL/mth

Uw kenmerk
266/2012 BMV MR/md
172/12 LER TB/md

Behandeld door
Birgit Loos
Head of Centre for
Sustainability, Environment
and Health

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birgit.loos@rivm.nl

Datum 29 mei 2013
Betreft letter of support RiverCare project E1b

Dear Prof. Hulscher,

In addition to our earlier letter of support for the program RiverCare (4-12-2012, 266/2012 BMV MR/md 172/12 LER TB/md) we herewith send a second letter of support to the program RiverCare in general and the project "Ecosystem services: assessing ecological assets and liabilities of river systems" more specifically. Operationalization of ecosystem services of river-floodplain systems is very important for the development of physical reconstruction measures and land use changes focused on sustainable river basin management and use of the system. The interest of RIVM in the project lays in the use of the results in the advices to the national and European governments on sustainable use and management of ecosystem services and indicators of their quality, based on insights in the biophysical processes in the environment and interests of stakeholders. In our opinion the results of the project can be applied very well in the advices RIVM develops for policy makers and environmental managers, and therefore we strongly support the program.

As the program RiverCare could very well join the research of the institute, RIVM has the intention to support the partial project "Ecosystem services: assessing ecological assets and liabilities of river systems" financially with 70 kEuro over the project period of 4 years, if the proposal is approved by STW.
In kind support of RIVM consists of provision of scientific guidance of the PhD student and the provision of data and models we develop and use in our research on the quantification of ecosystem processes and ecosystem service values, and the evaluation of management measures of ecosystem services.

With kind regards,

dr. M.T.M. van Raaij
Director Environment and Safety

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

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Our reference
091/2013 M&V MvR/TB/mth

Dealt with by
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DMG

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Date 5 June 2013
Subject letter of support RiverCare project E1b

Dear Prof. Hulscher,

The valorization of the in kind support of RIVM, as mentioned in our letter from the 29th of May (0084/2013 M&V/MvR/BL/mth), for the scientific guidance of the PhD student is (6 days per year over a period of 4 years = 24 days 24 * 952 Euro) 22.9 kEuro.

Yours sincerely,

Dr. M.T.M. van Raaij
Director Environment and Safety

WAGENINGEN UR
For quality of life

Postbus 47 | 6700 AA Wageningen

Prof. dr. S.J.M.H. Hulscher
Water Engineering and Management
University of Twente
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Board of Directors
Environmental
Sciences Group

DATE
June 4, 2013

SUBJECT
Expression of Interest

OUR REFERENCE
13/DOW0769

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HANDLED BY
ir. A.H. de Bruin

Dear Professor Hulscher,

The key objective of the proposed Perspectief-programme 'RiverCare: sustainable management of river systems' is to improve the predictive understanding of the effects of human interventions in (regional) river systems and utilize this knowledge to develop tools, instruments and guidelines that can be used to support river management worldwide. This requires a better understanding of the interaction between hydrological, morphological and ecological processes. The programme will be executed by a team of scientists from various disciplines in close collaboration with the end users.

Alterra, part of Wageningen UR, has over the years been involved in many projects related to river and stream restoration, in the Netherlands and abroad. Sustainability of measures and design is one of the key issues in Alterra's work in this field. Therefore, we are specifically interested in the proposed programme that aims at new knowledge that we can bring to practical applicability and exportable products.

Alterra specifically wants to contribute to project C, 'Regional river systems – implications of novel stream restoration approaches'. Regional river systems traditionally are a prime research focus of Alterra and we are interested in using the results of this project in our advisory and consultancy work. The need for better understanding of hydraulic and morphodynamic functioning of regional river systems is paramount, and a prerequisite for robust designs in stream restoration projects. Enhancing self-sufficiency through optimal use of natural processes, which the proposed project wants to contribute to, is a basic approach adopted in many of our applied projects as well. The utilization plan of the project gives us the confidence that the research products will meet our needs as a knowledge user.

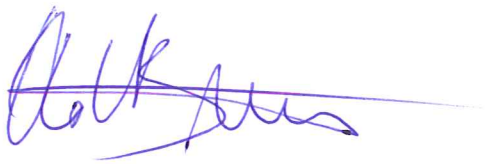
Alterra will contribute to project C 'Regional river systems – implications of novel stream restoration approaches' by a cash contribution of € 15,000.- (excl. VAT) in 2014. In the period 2015-2019, we intend to continue our cash support with another € 15,000.- in total (excl. VAT). The cash contribution by Alterra is budgeted as part of the 'Kennisbasis IV' ('KB 14 Duurzame Ontwikkeling Groenblauwe Ruimte') research funding from the Ministry of Economic Affairs. As KB 14 continuity and funding is subject to yearly ministerial program policies, Alterra cannot financially commit itself for a full six-year period. However, given the strategic interest of this research, Alterra does declare its full intention to continue support in the period 2015-2019 if the KB 14 programme will be extended after 2014.

In addition to our cash contribution, we will give an in-kind contribution of in total € 26,180.- (excl. VAT) to project C. This contribution will consist of 220 hours of work on activities related to the project by Dr. A. (Bart) Makaske, at a rate of € 119/hour (excl. VAT). These activities will consist of: (1) distributing the project deliverables within Alterra and encouraging application in relevant projects, (2) advising the project team in practical issues, (3) communicating about the project and its results in stakeholder communities. Dr. Makaske is recognized expert in regional water systems and involved in applied research and consultancy projects on stream restoration and morphodynamics. He is a member of the steering committee of the Community of Practice on stream restoration (CoP 'Hermeanderen') in which many stakeholders, such as STOWA, are involved.

Alterra agrees to publication and distribution of the results of the research as open-access literature or software.

We are looking forward to collaboration with our partners in the RiverCare programme.

Yours sincerely,



Auke de Bruin
Director of Operations

Bureau Waardenburg bv
Adviseurs voor ecologie & milieu

Universiteit Twente
Faculty of Engineering Technology, Civil Engineering, Department of Water Engineering & Management
Prof. dr. S.J.M.H. Hulscher
Postbus 217 7500 AE Enschede

our reference	13-397/13.02616/SjoDi
date	May 31, 2013
subject	support project RiverCare
no. of pages	2

Dear Prof. Hulscher,

On invitation of dr. R.S.E.W. Leuven, Bureau Waardenburg has been engaged in your RiverCare project. It is our pleasure to hereby confirm our support and contribution to the project.

We support the programme RiverCare in general and PhD project E2 "Ecosystem services: assessing ecological assets and liabilities of river systems" more specifically. Operationalization of ecosystem services of river-floodplain systems is very important for the development of physical reconstruction measures and land use changes focused on sustainable river basin management and use of the system.

The interest of Bureau Waardenburg in the programme has different angles. Firstly, being part of RiverCare enables our river ecologists to see what happens on the forefront of science in their field. This fits to our profile, where research and consultancy mixes and where in different parts of our company scientific papers are sometimes results of projects instead of the standard reports. Our staff wants to keep up their knowledge. Secondly, we believe that being part of RiverCare will result in getting knowledge that helps us to get, or keep, an advantage over our competition in the field. So far, our river projects are mainly within The Netherlands. RiverCare might help us to acquire projects abroad, as we already do in other areas of expertise. Thirdly, RiverCare will result in tools which we can help to get on the market, and by doing so, we will have an advantage in the use of these models ourselves and in providing training courses.

Given the described arguments for supporting RiverCare, Bureau Waardenburg has the intention to support subproject E2 "Ecosystem services: assessing ecological assets and liabilities of river systems" financially with 10 kEuro over the project period of 4 years (2,5

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kEuro each year) when the proposal is approved by STW. In kind support of Bureau Waardenburg 23 kEuro consists of provision of scientific guidance of the PhD student and active involvement of our staff during 6 days each year, 24 days in total.

We hope STW will judge in favour of the RiverCare project!

With kind regards,
Bureau Waardenburg,

drs. S. Dirksen
vice director

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Prof. dr. S.J.M.H. Hulscher
Water Engineering and Management
University of Twente
P.O. Box 217
7500 AE ENSCHEDE

WATER DIVISION

Subject:
Letter of Support
STW-perspectief proposal RiverCare

Amersfoort,
5 June 2013

Contact:
ir. D.W. van Raalten

Direct line:
+31 627060272

E-mail:
david.vanraalten
@arcadis.nl

Our ref.:
WATAP/2013:652

Project number:
C03021.

Dear Prof. dr. Hulscher,

At the moment the large river programme 'Room for the River' is being implemented in The Netherlands. The 'Maaswerken' are getting close to being completed. And the Deltaprogramme Rivers, as part of our national Deltaprogramme has started is regional consultation processes. As such we live in an exciting time, in which our extensive Dutch river system has become one big laboratory! A lot of interventions are already completed, many are currently under construction or about to start, and new measures are being planned.

For ARCADIS, and especially our Water Division, this is indeed exciting. Exciting as we are fully aware of the opportunities in the rest of the world: we live in a world which is changing due to climate change, increased population pressure on the delta's, and a working environment that is becoming more and more global. The excitement is fuelled by a recognition of our unique expertise being gathered in The Netherlands with water management, and our unique network of colleagues, currently around 22.000, across the globe. And recent floods in Europe clearly demonstrate that good River Care is required in order to sustain our own habitat! Rivers have turned into serious threats whereas this could have been avoided with proper River Care.

As such we are very much willing to supporting your proposed STW-programme RiverCare. We strongly believe that with the expected results we can further improve expertise, and hence confirm our ambition as being one of the leading consultancy firms in the world.

Nearly all the proposed projects in your STW-programme are somehow directly linked with the work that we do: be it working with longitudinal dams (for the Waal river), effect of side channels (preparation of plan for Veessen-Wapenveld), planning & implementation of river restoration works (Regional Process for Meuse river), or actual implementation of maintenance of rivers works (Prestatiecontract IJssel en Twentekanalen), etc. etc. The projects will provide us with in-depth knowledge of the long-term effects of the work that we do. And as such will help us in shaping our consultancy activities in the future.

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Water Division holds certificates
ISO 9001, ISO 14001, OHSAS 18001
and the CO2-Performance ladder

Dutch Trade Register
09036504

As such ARCADIS confirms herewith its commitment to support this proposal and to actively support the programme if and when STW decides to fund it. Our co-financing will be in the following ways:

- Cash contribution of 8,000 EUR for training sessions, with the aim to improve the technical capacity of our staff with the results of this programme;
- In-kind contribution of 22,500 EUR through the involvement of our experts as well as the provision of data and concrete cases for Project E on 'Floodplain Restoration and Ecosystem Services';
- In-kind contribution of 2,500 EUR through the involvement of experts for project H on 'Export opportunities & valorisation'.

We are fully aware that the results of this programme will be published. As such we agree that the Intellectual Property will be shared through open literature and open source software.

Yours faithfully,
ARCADIS Nederland BV

David W. van Raalten
Director Department for Rivers and Inland Waters

Royal HaskoningDHV
Enhancing Society Together

HASKONINGDHV NEDERLAND B.V.
RIVERS, DELTAS & COASTS

Return address: Postbus 8064, 9702 KB, Groningen, The Netherlands

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E-mail	:	lisette.heuer@rhdhv.com
Date	:	3 June 2013
Enclosure(s)	:	-

Subject : **STW-proposal 'RiverCare: sustainable management of river systems'**

Dear Professor Hulscher,

With this letter Royal HaskoningDHV would like to express its support for the STW research programme to the sustainable management of river systems.

Royal HaskoningDHV has been (and still is) involved in various prominent river management projects and programmes in the Netherlands and abroad. We have provided a significant contribution to two national programmes: de Maaswerken and Room for the River in all phases, starting with preparatory studies followed the master planning, EIA, design, management and supervision of many separate projects. We have successfully exported the Room for the River principles and implemented these principles in our projects abroad, e.g. recently in the "City on the River – Warta Masterplan", Poznan in Poland. We work in river management projects on all continents. We are proud to be one of the founding members of EcoShape, implementing the Building with Nature principles in our projects.

It is for this broad involvement in river management problems worldwide that we are sincerely interested in the proposed research programme RiverCare. The research themes focus in filling in the lacunas in the theoretical knowledge of riverine systems in terms of their long-term response to the human interventions and the related uncertainty. Enhanced knowledge will help to develop improved methods for river management, e.g. optimized ('smart') dredging, but also help to improve planning and implementation of river management and river restoration projects. We consider the utilization of the research work – a.o. implementation of its results in numerical models – a very important result which may improve Royal HaskoningDHV's position in the (inter)national consultancy market.

Royal HaskoningDHV
Enhancing Society Together

For these reasons, Royal HaskoningDHV fully supports the proposed research programme and is willing to contribute to it.
We are interested in the following themes of the RiverCare programme:

- Long-term effects of longitudinal dams (project A).
- Long-term stability of river banks and lateral channels (project B).
- Optimization of dredging and nourishment strategies (project D).
- Uncertainty in predicting long-term developments in river systems (project F).

Our financial contribution over the 6 years duration of the RiverCare programme will consist of the € 5,000 (excl. BTW) cash contribution for training of our staff by the postdocs working for the programme, and a 8 weeks in-kind contribution (€ 119 x 40 x 8 = € 38,080 excl. BTW) of our staff to the research to the long-term development of side channels (project B of RiverCare).

Furthermore, we are willing to participate in maximum 3 user committees and in assigning 2-3 Master students for this programme. We will select the specific themes and research projects after these have been defined in more detail.

We concur that the research results will be published in open literature and in open software.

We sincerely hope this research programme will be awarded by STW.

Yours sincerely,

Ir. L.A. (Lisette) Heuer
Technical Director, Business Line Rivers, Deltas & Coasts

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Faculty of Engineering Technology, dept WEM
University of Twente
attn Ms Prof.Dr. S.J.M.H. Hulscher
P.O. Box 217

7500 AE ENSCHEDE

date	your reference	reference
5 June 2013	-	ZZHW3000-113/zeir/113
handled by	**telephone**	**subject**
ir. C.H. Clemens	+31 570 69 73 75	Expression of support

Dear Ms Hulscher,

In a delta like the Netherlands water is inevitably present. Its presence gives us opportunities but it is also important to manage the water. In the coming years, we face the challenge to improve the safety of great rivers and our coast line. This is carried out within several programmes, such as 'Room for the River', 'Maaswerken', Deltaprogramme Rivers and 'Zandmotor'. This latter is an example of building with nature indicating that in the Netherlands we have embarked on a new path in the design of coastal protection. Nature plays an increasingly important role in the design. We go back to how ecosystems function, without losing sight of safety. For scientists and engineers, the challenge is to cross the boundaries of their discipline and to develop an integrated approach.

Witteveen+Bos is a company based in the Netherlands that provides consultancy and engineering services in the fields of infrastructure, water, the environment, spatial development and construction. Our multidisciplinary approach to projects is the distinctive feature of the way we work. Witteveen+Bos offers its clients value-added consultancy and top-quality designs for water, infrastructure, spatial development, environment and construction projects. We deliver reliable solutions built on the knowledge, experience, social insight and intellect of our employees. At Witteveen+Bos we maintain an inspiring working environment from where we tackle the fascinating challenges that the future holds. Professionalism, respect and integrity are our core values.

Witteveen+Bos provides services in the fields related to the topics of your initiative: morphological and hydraulic engineering, hydrology, ecology, uncertainty analyses, information technology, monitoring, execution of cost-benefit analysis, ecosystem services. Witteveen+Bos is involved in the preparation and execution of large scale river works in the Netherlands. Examples of these are Room for the River projects (e.g. Deventer, Avelingen and Overdiepse Polder), the 'Grensmaas River Project' and the 'River expansion project IJsseldelta-Zuid'. On international scale we are also involved in these kind of projects, for

example the technical assistance for rehabilitation and improvement of the Sava river waterway (Serbia, Kroatia).

We strongly underline the key statement of the RiverCare proposal: Rivers *live*. Knowledge about all variables that make rivers 'live, is crucial for managing rivers in a safe and durable manner. Therfore, we are prepared to support the RiverCare proposal as part of the Programm Users Community, with specific focus to the projects:

- A - training dams (morphology and ecology).
- C - stream restoration.
- D - ecomorphological changes, dredging and nourishments.
- F - uncertainty & management.

We are especially interested in the mentioned field-measuring and remote sensing techniques that will be used to improve insight in the development of vegetation structure and floodplain morphology.

We will support the above-mentioned four projects with an in-kind contribution to connect the research project to our previously mentioned projects 'in the field'. We offer our practical experience and will participate by being actively involved by supervision or co-operation in the case studies. We can provide an working environment for the PhD, MSc and Bsc-students involved. In return Witteveen+Bos would like to be given the opportunity to have detailed and frequent updated insights into the results, as well as to be given the opportunity to actively participate in (some parts) of the project and possibly co-author publications. In the table below we have specified our in-kind contribution for the selected projects, to be distributed in time on the basis of a project planning.

project	title	in-kind contribution (in EUR), excl. VAT	specification of in-kind contribution
A	training dams (morphology and ecology)	7.500,-	63 hr academic educated employee
C	stream restoration	7.500,-	63 hr academic educated employee
D	ecomorphological changes, dredging and nourishments	7.500,-	63 hr academic educated employee
F	uncertainty & management	7.500,-	63 hr academic educated employee

Additionally, an in-cash contribution of EUR 2.000,- (excl. VAT) will be provided by means of a contribution to organised courses by the RiverCare project. In return, one employee of Witteveen+Bos will be allowed to participate to one two-day course free of charge.

reference
ZZHW3000-113/zeir/113

date
5 June 2013

Witteveen+Bos agrees with publication of research results in the open literature and open software. Our support to the RiverCare Programme will be further specified during future elaboration of this proposal, if selected.

Yours sincerely,

Th.G.J. Witjes MSc
Manager of the Water Management Department
(In absentia S.C. van der Biezen Manager MSc of the Coasts, Rivers and Land Reclamation Department)

provincie GELDERLAND

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datum
6 juni 2013

zaaknummer
2013-008758

onderwerp
Opdrachtverlening RIVERCARE

Dear Prof S. Hulscher,

Through this letter and mediation of Prof Smits (Radboud University Nijmegen by letter 3 june 2013 nr:20130603LD) we like to express our support the RIVERCARE STW-proposal. One of the key responsibilities of the Province of Gelderland is, together with other societal stakeholder groups, to realise a good balance in the fluvial area between interests of safety (flood protection), economy, spatial quality and ecological values. Within this context the Provincial Executive is coordinating the so-called “Wealthy Waal” program along the 80 km long Rhine-Waal river section (German border – border of the Province of South-Holland).
The “Wealthy Waal” program is the result of an innovative bottom-up approach in which various regional stakeholder groups are involved to realise sustainable use of the floodplains. The program comprises various subprojects (approx. 48) that integrate nature rehabilitation, “Room for the River” goals (increase of water discharge capacity), leisure and flood adaptive housing. For the coming years (2014 -2020) approximately 60 million Euro will be spent to realise some of these sub-projects.

For the near future the “Wealthy Waal” program has to cope with a series of challenges. Challenges caused by direct or indirect effects of climate change, European guidelines with respect to biodiversity, Water Framework Directive (WFD) and national policy with respect to flood protection. Moreover, increased complexity of land use and water/river management in the fluvial area an the overall ambition to reduce costs demands for an improved governance structure with respect to floodplain management. The Province of Gelderland has, together with Rijkswaterstaat (division East Netherlands) the ambition to make use of various ecosystem services that are provided by the fluvial system such as sand, clay, leisure and renewables (biomass, solar).
All these challenges generate a number of knowledge gaps that are addressed for a great part by the RIVERCARE proposal.

Therefore, we decided to contribute 150K Euro in cash to the RIVERCARE project (period 2014-2019). Although, the Province of Gelderland is interested in the outcome of all sub projects of the RIVERCARE proposal this contribution is in particular linked to the sub-project; “Self Supporting Hydrosystems and Valorisation” (sub-project H). The Province of Gelderland approves the STW policy that research results may be published in scientific journals and software.

inlichtingen bij dhr. H. de Hartog

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provincie
GELDERLAND

If the RIVERCARE proposal is granted by STW a users group comprising employees of the Province of Gelderland and Rijkswaterstaat (East Netherlands) will be formed to inspire and guide the research project to ensure interaction between science and practice.

Deze opdracht wordt u verleend op grond van artikel 158, eerste lid, onderdeel van de Provinciewet. De Algemene Inkoopvoorwaarden van de provincie Gelderland zijn op deze opdracht van toepassing. Deze inkoopvoorwaarden zijn bijgevoegd.

Conform de afspraak kunt u voor de werkzaamheden een bedrag van € 150.000,- excl. BTW.
U kunt uw factuur sturen aan:

Provincie Gelderland
Afdeling Financiën/Project WaalWeelde
Postbus 9090
6800 GX Arnhem
Wilt u hierbij het volgende nummer vermelden: **Inkooporder nummer: 130660**

Namens Gedeputeerde Staten van Gelderland,

H.F. van de Wart
Teammanager Prioritair Programma Gelderse Gebiedsontwikkeling

Afschrift:

Radboude Universiteit
Factulteit der Natuurwetenschappen, Wiskunde en Informatica
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Postbus 9010, Postvak 77
6500 GL Nijmegen

HKV CONSULTANTS

Universiteit Twente, CT&M
Faculty of Engineering Technology, dept WEM
Attn. Prof. dr. S.J.M.H. Hulscher
Postbus 217
7500 AE ENSCHEDE

Reference: 1441/RO0544.10/HJB/CM

Date: June 5, 2013

Dear Professor Hulscher,

The management of river systems is of utmost importance for the Netherlands as well as abroad. Rivers serve various functions, such as navigation, water supply, nature, and very important, the safe conveyance of water, sediment and ice. In the coming years large scale river works will be carried out, so as to improve the safety against flooding (e.g. MeuseWorks, Room for the River) and enhance the ecological functioning (Framework Directive). These interferences will undoubtedly have consequences for the river system. This provides us with the unique chance to learn what the consequences are of these works and improve the understanding of the complex river system. This knowledge will be valuable for future river management and for making optimal choices for future interferences both in the Dutch river system as well as in foreign river systems. We strongly support your intention for using this unique moment to set up an integrated research programme aiming at investigating in detail the consequences of the major river interventions that are planned in the Netherlands.

HKV CONSULTANTS is a Dutch company that provides independent research and consultancy services in the field of water management and safety. With HKV's staff of over 65, all relevant expertise and services are available related to the topics of your initiative: morphological and hydraulic engineering, hydrology, flood risk management studies, uncertainty analyses, disaster management support, information technology, monitoring, flood risk insurance assessment, execution of cost-benefit analysis, and development of flood forecasting systems. HKV CONSULTANTS maintains close relationships with leading Dutch knowledge institutes as part of their intensive R&D activities.
HKV CONSULTANTS is and has been deeply involved in the preparation of large scale river works in the Netherlands. Examples are the hydraulic and morphological analyses for the MeuseWorks, various Room for the River projects (e.g. Lent, Vianen, Veessen-Wapenveld, Volkerak-Zoommeer) and the plans initiated within the Framework Directive (e.g. KRW IJssel).

Furthermore HKV CONSULTANTS has been involved in studies related to navigation (e.g. DVR) and water safety (e.g. FLORIS, WV21, Deltaprogramme).

The above description of our fields of expertise, together with our ambitions for applying the knowledge in international projects and our conviction that research and development is essential (expressed in our intensive R&D programme and co-operation with research institutes), are the reasons why HKV CONSULTANTS has strong interest in the RiverCare proposal.
HKV CONSULTANTS intends to support the program if and when STW decides to fund is. We intend a substantial in-kind contribution to RiverCare. Our proposed annual contribution to the sub-projects of RiverCare is summarized in the table below:

Project	Description	Contribution	Days /year	Academic (Y/N)
A	Training dams (morphology and ecology)	Supporting discussions on dominant three-dimensional flow and morphology processes. Definition of and participation in case studies in which the contribution of HKV relates to • feasibility of CFD methods for modelling flow patterns, including flexible mesh approaches • providing requirements for simplified design rules for training dams • revealing historical studies of impacts on morphology and navigation	10	Y
B	Banks & side channels	Supporting discussions about the theory of channel width formation and providing field data from rivers in the Netherlands and abroad to test methods. Definition of and participation in case studies in which the contribution of HKV relates to • Supporting discussions on three-dimensional morphology at bifurcations • Practical ways to influence the sediment distribution at bifurcation points • Set-up of a probabilistic approach	10	Y
D	Ecomorphological changes, dredging and nourishment	Monitoring: exploration of the possibilities for combining satellite data and in-situ data for monitoring the river bed.	7	Y
F	Uncertainty & management	Definition of and participation in case studies in which the contribution of HKV relates to • Influence of natural, soft and hard solutions on uncertainties • Influence of morphodynamics on uncertainties	10	Y
G	Data/Knowledge base & Virtual River (serious game)	Support during the set-up of design criteria for the knowledge management system and for the virtual river tool. Providing requirements for applying the tools in practice and test cases, using international project references.	3	Y
Total			40	

In addition HKV CONSULTANTS will provide working environment for PhD, MSc and BSc students and will closely follow the project "Export opportunities & valorisation" so that the result can be used in our consultancy.

HKV CONSULTANTS agrees on distributing the results of the projects in open literature and open source software.

Sincerely yours,

Ir. Drs. K. Vermeer
Director

T-Xchange THALES

Prof.dr. S.J.M.H. Hulscher
Water Engineering and Management
University of Twente
P.O. Box 218
7500 AE Enschede

Hengelo, May 30th 2013

Reference: T-Xchange/003/20130530

Dear Prof. Hulscher,

On behalf of Thales Netherlands, in particular T-Xchange, we would like to contribute to the proposal RiverCare. We consider this initiative worthwhile and it fits well into our research and technology roadmap with respect to our serious gaming activities

T-Xchange - a joint venture between Thales Netherlands B.V. and Twente University - designs and develops serious games for public and private organizations. Our vision is that serious gaming has great potential for supporting human judgment and decision-making regarding innovation and change processes. Taking the 'right' decisions in these processes is complex due to the absence of reliable information, the different knowledge disciplines that need to be taken into account, and the different interests and perspectives of stakeholders involved. From that perspective we are very much interested to participate in and contribute to the Virtual River project within the RiverCare program. Our main interest is how serious gaming can extend and compliment the decision-making process regarding planning and intervention techniques by bringing the human in the loop.

Provided the RiverCare project is granted we will contribute to the Virtual River project by facilitating the PhD student with our serious gaming knowledge and tooling. This support will consist of active participation towards realisation of the serious game system. This in-kind support has the equivalent of 72.500 Euro (400 hours x 119 euro senior researcher and 300 hours x 83 euro junior researcher). In addition, T-Xchange will supply a gaming license with a monetary value of 15.000 euro per year .to be used for the duration of the project free of charge. To ensure project involvement, Dr. Johan de Heer, director of the T-Xchange lab, will act as co-supervisor of the PhD candidate. The PhD candidate will be hosted by both Twente University and T-Xchange.

We sincerely hope that STW Perspectief will find sufficient grounds to grant the RiverCare project.

Yours sincerely,

M.G.M. Koning ter Heege
CTO Thales Nederland B.V.

TYGRON

Prof.dr. S.J.M.H. Hulscher
Water Engineering and Management
University of Twente
P.O. Box 218
7500 AE Enschede

Date ; 30 May, 2013
Concerns; Support

Dear Prof. Hulscher,

Tygron would hereby like to confirm its support to the STW Perspectief program RiverCare.

Tygron, is developing software to support decision making in spatial development and water management. We aim for the development of software to interactively manipulate the multiplicity of issues surrounding these domains. Consequences are calculated and visualized in state of the art 3D game technology thereby giving individual users deeper insight into areas of conflict or mutually beneficial solutions beforehand. This can be used to resolve conflicts, enhance transparency, accountability and dramatically saves time and, therefore, money.

We consider this to be the next generation decision support system in Water Management. From that perspective we are very much interested to participate in and contribute to Project G - Communicating program outcome: Knowledge base, visualisations and Virtual River. We are aiming for scientific foundations of the next generation decisions support systems

We will support project G by supporting the PhD student in the realisation of the required visualisations. The in-kind support will consist of training of the PhD student and the two post-docs and realisation support:

- 150 hours of training by a senior trainer: 17.850€
- 80 hours of support by senior developer: 9.520€
- 214 hours support by junior developer: 17.762€

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Rabobank
14.25.28.641

TYGRON

The visualisations of the outcome of the RiverCare program will be realised with the Tygron Game Engine. Tygron will supply a licence for this engine to be used. Our general terms and conditions apply to the use of the Tygron Engine. Tygron is aware of the IP-policy of STW and hereby confirms to it as long it is not conflicting with our own general terms and conditions.

To ensure project involvement, a representative of Tygron will attend project meetings as well as be a member of the Advisory board of the RiverCare program.

We sincerely hope that STW will find sufficient grounds to grant the STW Perspectief program RiverCare.

Yours sincerely,

Florian Witsenburg
CEO Tygron

MILIEU ▪ RUIMTE ▪ WATER

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Mevrouw Prof. dr. S.J.M.H. Hulscher
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Our reference	Your reference	Date
CSO/rivercare/BRF001	STW-programme RiverCare	May 28, 2013

Subject
Letter of Support

Dear professor Hulscher,

The Netherlands is a densely populated country situated in the Delta of the Rhine-Meuse rivers. Ever since the Middle Ages we have had a tradition of building defences against flooding. This early Water Management resulted in current river systems which are highly influenced by man. As a result most rivers are straightened and floodplains are bounded. Since we have to deal with changing flood regimes and sea level rise new strategies in Water management have to be developed. The short term programs 'Room for the River', 'Maaswerken' and 'Stroomlijn' are currently being implemented, and the 'Deltaprogramme' should solve long term issues concerning flood safety.

CSO consultancy has a long history of involvement in these river projects, covering a broad range of subjects from developing GIS software for flood modelling, hydraulic and morphological analyses to gravel/sand extraction and environment impact assessment. In our role as consultant for the government we are continually expanding our knowledge and experience. The proposed STW-programme RiverCare can fulfil this demand for new insight and comprehension.

Therefore CSO is very much interested in the results of the RiverCare programme and willing to contribute to it.

Support will be given in kind by:

- Participation in courses / case-days
- Facilitating work environment and case-studies for MSc /BSc students
- Supervision of MSc /BSc students
- Being actively involved in case-days

- Being a member of a user group of at least two sub-projects

In average, the contribution will be 8 days a year, which is the equivalent of 7.500 euros a year or 45.000 euros during the entire programme .

Further specification of our support to the STW-programme will be done after the proposal has been selected.

Yours sincerely,

Marijn Rang MSc.

Managing Director
CSO Adviesbureau Milieu, Ruimte, Water

Bundesanstalt für Wasserbau
Kompetenz für die Wasserstraßen

Bundesanstalt für Wasserbau · Postfach 21 02 53 · 76152 Karlsruhe

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Ihr Zeichen:

Datum: 05.06.2013

Subject: Letter of Support / STW-perspectief proposal RiverCare

Dear Prof. Hulscher,

The German Federal Waterways Engineering and Research Institute (Bundesanstalt für Wasserbau, BAW) is the technical and scientific federal authority of the German Federal Ministry of Transport, Building and Urban Development (BMVBS). We are the central providers of consultancy and expert opinion services to the ministry and its water and shipping authorities (WSV) concerning their waterways engineering tasks, construction supervision and ensuring safety and regulatory compliances of structures and facilities.

Our work is an important contribution to ensuring that waterways in Germany meet ever tougher technical, economic and ecological demands. We have extensive expertise and experience in the field of waterways engineering and, as key players in the ongoing development of this discipline, enjoy a considerable reputation in the national and international scientific community.

We are deeply interested in international co-operation with scientific and/or technical institutes, joined projects and other activities which deal with waterways engineering. This is especially true in the case of the Netherlands, where we are the natural partners, "upstream neighbours", for any project concerning maintenance of rivers, which flow we actually share. We already co-operate with Rijkswaterstaat, Deltares, TU Delft and will be happy to intensify our common effort in a broader, international network.

To our understanding, the STW Perspectief proposal RiverCare has an ambitious and valuable scope of activities aimed at developing a new interdisciplinary knowledge base and transferring it to tools available for scientists, engineers, stakeholders and decision makers equally.

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Wedeler Landstraße 157 · 22559 Hamburg
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Numerous activities planned in the framework of the RiverCare project are directly connected to our scope of activities. Working on the sediment dredging and nourishment, quantifying uncertainties and on optimizing the training dams are in a direct connection with our present research and development. Although we are particularly interested in the themes regarding waterways engineering, we understand and support a larger interdisciplinary network in which these particular themes are embedded.

We would be happy to utilize the results of the joint project in our future activities and are open to new methods of decision making systems expressed in the idea of "virtual river".

BAW wishes to express its encouragement for the proposed RiverCare programme. We intend to support this project by:

- Considering and joining our own research and development activities with the RiverCare project
- Sharing our data
- Providing researchers in the project with a working environment and co-supervision by our qualified staff
- Actively facilitating the co-operation and participating in the programme users group

In due course, we will further specify our support in accordance with the consultations with the project proposers and other funding partners.

Sincerely yours,

Dr. sc. Tech. Roman Weichert
Deputy Head of Department Hydraulic Engineering in Inland Areas

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT CORPS OF ENGINEERS
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103-2833

REPLY TO
ATTENTION OF:

JUN 0 3 2013

Engineering and
Construction Division

Professor DR. S.J.M.H. Hulscher
University of Twente
Faculty of Engineering Technology
Civil Engineering
Department of Water Engineering & Management
P.O. Box 217
7500 AE Enschede, The Netherlands

Dear Professor Hulscher,

The U.S. Army Corps of Engineers, St. Louis District ("Corps") supports research on the long term hydrodynamic, morphological and ecological effects of the extensive river management projects being carried out and planned in the Netherlands. These river management projects include, but are not limited to, Room for the River, 'Maaswerken', and the Deltaprogramme.

The results of this research can be used by the Corps to gain insight into the potential impacts of similar projects on rivers in the United States. The development and implementation of these large scale, innovative measures, combined with a robust monitoring and research effort, provide a rare opportunity to gain further insight into hydraulic, ecological, and morphological impacts of river engineering measures.

It is expected that this research will lead to improvement of hydraulic, ecological, and morphological models which will also greatly benefit the Corps. Monitoring and research efforts like these help move towards the ultimate goal of using lessons learned to develop methods that promote the development of self sustained river systems that combine all desired functions.

Sincerely,

David Busse

David Busse, P.E.
Chief, Engineering and
Construction Division

Dienst Landelijk Gebied
Ministerie van Economische Zaken

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Universiteit Twente Water Engineering and Management
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Datum 28 mei 2013
Betreft Letter of support perspective project proposal River Care

Onze referentie
DLG/2013/18470

Already some time ago DLG was pleasantly surprised by the appearance of the initiative of River Care Program.

DLG is a national public organisation that works for governmental organisations on rural and peri- urban development in all its facets.

Derived form the last political (governmental) statements on National and provincial level DLG is aiming to invest in the nearby future on the themes as water management, climate and international affairs. In that context DLG is also searching for more cooperation with RWS and Regional water authorities.

As you know, DLG is involved in river related activities, in developing and executing plans of measures for river systems to future use. We are active in plans on various levels, both large river systems, such as "Room for the River", and smaller rivers and brooks. We are also participating in river related projects abroad, mostly in Europe but also elsewhere in the world.
As you may know the role of DLG varies form more process-oriented to content – multi or uni disciplinary - . In practise we try to use all kind of (inter)disciplinary knowledge and techniques, generated by several organisations. On the other hand we develop sometimes our own tools in good cooperation with research institutes.

Moreover we are occupied in the river (interdisciplinary) platforms focussing on knowledge exchange, such as "Community of Practise Remeandering", the Dutch Platform Stream and River Restoration and European Centre for River Restoration.

We expect this initiative will lead to more focus and cohesion in using research capacity on this interesting and broad field. To achieve more effectiveness and efficiency in these times of cutting financial sources this should be encouraged.

We therefore express our support to this initiative. The active participation of DLG can happen on program and project level to enhance the application of the results in (our) practise. We have to make up our mind on which projects we want to focus, depending on the demanded capacity-input form our side. We may be able to stimulate and support application in pilot- areas too, if needed.

We expect this program will be connected respectively embroider on current research projects, such as REFORM, several projects of WUR/Alterra.

We are looking forward to a good cooperation with the consortium.

Yours sincerely,

ir Stephon van der Hulst,
head of the department of environment

Vakgroep Leefomgeving

Datum
28 mei 2013

Onze referentie
DLG/2013/18470

University Of Twente
Water Engineering and Management
Prof. Dr S.J.M.H. Hulscher
Postbus 2017
7500 AE Enschede

staatsbosbeheer

Datum 28 mei 2013
Onderwerp Letter Of Support Researchprogram "Rivercare"
Behandeld door Mr. T. Meeuwissen, telephonenumber: 0570-747144
Ons kenmerk Sbo2013-1605-tme
Uw kenmerk
Bijlagen

Dear mister Hulscher,

Staatsbosbeheer, the Dutch Forestry Commission, is responsable for the management of more than 15.000 hectare of floodplains. Partly this floodplains consists of Nature2000 areas, nature restoration areas and wetlands. The longue terme objectives for these areas are flood protection and nature conservation. In order to combine those objectives it is premordial to understand the processes and dynamics of the lowland rivers in the Neterhlands.
The researchprogram "RiverCare" aims to develop a better understanding of the interaction between hydrodynamic-, morphological- and ecological processes. This knowledge and understanding will give the possebility to asses hydro-morphological changes and linked ecological changes. It is also important to define key-data and –parameters for the monitoring of mentioned processes.

Staatsbosbeheer strongly supports the researchprogram "RiverCare". Ecological data for more than 30 years collected by Staatsbosbeheer can be used, furthermore vegetation studies and digital vegetation maps can be used. Staatsbosbeheer can bring in local field expertise and working hours of our rangers and ecologists as well as practical support for researchers. We also offer to become a member of your steering committee. When the researchprogram starts we want to make further concrete agreements with you about these aspects. The researchprogram will give a scientific base to the management of floodprotection and nature conservation/restoration in the floodplains along the Dutch rivers. The expected outcomes of the researchprogram "RiverCare" will be of importance for nature management along the rivers in the Netherlands.

If you have any questions regarding this letter, please contact Mr. Meeuwissen whose details are listed at the top of this letter.

On behave of the director of Staatsbosbeheer,
Yours sincerely,

Ir. P. Winterman
Regiodirecteur Oost

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Ministerie van Infrastructuur en Milieu

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Ons kenmerk
IenM/BSK-2013/114268

Datum 4 juni 2013
Betreft Support RiverCare project

Dear Professor Hulscher,

With this letter we support the intentions of the project RiverCare which is going to be submitted within the 'Perspectiefprogramma' of the Technology Foundation STW.

The Ministry of Infrastructure and Environment is responsible for the water management policy of the Netherlands. Adequate river management is essential for flood risk management, fresh water supply and shipping.

At the moment we are successfully implementing the Room for the River policy. The research project RiverCare is an excellent opportunity to monitor and scientifically explore the consequences of changes carried out in the river system.

In the Dutch Delta-program, national and regional organizations cooperate to develop a sustainable and adaptive strategy for future river basin management. For future policy decisions on river basin management it is important to increase our knowledge of the river system. Therefore we would like to express our support for the RiverCare project. Especially the research on morphology and uncertainties has our attention. We are also enthusiastic about the 'virtual river'. This tool can be used to explain the river system to a broader public and can contribute to the process of stakeholder participation.

We are confident that the results of the project will enable us to reflect on flood risk management as well as ecological and shipping issues in The Netherlands and abroad. Wishing you success with the preparation of the project,

Sincerely Yours,

DIRECTEUR ALGEMEEN WATERBELEID EN VEILIGHEID,

drs. R. Feringa

TOPSECTOR
WATER

University of Twente
Horst building, group WEM
Attn. Prof dr S.J.M.H. Hulscher
P.O. Box 217
7500 AE ENSCHEDE
The Netherlands

4 June 2013

Dear Prof Hulscher,

We are aware of your initiative to submit the Programma RiverCare and with this letter we want to show our support.

Firstly, the proposal includes the international context and looks for connections with delta's abroad, the field where a large part of the Dutch Deltatechnology sector is employed. In the Programme RiverCare, project H, explicit emphasis is on the export possibilities of the knowledge and it includes the application on the Waalweelde, which can act as a showcase for applying the concepts outside the Netherlands.

Secondly, RiverCare links to the questions and research possibilities of the Dutch watermanagers (RWS and Water Boards) in the Deltatechnology sector.

Also, the programme nicely fits with the wish to reduce uncertainties in innovative long-term solutions. We also acknowledge that RiverCare is of a multi-disciplinary nature, which is in line with the complex nature of the water management questions.

We hope that STW will fund the Programme RiverCare.

Sincerely yours,

Peter van der Linde
Chairman Team Deltatechnology