

Civil Engineering & Management

**Scientific report
1995-1999**

May 2000

This scientific report has been written by the Department of Civil Engineering of the Faculty of Technology & Management of the University of Twente for the periodic quality assessment of research under auspices of the VSNU.

University of Twente
Faculty of Technology & Management
Department of Civil Engineering
P.O. Box 217
7500 AE Enschede

Editor:
prof. dr ir M.F.A.M. van Maarseveen

Coverdesign:
Ontwerpers pur sang

ISBN: 90 365 1464 9

© Department of Civil Engineering

All Rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the Department of Civil Engineering of the University of Twente

Preface

This report has been written for the periodic Quality Assessment of the research programme “Civil Engineering & Management” of the Faculty of Technology & Management of the University of Twente, covering the period from 1995 to 2000.

Section A summarises the views of the Department of Civil Engineering on its research activities. It briefly describes the organisation and the history of the research and education programmes “Civil Engineering & Management” since the foundation in September 1992. The information has been added to familiarise the reader with the background of the new Department.

The key data as required by the VSNU for the Department as a whole is presented in section B. This is followed in Section C by a detailed overview of each of the research (sub)programmes and research themes covered by the Discipline Groups within the Department of Civil Engineering. Programme leaders compiled the reports on each of the research (sub)programmes.

Finding oneself in the middle of a development stage and keeping in mind the phase lag between input, production and actual output date, the correlation between input and output volumes is somewhat weak. Therefore, the realised research output in 2000 at the time of writing of this report has been added in a separate column of the various output tables for the sake of completeness.

Information concerning finances and personnel came from the Faculty’s administration. Data concerning the research input was collected from the time allocation system of the Department, in which available capacities for each of the discipline groups are allocated annually for education, for research and for managerial tasks. For education and management there is a detailed system of standards.

The report was prepared by a steering group of programme leaders, supported by members of the Research Office and under responsibility of the Research Director. A draft version was discussed by members of the staff and the Research Committee. The final report was discussed and approved by the Management Team.

Enschede, May 2000

prof. dr T.J.A. Popma
Dean of the Faculty of Technology & Management

prof. dr ir M.F.A.M. van Maarseveen
Research Director CE&M

A Research profile

1 The Faculty and Civil Engineering & Management

The research and education programmes “Civil Engineering & Management” (CE&M) are embedded in the Faculty of Technology & Management of the University of Twente. In addition, the Faculty includes the research and education programmes “Industrial Engineering & Management” and the “Technology & Development” Group. Head of the Faculty is the Dean who is supported by a Management Team. Members of this Management Team are, among others, the Research Director CE&M, the School Director CE&M and the Deputy Administrator CE&M.

Since 1998, by introduction of the Act on Modernisation of University Administration (MUB) the Faculty has a Representative Faculty Council.

Within the Faculty CE&M is treated as a separate entity with its own budget. It has a Committee for Research, a Committee for the Education Programme, an Examination Committee, and a Chamber of Professors.

2 Mission and objectives

The mission of CE&M is formulated as:

Civil Engineering & Management operates at the interface of Civil Engineering, Business Management and Public Administration. It attempts to acquire qualitative and quantitative knowledge on all phases of the lifecycle of civil engineering systems and objects, i.e. initiative, design, production, operation, maintenance and demolition, all in a societal and environmental context. CE&M aims at disseminating this knowledge among students and practitioners, e.g. via the development of practically applicable and transferable methodologies and tools for the design, analysis and control of infra structural civil engineering systems and the integrated design and construction of civil engineering objects. It strives to provide the university with a technical basis in civil engineering, and to place this in the relevant managerial, administrative and environmental context. It is interdisciplinary and international in its orientation and seeks relations with other universities and organisations that are leading in this field.

The following objective is derived from this mission:

CE&M wants to be an internationally oriented leading scientific institute, which develops, applies and disseminates knowledge and tools for civil engineering in a societal and environmental context.

3 Strategic development

3A Education programme

The education programme CE&M has been in operation since September 1992. It started as a completely new programme, prepared at that time by a (small) Department of Civil Engineering within the Faculty of Public Administration, the predecessor of CE&M. From 1992 until 1996 the rapidly growing staff has been intensively involved in the development of the education programme. Now the programme has an enrollment of some 500 students.

3B Research programme

The preceding Quality Assessment of Research in 1995, which covered the period 1989-1993, came rather early in the development of the CE&M research programme. Yet, the University requested to have CE&M included in order to make clear that CE&M wished to be considered as part of the civil engineering research community and to have the Review Committee's views on how the programme should be developed further.

In the first phase of CE&M (period 1992-1996) priority had been given to constitution of the organisation with qualified staff, development of the education programme, and design of the research programme. Some research projects (including Ph.D.-projects) were initiated already in the pre-CE&M phase. Strictly speaking the first generation of researchers started their Ph.D.-projects from the mid 1990s.

In view of the mission and objectives of CE&M, in particular the interdisciplinary and international orientation, researchers have been explicitly stimulated to submit papers for and attend (selected) international conferences in order to build up the necessary research networks in the various fields. This strategic action for the second phase of CE&M (period 1996-2000) has been supported by the implementation of a human resources policy with respect to Ph.D. students. Giving priority to network building, research output with respect to academic publications in refereed international journals is pushed somewhat forward in time.

The main objectives in the third phase of CE&M (period 2000-2004) are:

- priority for research output in refereed international journals,
- setting up research proposals aiming at enlarging the 2nd and 3rd money stream, and
- expansion of the co-operation with other (leading) scientific groups.

In this period also the graduation of the first generation of Ph.D. students is foreseen (years 2000 and 2001), as well as the start of the second generation of Ph.D. students with an increasing share of M.Sc. students of CE&M.

3C Organisation

Recently, for administrative and managerial considerations, discussions have taken place within the University, as is the case within other Dutch universities, to explore the desirability and potential for scaling up the organisation by combining two or more faculties. Because of disciplinary affinity and research tradition, the University intends to establish a new Faculty Constructive Engineering Sciences, consisting of the education and research programmes of CE&M and Mechanical Engineering in the year 2000. Apart from these considerations both organisations are already accommodated in one and the same building.

A part of the Discipline Group of Construction Engineering & Management, the Construction Management group, has a strong affinity with the research tradition of Industrial Engineering & Management and will therefore continue to operate within this Faculty. The University has explicitly stated that the change in organisational structure is not allowed to have any consequences, *ceteris paribus*, for the mission and contents of the education and research programmes of CE&M.

4 Key research themes

In view of the mission of CE&M along with the broad scope of the civil engineering discipline the research programme consists of four (sub)programmes in accordance with the education programme and the organisational structure. These (sub)programmes are:

Construction Engineering & Management

programme leader: prof. dr ir A.G. Dorée

Integrated Modelling of Civil Engineering Systems

programme leader: prof. dr ir H.J. de Vriend

Transportation Engineering & Management

programme leader: prof. dr ir M.F.A.M. van Maarseveen

Water Resources Management

programme leader: prof. dr ir H.G. Wind

5 Involvement in Research Institutes and Schools

The Department of Civil Engineering participates in two Research Schools that have received formal recognition from the Royal Dutch Academy of Sciences (KNAW): the Netherlands School for Advanced Studies in Construction, and the Netherlands School for Advanced Studies in Hydraulic and Geotechnical Engineering. The Department also participates in the Netherlands Centre for Coastal Research (NCK) and the Netherlands Centre for River Studies (NCR), which have both been founded in close co-operation with the latter research school.

In 1999 the corporation P3BI was established. P3BI, a co-operation of public as well as private organisations, aims to bridge the gap in research and development between construction industry and science. The Discipline Group of Construction Engineering & Management has scientific and personal links with P3BI.

6 Internal organisation

At the time of writing there are four discipline groups, each containing one or more chairs:

Construction Engineering & Management (Bouwtechnologie & Bouwproces, Bt&Bp)

full-time: prof. dr ir A.G. Dorée (Market and Organisation Forms)
 vacancy (Construction Engineering)
 vacancy (Design Processes)

part-time: prof. ir H. van Tongeren (Management of Technology and Innovation)
 vacancy (Planning and Development)

Integrated Modelling of Civil Engineering Systems (Modellering van Integrale Civieltechnische Systemen, MICS)

full-time: vacancy (Integration of Civil Engineering Systems)

part-time: prof. dr ir H.G. de Vriend (Morphology and Sediment Transport)
 prof. dr A. van der Veen (Land Use Economy)

Transportation Engineering & Management (Verkeer & Vervoer, V&V)

full-time: prof.dr ir M.F.A.M. van Maarseveen (Transportation Engineering & Management)

part-time: prof. dr ir E.C. van Berkum (Strategic and Operational Traffic Management)

Water Resources Management (Waterhuishouding & Milieu, Wh&M)

full-time: prof. dr ir H.G. Wind (Civil Engineering)

prof. dr ir C.B. Vreugdenhil (Water Resources Management)

7 Infrastructural resources

Inspired by the enormous developments in computer capacity in numerical techniques, emphasis is placed on the development and application of (integral) methods for computer simulation for a variety of civil engineering problems. The role of experiments has shifted towards validation, while the extra information available via numerical simulations has facilitated a reduction in the number of tests.

On the other hand, the need to consider the coherence of phenomena or the behaviour of phenomena at other levels of detail in experiments has increased significantly. The quality of computer simulation depends to a large extent, of course, on the quality with which the reality is ‘captured’ in mathematical models. It has become ever apparent that increasing insight into what is actually happening is essential if further improvements are to be made in the reliability and accuracy of numerical simulations. The function of experiments will therefore shift from validation towards exploring phenomena and basic relations in physics and human behaviour, requiring advanced experimental methods and facilities.

Priority has been given to investments in computer equipment, networks and facilities, including libraries with application software and home facilities.

Because of the interdisciplinary nature of both research and education programmes a large proportion of experimental tests can be characterised as field research. Therefore, investments in laboratory equipment are rather modest and basic. In case of a need for advanced experimental methods, facilities are leased from research partners (e.g. TNO, WL, TU Delft) for reasons of financial efficiency.

8 Human resources

Annually, the Faculty organises assessment talks for each employee. In an open discussion the past performance of the employee is evaluated with reference to the assigned tasks and considering the personal abilities and development, and explicit goals are set for the next year with respect to education and research tasks, including professional training. The conclusions are documented in written reports.

In 1998 the University has established a new policy plan for Ph.D. students. The plan involves a significant upgrading of wages of Ph.D. students at the level of starting academic researchers, and the assignment of a personal Ph.D. budget. The Faculty has implemented the plan with retroactive effect for all Ph.D. researchers. The budget (Dfl.

40.000 for the 4 years period) is managed by the Ph.D. student, and can be spent within well-defined constraints for educational purposes, conference attendance, travel costs, (home) computer equipment and facilities, purchase of specialist literature, and printing and translation costs.

Due to the desired rate of expansion of the CE&M staff and the tense situation on the labour market, the Department of Civil Engineering has struggled with a large number of vacancies over the years. Gradually, the size of this problem appears to diminish, but it is still very difficult to find qualified and suitable academic staff.

9 Internal quality management

The Committee for Research, chaired by the Research Director CE&M, consists of all full-time professors - part-time professors have a standing invitation - as well as an appointed full-time professor of both the Faculty of Public Administration and the Faculty of Industrial Engineering & Management. The Committee advises the Dean in all research matters and, thereby, plays an explicit and important role in the internal quality management.

All research proposals (including Ph.D. projects and regardless of the financing source) are refereed in terms of scientific quality and appropriateness with respect to the research programme by the Committee. The outcome of this procedure can be threefold: the proposal is accepted, the proposal is interesting but immature and has to be rewritten after which it will be refereed again, or the proposal is rejected. The judgement of the Committee is consequential.

For Ph.D. projects, the research plan has to be elaborated in more detail by the researcher and has to be presented in front of the Committee for Research nine months after the start of the project. The plan is refereed again, among others in terms of scientific quality, degree of innovation, and feasibility. Moreover, the progress in the education programme of the Ph.D. student is discussed. Again, the judgement is consequential.

Yearly, within an integral performance framework, the research output, progress and plans are discussed and evaluated both on an individual basis by the head of Department, and on the Department, i.e. programme level by the Management Team. The latter discussion takes place on the basis of a written self-assessment.

The Research Director, one of the full-time professors and appointed by the Dean of the Faculty, is supported by a Research Office. The Office has both administrative and managerial supporting tasks.

10 Assessment

At the start of Civil Engineering & Management in 1992 it was expected that the establishment of a research group with a mission and objective as stated in chapter 2 of section A would take at least fifteen years. We are only eight years into the programme and have realised many of our goals. Obviously, the development of the education programme has taken a lot of time and effort, and the progress of the research programme has been hampered by problems encountered in finding qualified and suitable staff in good time. However, the key factor in the development process is that CE&M stands for an interdisciplinary orientation within the civil engineering domain that is new and ambitious. Moreover, the programme it is not purely market driven, but rather a long term, strategic activity with roots both within the theoretical and practical evolution of the civil engineering discipline.

In accordance with the research policy, active participation in prominent scientific international conferences is expanding rapidly, and CE&M is already amply involved in an increasing number of (inter)national research networks. The next steps in the development will be essential: the dissemination of research output in international scientific journals, a growth in staff to facilitate applied research and the dissemination of research output among practitioners, and the further development and consolidation of the transferability of integrated methodologies and tools.

B Key data

1A University

University of Twente (UT)

1B Faculty or institute

Faculty of Technology & Management

1C Section

Department of Civil Engineering

2 Departments

Discipline Group of Construction Engineering & Management
Discipline Group of Integrated Modelling of Civil Engineering Systems
Discipline Group of Transportation Engineering & Management
Discipline Group of Water Resources Management

3 Research Institutes

(participant)

Netherlands Centre for Coastal Research
Netherlands Centre for River Studies

4 Research Schools

(participant)

The Netherlands School for Advanced Studies in Construction
The Netherlands School for Advanced Studies in Hydraulic and Geotechnical Engineering

5 Education programme

School of Civil Engineering & Management

6A Income final year of evaluation period

Direct funding	: 9,363 kf
NWO funding	: 0,128 kf
Contract research	: 1,189 kf

6B Costs final year of evaluation period

personnel costs	: 7,433 kf
housing	: 956 kf
equipment	: 699 kf
materials	: 656 kf
other	: 1,005 kf

7A Human resources final year of evaluation period

academic staff	: 39 fte
supporting staff	: 18 fte

7B Students final year of evaluation period

511

8 Summary of research programmes

Short title	research input of academic staff 1999
Construction Engineering & Management	3.3 fte
Integrated Modelling of Civil Engineering Systems	9.1 fte
Transportation Engineering & Management	4.5 fte
Water Resources Management	4.7 fte
Total research input of academic staff in 1999	21.6 fte

9 External income of Departments (1999)**Departments**

	2nd money str.	3rd money str.
Civil Engineering & Management	0 kf	208 kf
Discipline Group of Construction Engineering & Management	0 kf	9 kf
Discipline Group of Integrated Modelling of Civil Engineering Systems	128 kf	658 kf
Discipline Group of Traffic Engineering & Management	0 kf	178kf
Discipline Group of Water Resources Management	0 kf	136kf
	-----	-----
Total	128 kf	1,189 kf

1 Construction engineering & management

3 Programme members

prof. dr A.G. Dorée, professor, programme leader

dr S.H.S. Al-Jibouri, assistant professor (1998-...)

prof. ir E.K. de Boer, professor (1996-1998)

dr ir H.J.H. Brouwers, associate professor

dr ir U.F.A. Karim, assistant professor

dr ir W. Tjihuis, assistant professor (part-time) (1997-...)

ir C.M.J. Schols, assistant professor (1998-1999)

drs W.D. Spiering assistant professor (1998-...)

ir Y.E. Suurenbroek assistant professor (1998-....)

prof. ir H. van Tongeren, professor (part-time)

ir K.Th. Veenvliet, assistant professor

4 Key words

Construction process

Construction engineering

Construction technology

Construction management

Design process

Design management

Concurrent engineering

Process innovation

Procurement systems

5 Research input of academic staff

fte		1995	1996	1997	1998	1999	total
wp1	aio	0	0.2	0.9	1.5	1.9	4.5
	other	0.4	0.9	1.8	1.9	1.4	6.4
wp2	oio	0	0	0	0	0	0
	other	0	0	0	0	0	0
wp3	aio	1.8	1.5	1.4	0.6	0	5.3
	other	0.1	0	0	0	0	0.1
total		2.3	2.6	4.1	4.0	3.3	16.3

6 Research output

				1995	1996	1997	1998	1999	total	forth.
Ph.D. theses				0	1	0	1	0	2	
academic publications	journal articles	refereed	international	6	5	3	3	1	18	3
			Dutch	0	0	0	0	0	0	
	non refereed	international	0	0	0	0	0	0	0	
		Dutch	2	1	1	0	0	4		
	other acad. publications: books, chapters	international	0	0	0	1	0	1		
		Dutch	0	0	0	0	0	0		
conference proceedings			2	5	5	7	9	28	5	
professional publications			international	0	0	1	0	0	1	1
			Dutch	4	2	6	1	4	17	
scientific reports				1	1	3	2	1	8	1

7 Composition of research input of academic staff in 1999

<i>fte</i>	wp1	wp2	wp3	total
professor	0	0	0	0
associate professor (uhd)	0.4	0	0	0.4
other senior staff (ud)	1.0	0	0	1.0
postdoctoral fellows	0	0	0	0
junior staff (aio,oio,moz)	1.9	0	0	1.9
other junior staff	0	0	0	0
total	3.3	0	0	3.3

8 Programme design in brief

8.1 Mission

The research on construction processes (CP) is aimed at improving the effectiveness and efficiency of the - integral - construction processes and subsequent project organisations (from initiative to delivery). The effectiveness relates to the use-phase of the constructed objects. The value and significance of the facility should be assessed from a useability perspective. Efficiency relates to the performance of the project organisation in terms of quality, time to delivery, innovation, cost and profit.

At this time and moment the performance of construction industry is widely perceived as unsatisfactory. Construction processes are seen as the sum of sub-optimal segregated processes. Through approaching and analysing the construction projects as development- and production processes (like in other industries) improvements are expected. The integration of design-construction, facilitating integrated product- and process development, is observed as vital for innovation. The focal point in the research is integration of design and construction: Expressed in *constructability*-research at the level of the knowledge, methods and ICT-instruments. At the level of organisation expressed in research into *procurement systems* and co-operation/conflicts within construction projects.

Research on construction technology (CT) is by definition more technical than the process oriented CP-research. The basic engineering features that are chosen for CT-research are cement & concrete elements, and soil & foundation. Research in CT will take into account the materials, the structures, the function(s), their production, their performance, and the environment in which they are built.

8.2 Research programme

The problem domain

The organisations within construction industry, ranging from clients to construction contractors, are forced to operate within smaller boundaries. The pressures on budgets, on time to completion, on quality (including more and more factors), and regulatory demands, show the insufficiency of the tradition design-bid-build approach. Although these insufficiencies were acknowledged over 30 years ago, the inert nature of construction industry, with the professional organisations and vested interests, causes the change to be slow. Since the early 90's new Design-Build and Design-Construct procurement routes are applied in projects (starting with the New Waterway Storm Surge Barrier). The government now forcefully promotes these more integrated approaches.

The change from traditional design-bid-build to Design-Construct-like procurement effects the whole industry. Clients, consultants and contractors (have to) redefine their markets,

the market behaviour, the competencies. They are plunged into a "new business", and have to adapt to new business drivers. Key in the new construction process is taking advantage of the integration of design into the process. The design process is the nexus in the integral construction process. It has to be connected to the clients domain as well as to the technology domain. In the design phase clients demands and wishes have to be challenged and optimised against the capabilities of construction technology (and vice versa). Since new procurement systems change the tasks and contributions, and shift the boundaries between the organisations, all organisations are trying to find out which strategies of the integration and co-development will yield best results. In an industry dominated by engineering educated professionals and reigned by the engineering paradigm, this seems an alien undertaking. Better understanding of construction processes - the structures as well as the dynamics - of the opportunities and methods for integration (esp. design), of the effects of market behaviour and business drivers, will accelerate improvement of the construction process and construction industry.

Advanced cement and soil research (CT) is pertinent to the new challenges facing the Dutch construction industry. Many planned and ongoing underground construction projects create the demand for this type of research. These projects are often in city environments and involve use of untried technologies where their applicability and optimisation is of major interest. Of particular interest are innovations in the use of new methods (and techniques) to enhance the performance (behaviour) of the basic building materials during the entire life-cycle taking the surroundings into consideration (integral approach). A further challenging problem is the integration and optimisation of under(ground) design and construction where engineering as well as project management aspects (planning and cost) are taken into consideration.

Approach

The construction process group sees buildings and other constructed artefacts and facilities as man made objects (not a part of nature). Although sometimes technologically complex and challenging, buildings are - considered to be - the outcome of a combined human effort (produced by humans for humans). It is through deliberate human intervention and effort that buildings are realised, and that technology progresses. These interventions and efforts have their own structure and dynamic. These notions are the starting-point of the research approach.

The phenomena studied cannot be isolated and investigated in lab-setting. The topics addressed in research have to be studied within, and in strong co-operation with, the participants in construction industry. Methods mainly applied are case-research, participative observations, experiments, interviews and surveys to validate. Graduation projects of our students play a strong part in this research practice (as synapse). The work and results of those graduate projects are incorporated in the work of Ph.D. projects. Such an approach combined with the preferred types of research methods, require a strong

network in industry. Over the last decade we managed to build and establish such a network.

To get a better understanding of decision making, trade-offs, and optimisations during the integral construction process, we aim research projects at specific topics (such as constructability, sustainability, safety). The actions and interactions of the project participants, as stakeholders, can then be studied in a coherent way. This provides more in-depth understanding of functioning of the project organisation and the construction process. On the other hand, the CT research on cement, concrete and soils is amenable to be studied in a lab setting. Use is made of the established concrete and soil laboratories, as well as the available computational hardware and software facilities (on cement hydration simulation, programming and artificial intelligence, and numerical methods). The research utilises the existing multidisciplinary experiences within and outside the group (at CE&M, Mechanical Engineering and of other Dutch and overseas research organisations) and its broad technical background to reach these objectives.

Objectives

The research approach, as described above, takes the research into the realm of social science (instead of natural science). The global objective is **(1)** to bring social science theory into - engineering paradigm dominated - construction management practice and education. On the other hand it is the aim **(2)** to bring the construction industry into the domain of management science; which up to now focussed on industries such as automotive and consumer electronics, and ignored project-based industries as construction. Construction industry has a lot to offer for organisation theory and research. Furthermore it is the aim **(3)** to extend construction technology knowledge and stimulate technical innovation.

The more specific objectives of the research are to improve and increase knowledge and understanding of:

1. the development of buildings and other constructions from both a process and a technological viewpoint (revealing the structures and the dynamics);
2. the integration of design and construction (concurrent product- and process development); through instruments, methods and ICT, as well as through organisational and contractual arrangements;
3. the functioning of construction industry, and the organisations within, from a business science point of view (compared to other industries);
4. the factors driving and inhibiting improvement and innovation in construction industry and technological innovation as such.

This knowledge and understanding is brought back to the industry in several ways. Organisations out of industry participate in research. New knowledge and insights are put into our CE&M course program. Students have to fulfil exercises and projects within, or in

collaboration with, industry. When graduated the students take their education with them into industry. Practitioners are offered post-graduate courses.

8.3 The significance for education

Much of the knowledge and insights acquired through research is put back into the CE&M courses. Since the Civil Engineering & Management is a new course program, a number of the subjects still require substantial knowledge building through research. Also a number of students' assignments and projects are related to ongoing research projects. This is especially the case with their graduation assignments. The course packages in the final part of the CE&M program are tailored to bring the student up to a knowledge level such that they can participate in ongoing research directly.

The research contributions so far have been included in the following courses:

- ♦ construction processes;
- ♦ soil mechanics, site investigation, foundation engineering and soil remediation
- ♦ integral design processes;
- ♦ materials science and sustainable construction;
- ♦ management of technology & innovation in construction industry.

9 Overview of academic results

a. Procurement systems

/// Research into construction procurement behaviour of municipalities showed the economic reasons beyond recurrent transaction with the same contractor. Furthermore it gave insights in the characteristics of the construction production system that distinguish it from other industry production systems. It showed that economic organisation theory and the network theory provide useful perspectives for understanding interaction in construction projects and processes. Research shows the procurement policies and subsequent regulation are drafted from classic economic paradigms, disregarding modern understanding and theory.

/// In the early nineties the states building agency for housing developed performance contracting as a method of procurement. The main drivers behind this scheme were the assumption that it would produce buildings more in conformance with market demands, and that through the possibilities of Design-Build-integration these buildings would be less expensive. Research showed that the performance, in terms of design-construction integration and flexibility, depended on the organisation

structure of the bidder/contractor. Furthermore it showed that the instruments that the project managers were given were inadequate.

- ⚡ Ongoing research into Public Private Partnership projects shows the social dynamic nature, and the importance of the early – pre-PPP contract - stages. The research focuses on stagnations (as critical incidents) in these projects, and uncovers the main reasons behind these stagnations.

b. Process analysis on specific topics

- ⚡ Research into the development of sustainable housing showed the nature and amount of interaction between parties involved, and the interpretation and effectiveness of governmental and local sustainability regulation. Parties are highly interdependent and progress is made in a negotiating muddling-through process. Parties strategically utilise information and other power sources (ownership of plots, market gates, decision making power etc.). Development of new "sustainable" city extensions can seldom be explained through the standard "rule & control" type of project management. It is a loosely coupled coalition of parties (multiple constituents). The parties, that each interpret sustainability in their own way, depend on each other to fulfil their objectives. But each of them continually assesses the net-outcome of the process (and can opt-out; and may threaten to do so). In drafting regulation this organic nature should be more acknowledged.
- ⚡ A survey showed that constructability is not a real issue yet in the Netherlands. Although it is acknowledged as an important issue for process integration, the philosophy, the methods and instruments are sparsely present and implemented. Given the US constructability initiatives and the results in other industries (as shipbuilding) guidelines for implementing constructability in the Netherlands are being developed.
- ⚡ Safety is one of those design criteria that is seen as a non-negotiable. The norms should set the standards on safety. Often, however, esp. with new types of innovative construction, of new specific types of facilities, the standards are not directly applicable. The general standards then need project specific exegeses. Since on the one hand safety comes at a price, safety measures are often costly, but on the other hand safety benefits are often hard to monetarise, safety becomes a point of negotiation. The intention is to develop a protocol for this negotiations through the analysis of cases.
- ⚡ International comparison shows the differences between countries in culture and procurement practice. Special in this matter is the research into the German construction industry. In may 2000 we host the CIB-working commission meeting "culture in construction".

- /// Commonly used project progress and performance monitoring systems are evaluated in terms of type and detail of information required and provided, as well as their effectiveness and accuracy in reporting divergences of work from the plan. This research is aimed at selection and improvement of these monitoring systems.

c. Construction technology research topics

- /// Research into the remediation of contaminated soils and granular materials revealed alternative techniques are needed in order to render them suitable as construction material. Contaminated soils have been treated with the help of air and steam (patent applied). A university laboratory for soil cleaning has been established. Projects in co-operation with BP, Oranjewoud Engineering, Shell, Delft University and three Provinces. The group has been involved in feasibility study and design of industrial installation based on the invented technique.
- /// Research into the use of waste materials as secondary raw material in cement/concrete and the use of cement-based binders for Solidification/Stabilisation (S/S) of waste. Hydra3D software code is modified and extended to model the chemical reaction of cement (hydration) containing among others fly ashes and blast furnace slags, aiming to predict the microstructure of the hardened cement paste. This will function as a tool for designing cement recipes. Project in co-operation with the US National Institute of Standards and Technology, KEMA, ENCI and Dyckerhoff Zement. Cement and concrete laboratory established, sponsoring by the Dutch Cement Industry Association and Dutch Ready Mixed Concrete Association obtained. Besides the development of scientific and technical knowledge, also the role of certification for stimulating the use of secondary materials in the construction industry is studied.
- /// Ongoing research into the development of a DSS to model the effect of ground conditions on the construction process using AI techniques. This research breaks the boundaries of current design practice by integrating design, construction and project planning objectives for the whole construction from the onset of the project. Another, separate, research concerns computer based learning (CBL) in soil mechanics. A novel CBL package was developed to simulate the standard consolidation test on Dutch soils.
- /// The effect of soil sampling processes on the quality of the sample-material is one of the ongoing research projects. Crucial are the effects of the extraction process and delays during extraction and analysis. These events and their effect on the soil sample state was numerically modelled and quantified using the FEM. The other area for research concerns the measurement of in-situ soil properties and assessing the suitability of some field testing apparatus for that purpose. In particular soil stiffness determination under dynamic conditions was determined and a simple

mechanical model was proposed. Based on the model, some of the equipment were found to provide unrealistic test conditions and measurements.

10 Future perspective

The aim is, in conjunction with P3BI¹, to grow to and be acknowledged as the Dutch centre of expertise on matters of construction processes, process integration, construction contracts & procurement methods. P3BI provides a committed high-value and high-profile network in construction industry. The Faculty of Technology & Management provides the right surroundings for the research approach and for further development of the process perspective. Given this context, insights from management and organisation theory can penetrate the realm of construction process research. Knowledge, experience and practices from other industries can be explored and assessed for transfer to the construction domain. In collaboration with colleagues we intend to open up the construction industry, traditionally a blind spot for organisation and management theorists, for other research disciplines.

Internationally we intend to build relationships with centres of expertise on Construction Management and Constructability. Conseil International du Batiments (CIB) and Association of Researchers in Construction Management (ARCOM) provide steppingstones to peers. Some institutes we will approach directly (as Stanford-Cife; Reading-CM; Loughborough-Cice). In the near future we intend to intensify the research activities in the fields of Integrated procurement systems (DB, DC, B(O)OT, PPP, Alliance contracting etc.), construction supply chain, and design integration.

The construction technology group aims at further research into the engineering materials cement, concrete and soil. The knowledge of soil and cement will be integrated in order to study the grouting of soft soils with cement. The experience with cement hydration will be extended to the concrete industry: the microstructure of hardened cement paste (as predicted by Hydra 3D) can be related to its properties (strength, permeability, leachability etc) which can in turn be related to these properties of a concrete structure. In this way predictions with regard to the sustainability and service life of these structures can be done. Sustainable construction and the use of Life Cycle Analysis (LCA) in the construction industry will also be investigated. This research will take place in co-operation with CP.

¹ P3BI was founded may 1999. In P3BI several organisations, public as well as private, participate in research and development. Focus in research lies upon understanding the processes in the planning, design and construction of buildings and infrastructure. Three research lines are being developed: (1) Public Private Partnerships, (2) Integrated procurement systems, and (3) Enterprise Resource Planning in Construction.

11 Societal relevance

The relationship(s) with activities and initiatives outside the research community are seen as indicators of societal relevance:

- The research projects described were mainly externally funded (approx. dfl 1 mln). This external funding explicitly confirms the social relevance. Through participation of sponsors in research steering committee's societal relevance is secured.
- The research lead to several external lectures and symposia.
- Several industry leaders expressed their commitment to the Twente Construction Management approach by personally partaking in the board or advisory committee of P3BI.
- The Foresight Committee Construction & Build Environment - established by the Advisory Council for Science and Technology Policy - sees above all "construction process integration", as the topic to address in the forthcoming years. The Foresight Committee emphasises to strengthening of education and R&D in this field of construction process integration.

12 Other indications of quality and reputation

- In May 2000 we will host the CIB Task Group 23 "culture in construction";
- In 2001 and 2002 we will host the international annual conference on Public Private Partnerships.

Prof. ir H. van Tongeren:

- ♦ member of Forum Technology & Science;
- ♦ member of the Advisory Council for Science and Technology Policy (AWT);
- ♦ member of the Board of Governors of the Economic Institute for Construction Industry (EIB);
- ♦ member of the board of Foundation Future perspective on Technology;
- ♦ member of the editorial board of Heron;
- ♦ member of the program- & examination committee of the MBA Project Management in Construction (of Technology Science & Management Business School);
- ♦ Congress New Procurement methods in Construction; 3.2.98; moderator, chairman and key note address; The Construction Industry Congress; 1.12.98; moderator, chairman and key note address; several lectures on congresses and interviews in magazines;

Prof. dr ir A.G. Dorée

- ♦ director research of P3BI research Foundation;

Construction engineering & management section C

- ♦ member of the expert panel of the Advisory Board Technology Policy Construction industry.
- ♦ expert advisor for project Schiphol Airport Island, and for risk allocation strategy Noord-Zuid lijn Amsterdam;
- ♦ member of the program- & examination committee of the MBA Project Management in Construction (of Technology Science & Management Business School);

Dr ir H.J.H. Brouwers

- ♦ member of the Scientific Council of the Centre for Immobilisation;
- ♦ moderator of the of the course "immobilisation" (by Post Academic Education);
- ♦ referee/reviewer of 8 International Journals, among which International Journal of Heat & Mass Transfer; Cement & Concrete Research; Journal of Hazardous Materials;
- ♦ reviewer of the Technology Foundation (STW).

Dr ir W. Tjhuis

- ♦ expert advisor for the ministry of Foreign affairs on export activities of Dutch construction industry.

Dr ir U.F.A. Karim

- ♦ member of the techn. sub-committee of the European COST 333 project on the development of new bituminous pavement design methods.
- ♦ reviewer of the International Journal of Numerical Methods in Geomechanics.

Ir K.Th. Veenliet

- ♦ member of INCOSE (int. council systems engineering)
- ♦ member of STUMICO (Studygroup Micro Computers);
- ♦ moderator of the course "integral design process in civil engineering" (by Post Academic Education).

Ir Y.E. Suurenbroek

- ♦ member of the council for transport safety;
- ♦ member of the safety committee Groene Hart Tunnel.

Ir M. Bonebakker

- ♦ editor of the "construction process" edition of the Jellema series.

Consideration

In the Netherlands the construction industry is booming. Also there is hardly an academic tradition in the field of Construction Management. As a consequence it is difficult to find

qualified and suitable staff. The Department has had great difficulties in attracting academic staff and Ph.D.-candidates. Assigned chairs were not occupied. In 1998 the employment of a full-time professor was terminated. Over the years the Department has struggled with a large number of vacancies (up to 40%). During the development of CE&M, teaching and continuous redesign of courses have been given priority. Therefore the research could not develop as quickly and strongly as we would have wanted. This was especially the case for the field of Construction Process. In the field of Construction Technology the staff was not as heavily loaded with teaching obligations, and therefore had more time for research, writing papers and externally financed research.

Because of this bottleneck in staff we had to put the acquisition of external (funded) projects on low burner during 1998-1999.

13 Key Publications

Bossink, B.A.G., & Brouwers, H.J.H.(1996). Construction Waste: Quantification and Source Evaluation. *Journal of construction engineering and management*, 122 (nr: 1), (pp.55-60). ISSN 0733-9364.

Davies, T.G., & Karim, U.F.A.(1995). An elastodynamic interpretation of impact test apparatus for soils. *Geotechnique : international journal of soil mechanics*, XLV (nr: 4), (pp. 691-700). ISSN 0016-8505.

Dorée, A.G.(1997). Construction Procurement by Dutch Municipalities. *Journal of construction procurement*, (nr: 3), (pp. 78-88). ISSN 1358-9180.

Eijk, R.J. van., & Brouwers, H.J.H.(1998). Study of the relation between hydrated portland cement composition and leaching resistance. *Cement and concrete research*, 28 (nr: 6), (pp. 815-828). ISSN 0008-8846.

Tijhuis, W.(1998, June 01). Procurement and sustainability in construction industry: tendering for durable relationships with process and projects., [Construction and environment. Proceedings of CIB-world Building congress 1998. 7-12 juni Symposium C: Legal and procurement practices].(pp. 1635-1643). Gävle, Sweden.

Tongeren, H. van., & Dorée, A.G.(1997). Quasi-firms for real innovations., [Procurement - a Key to Innovation, CIB Proceeding, Int. Symposium of Commission W92, Publication 203. 20-23 May. Davidson, C.H. & T.A. Meguid (eds.),].(pp. 761-770). Université de Montréal, Montréal, Canada. ISBN 0-9682215-0-5.

14 Dissertations

Dorée, Dr.ir. A.G. (1996, April 11). Gemeentelijk aanbesteden. Universiteit Twente, 316 pp. Promotor(en): Prof. ir H. van Tongeren. ISBN 90-9009387-7.

Bossink, Dr.ir. B.A.G. (1998, October 30). Duurzaam bouwen in interactie: doelontwikkeling in de woningbouw. Universiteit Twente, 235 pp. Promotor(en): Prof. dr ir O.A.M. Fisscher. Prof. ir H. van Tongeren. Assistent promotor(en): Dr ir A.G. Dorée. ISBN 90-365-1184-8.²

15A Academic publications

Journal articles

Refereed, International

Brouwers, H.J.H.(1995). A stagnant film model for effect of diffusional layer thickness on heat transfer and exerted friction. AIChE journal, 41 (nr: 7), (pp. 1821-1825). ISSN 0001-1541.

Brouwers, H.J.H.(1995). Comments on "Effect of humid air flow rate on the filmwise condensation inside a vertical cooled pipe: numerical and experimental study". International journal of heat and mass transfer, 38 (nr: 11), (pp. 2139-2140). ISSN 0017-9310.

Brouwers, H.J.H.(1995). Comments on "Transition from transpiration to film cooling". International journal of heat and mass transfer, (nr: 38), (pp. 183-184). ISSN 0017-9310.

Brouwers, H.J.H., & Li, S.(1995). Steam stripping of contaminated unsaturated zone of sub-soils: theoretical model of start-up phase. Water resources research, 31 (nr: 9), (pp. 2253-2261). ISSN 0043-1397.

² Ph.D. dissertations are written in Dutch for three reasons. First: the projects were completely externally funded by Dutch (primarily public) organisations. These organisations also participated in the research. Second: The research projects dealt with changes in practice, policy, law and regulations. Policy and regulations are written, and interpreted through the Dutch language for the Dutch practice. Third: Through it's nature, construction industry and practice are heavily influenced by local and cultural factors.

Davies, T.G., & Karim, U.F.A.(1995). An elastodynamic interpretation of impact test apparatus for soils. *Geotechnique : international journal of soil mechanics*, XLV (nr: 4), (pp. 691-700). ISSN 0016-8505.

Geld, C.W.M. van der., & Brouwers, H.J.H.(1995). The mean condensate heat resistance of dropwise condensation with flowing inert gases. *Wärme- und Stoffübertragung*, (nr: 30), (pp. 435-445). ISSN 0042-9929.

Bossink, B.A.G., & Brouwers, H.J.H.(1996). Construction Waste: Quantification and Source Evaluation. *Journal of construction engineering and management*, 122 (nr: 1), (pp. 55-60). ISSN 0733-9364.

Brouwers, H.J.H.(1996). An experimental study of constant-pressure steam injection and transient condensing flow in an air-saturated porous medium. *Journal of heat transfer*, (nr: 118), (pp. 449-454). ISSN 0022-1481.

Brouwers, H.J.H.(1996). Effect of fog formation on turbulent vapor condensation with noncondensable gases. *Journal of heat transfer*, (nr: 118), (pp. 243-245). ISSN 0022-1481.

Brouwers, H.J.H.(1996). Experimental and theoretical study of combined solvent and steam stripping of 1,2,3,4,5,6-hexachlorocyclohexane (HCH) and mercury from contaminated natural soil. *Journal of hazardous materials*, (nr: 50), (pp. 47-64). ISSN 0304-3894.

Brouwers, H.J.H.(1996). Heat transfer, condensation and fog formation in crossflow plastic heat exchangers. *International journal of heat and mass transfer*, 39 (nr: 2), (pp. 391-405). ISSN 0017-9310.

Brouwers, H.J.H.(1997). Leaching models for multiple immersed materials and for granular materials flushed in a column. *Journal of hazardous materials*, 1997 (nr: 53), (pp. 1-17). ISSN 0304-3894.

Brouwers, H.J.H.(1997). Reply to: Letters to the Editor (Warren E. Stewart). *AICHe journal*, 43 (nr: 1), ISSN 0001-1541.

Dorée, A.G.(1997). Construction Procurement by Dutch Municipalities. *Journal of construction procurement*, (nr: 3), (pp. 78-88). ISSN 1358-9180.

Dorée, A.G.(1998). Towards positive tendering. *Construction management and economics*, 16 (nr: 3), (pp. 374-375). ISSN 0144-6193.

Eijk, R.J. van., & Brouwers, H.J.H.(1998). Study of the relation between hydrated portland cement composition and leaching resistance. *Cement and concrete research*, 28 (nr: 6), (pp. 815-828). ISSN 0008-8846.

Ham, A.G.J. van der., & Brouwers, H.J.H.(1998). Modelling and experimental investigation of transient, non-equilibrium mass transfer during steam stripping of a non-aqueous phase liquid in unsaturated porous media. *Water resources research*, (nr: 34), (pp. 47-54). ISSN 0043-1397.

Brouwers, H.J.H.(1999). Transport models for desorption from natural soils packed in flushed columns. *Water resources research*, 35 (nr: 6), (pp. 1771-1780). ISSN 0043-1397.

Non-refereed, Dutch

Bossink, B.A.G.(1995). Kwaliteit in 'Lila' van Robert M. Pirsig. *Filosofie in bedrijf*, (nr: 3), (pp. 10-17). ISSN 1384-1009.

Dorée, A.G.(1995). Aanbesteden van GWW-werken door gemeenten. *Bouwrecht*, 32 (nr: 8), (pp. 643-648). ISSN 0165-1528.

Dorée, A.G.(1996). Tendering for co-operation. *Heron (Delft)*, 41 (nr: 4), (pp. 229-240). ISSN 0046-7316.

Eijk, R.J. van., & Brouwers, H.J.H.(1997). Cement composition and leaching resistance. *Heron (Delft)*, 42 (nr: 4), (pp. 215-229). ISSN 0046-7316.

Books and bookchapters

International

Dorée, A.G., & Nelissen, M.B.(1998). Netherlands. In: *Dispute resolution and conflict management in construction; an international review* (pp. 449-469). E&FN Spon. ISBN 0-419-23700-3.

Conference proceedings

Brouwers, H.J.H.(1995). Solvent steam stripping of 1,2,3,4,5,6-hexachlorocyclohexane (HCH) and mercury contaminated soil., [XXVI International Congress International Association of Hydrogeologists]. 6 pp. Edmonton, Canada.

Karim, U.F.A., & Obaid, H.H.(1995). Failure mechanisms in 3-D limit equilibrium analysis of soil slopes., [Landslides. Glissements de Terrain, Volume 3. Bell, D.H. (ed.)].(pp. 1679-1684). Rotterdam. ISSN 90 5410 032 X.

Bossink, B.A.G., Brouwers, H.J.H., & Kessel, R.A. van.(1996). Financial consequences of construction waste., [Construction Modernization and Education, CIB W89 Beijing International Conference, 21-24 October (verschenen op CD-ROM)].(pp. 1-15). Beijing, China. ISBN 7-112-02264-9.

Neerhof, H.A.J.(1996). Performance control and redesigning the design and construction process., [Proceedings of the AIO Congress, From Materials to Building Structures, Van Mier J.G.M. & L.J. Sluys (eds.) 25-26 april].(pp. 163-170). Elsevier. ISBN 90-75729-02-2.

Neerhof, H.A.J.(1996). Performance control and redesigning the design and construction process., [Applications of the Performance Concept in Building, Vol. 2, CIB-ASTM-ISO-RILEM, 3rd International Symposium, 9-12 December. Becker, Rachel & Monica Paciuk (eds.)].(pp. 5-13-5-22). Tel-Aviv, Israel. ISBN 965-222-753-6.

Veenvliet, K.T.(1996). De stap naar Concurrent Engineering. Gereedschappen ten behoeve van de interface ontwerp/uitvoeren., [Workshop Concurrent Engineering, nr. 1, 23-24 juni].(pp. 19-24). Eerbeek. ISBN 90-75729-01-4.

Veenvliet, K.T.(1996). Reflectie op de discussies en stellingen., [Workshop Concurrent Engineering, nr. 1, 23-24 juni].(pp. 117-124). Eerbeek. ISBN 90-75729-01-4.

Eijk, R.J. van., & Brouwers, H.J.H.(1997). Simulation of cement-hardening in the presence of carbon using Hydra2D., [Proceedings of the 10th International Congress on the Chemistry of Cement, Edited by Dr. Harald Justnes, Volume 2, June 2-6]. 7 pp. Gothenborg (Sweden). ISBN 91-630-5496-5.

Tijhuis, W., & Maas, G.(1997). Contractors offering total packages to clients: Changing culture of contractual relationship., [Procurement - a Key to Innovation, CIB Proceeding, Int. Symposium of Commission W92, Publication 203. 20-23 May. Davidson, C.H. & T.A. Meguid (eds.)].(pp. 751-760). Université de Montréal, Montréal, Canada. ISBN 0-9682215-0-5.

Tijhuis, W.(1997). General contractors and facade-industry: Partners or opponents?., [FAECF 'Future of facade-technology'].(pp. 163-169). Frankfurt am Main, Germany.

Tongeren, H. van., & Dorée, A.G.(1997). Quasi-firms for real innovations., [Procurement - a Key to Innovation, CIB Proceeding, Int. Symposium of Commission W92, Publication 203. 20-23 May. Davidson, C.H. & T.A. Meguid (eds.)].(pp. 761-770). Université de Montréal, Montréal, Canada. ISBN 0-9682215-0-5.

Veenvliet, K.T.(1997). Concurrent Engineering in the Building Industry., [Internatioal Conference on Engineering Design ICED '97, Vol. 3, Augustus 19-21].(pp. 785-790). Tampere, Finland. ISBN 951-722-788-4.

Al-Jibouri, S.H.S.(1998, April 20). Two cost control models: their effectiveness for controlling construction projects., [15th International Cost Engineering Congress, 20-22 april 1998, volume I].(pp. 61-70). Rotterdam.

Brouwers, H.J.H., & Augustijn, D.C.M.(1998, October 14). An analytical model for complete removal of pure contaminant under nonequilibrium conditions., [Deicing and dustbinding - risk to aquifers. Proceedings of an international symposium, 14-16 october Nordic Hydrological Programme. NHP report no. 43. T. Nystén & T. Suokko eds.].(pp. 187-192). Helsinki, Finland. ISBN 952-11-0348-5, ISSN 0900-0267.

Eijk, R.J. van., & Brouwers, H.J.H.(1998, February 10). Optimizing the Portland cement matrix with regard to leaching resistance., [Environmental management: Engineering the Water-Environment and Geo-environment. Proceedings of the Second International conference on environmental management (ICEM2). 10-13 februari 1998. Volume 2. Sivakuma, M. & R.N. Chowdhury (eds.)].(pp. 839-854). Wollongong, Australia. ISBN 0-08-042847-9.

Spiering, W.D.(1998). Managerial-organisational processes of public-private partnerships in urban revitalisation., [Public and private sector partnerships: Fostering enterprise Montanheiro, M B, Haig, D. Morris & N. Hrovatin eds. Proceedings of the 4th international conference on public and private sector partnerships].(pp. 583-591). Ljubljana, Slovenia. ISBN 0-88339-7883.

Tijhuis, W.(1998, August 26). Connecting marketing to construction process: The impact of internationalization., [Opportunities and strategies in al global market place. Proceedings of the first international construction marketing conference. 26-27 augustus. Preece, Chr.N, (ed.)].(pp. 141-148). Leeds, UK.

Tijhuis, W.(1998, June 01). Procurement and sustainability in construction industry: tendering for durable relationships with process and projects., [Construction and environment. Proceedings of CIB-world Building congress 1998. 7-12 juni Symposium C: Legal and procurement practices].(pp. 1635-1643). Gävle, Sweden.

Tijhuis, W., & Lousberg, L.(1998). TQM and procurement in construction projects: How to handle quality in contractual relationships., [Total Quality management in construction: Towards zero defect. Proceedings of the first South african International conference on TQM. Haupt, Th.C., G. Smith & O.J. Ebohon (eds.)].(pp. 25-36). Cape Town, South Africa.

Dooren, M. van., Mawdesley, M., Al-Jibouri, S.H.S., & Karim, U.F.A.(1999, August 06). A new approach to the process of selecting foundation type., [Concurrent engineering in construction challenges for the new millenium. Proceedings of the 2nd international conference on concurrent engineering in construction, 25-27 august. CIB publication 236.].(pp. 139-148). Espoo, Finland.

Eijk, R.J. van., & Brouwers, H.J.H.(1999, April 13). Cement hydration in the presence of pollutants., [Waste stabilization and environment. Proceedings of Waste stabilization & environment 99 (Stab&env 1999), 13-16 april. Mehu, J., G. Keck & A. Navarro (eds.)].(pp. 58-63). Lyon - Villeurbanne, France. ISBN 2-905015-40-3.

Karim, U.F.A., & Al-Nayar, A.M.(1999, August 12). A finite element study of the mechanics of soil sampling disturbance., [XI-Panamericam Conference on Soil Mechanics and Geotechnical Engineering (PCSMGE), 8-12 august 1999].(pp. 1313-1319). Foz do Iguassu, Brazil.

Karim, U.F.A., & Geloven, M.P. van.(1999, June 02). CBL in soil mechanics., [Computer based learning in science. Proceedings of the 4th international conference on computer based learning in science, 2-6 juli University of Twente. Chapman, Graham M. (ed.)].(pp. D13-1-D13-10). Enschede. ISBN 80-7042-1444-4.

Karim, U.F.A.(1999, August 12). Soils shear modulus interpretation from impact tests., [XI-Panamericam Conference on Soil Mechanics and Geotechnical Engineering (PCSMGE), 8-12 august 1999].(pp. 875-878). Foz de Iguassu, Brazil.

Tijhuis, W.(1999, September 05). Focussing at the clients wishes and behaviour in construction management - (Re)starting at the front-end of construction process., [Customer satisfaction: A focus for research & practice in construction. Proceedings of a joint triennial symposium. 5-10 september. Volume 1: Construction process innovation.

Bowen, P.A. & R.D. Hindle, eds. CIB publication 234. Also on CD-rom.].(pp. 148-156). Cape Town, South Africa. ISBN 0-620-23944-1.

Tijhuis, W.(1999). Harmonious contracts and higher profits: dilemma or opportunity?., [Profitable partnering in construction procurement. Proceedings of Joint symposium Harmony and profit. 25-28 January 1999. Stephen O. Ogunlana ed. Published by E&FN SPON / Routledge].(pp. 75-83). Chiang Mai, Thailand. ISBN 0-419-24760-2.

Veenvliet, K.T.(1999, August 06). Systems engineering an explicit way of working to control the design process in the building industry: a research agenda., [Concurrent engineering in construction challenges for the new millenium. Proceedings of the 2nd international conference on concurrent engineering in construction, 25-27 August. CIB publication 236.].(pp. 377-387). Espoo, Finland.

Wognum, P.M., & Veenvliet, K.T.(1999). Concurrent engineering in industry and civil engineering., [Advances in concurrent engineering CE99. Proceedings of the sixth ISPE international conference on concurrent engineering: research and applications. 1-3 September 1999].(pp. 471-478). Bath, UK. ISBN 15-667-6790-3.

15B Professional publications

International

Tijhuis, W.(1997, November 01). Der Generalunternehmer / general contractor. [FAECF Kongresbericht '97 Fenster und Fassaden der Zukunft. 30-04-1997/03-05-1997].(pp. 163-168). Berlin, Germany.

Dutch

Boer, S.J. de., Bannier, Y., Lindeboom, W., & Schols, C.M.J.(1995). Management tegen de bierkaai? Onderhoud in niet-Westerse landen. Doelmatige bedrijfsvoering, 7 (nr: 9), (pp. 12-16). ISSN 0923-9154.

Bossink, B.A.G., & Brouwers, H.J.H.(1995). Betere scheiding vermindert afval: inventarisatie geeft inzicht in herkomst bouwafval. Land + water, (nr: 4), (pp. 57-59). ISSN 0926-8456.

Bossink, B.A.G., & Neerhof, H.A.J.(1995). Wat kan marketing voor kwaliteitszorg betekenen?. Sigma, 1995 (nr: 2), (pp. 24-27). ISSN 0314-7606.

Dorée, A.G., & Berg, J. van den.(1995). Gemeentelijke aanbesteding: beleid en praktijk. Stadswerk, 24 (nr: 2), ISSN 0927-7641.

Bossink, B.A.G.(1996). Evenwichtig invoeren van Total Quality. Sigma, (nr: 4), (pp. 7-12). ISSN 0314-7606.

Dorée, A.G.(1996). Aanbesteden bouwprojecten staat ter discussie. Land + water, 36 (nr: 5), (pp. 27-29). ISSN 0926-8456.

Dorée, A.G.(1997). Gemeentelijk aanbesteden. Stadswerk, 26 (nr: 2), (pp. 6-7). ISSN 0927-7641.

Dorée, A.G.(1997). Gemeentelijk aanbesteden (II). Stadswerk, 26 (nr: 3), (pp. 6-7). ISSN 0927-7641.

Dorée, A.G.(1997). Kwaliteit projecten en samenwerking aannemers en gemeenten beter door onderhandse aanbesteding. Tender nieuwsbrief, (nr: 4), (pp. 2-2). ISSN 1384-2838.

Dorée, A.G.(1997). Gemeentelijk aanbestedingsbeleid in de bouw. Als beste uit de bus (pp. 15-47). Den Haag: VNG Uitgeverij. ISBN 90-322-7741-3.

Dorée, A.G.(1997). Praktijk van het aanbesteden - facts and figures (Bijlage 1). Als beste uit de bus (pp. 153-155). Den Haag: VNG Uitgeverij. ISBN 90-322-7741-3.

Tijhuis, W.(1997). Ervaringen van Nederlandse bouwers met Duitse aanbestedingen. Tender nieuwsbrief, 1997 (nr: 2), (pp. 2-2). ISSN 1384-2838.

Schols, C.M.J.(1998). Strategisch huisvestingsmanagement. Handboek facility management, Hofstra, A. et al (eds.) (pp. d1550-1-d1550-18). Alphen aan de Rijn: Samsom. ISBN 90-6500-397-5.

Maathuis, B.B.T.M., Eijk, R.J. van., Brouwers, H.J.H., & Cornelissen, H.A.W.(1999). Introductie en acceptatie van secundaire grondstoffen in het bouwproces. Land + water, 1999 (nr: 4), (pp. 26-27). ISSN 0926-8456.

Schols, C.M.J.(1999). Van bouwen naar huisvesten. Focus op het voortraject. Facility management magazine, 12 (nr: 74), (pp. 55-59). ISSN 0924-8641.

Suurenbroek, Y.E.(1999). De afweging tussen interne en externe veiligheid. Alert, 16 (nr: 9), (pp. 21-23). ISSN 0920-3168.

Dorée, A.G., & Veen, B. van der.(1999). Strategische allianties in de bouw: Van hooggespannen verwachtingen naar concrete actie?!. Enschede: Universiteit Twente, 46 pp. ISBN 90 365 13294.

15C Scientific reports

Neerhof, H.A.J.(1995). Besturingsrisico's bij de toepassing van het Prestatiebeginsel. (Extern rapport, Ref.: UT/Cit/96012.UT/JN). Enschede: Universiteit Twente, 60 pp.*

Neerhof, H.A.J.(1996). Reductie van besturingsrisico's bij prestatiecontracten. (Extern rapport, Ref.no.: JN/96030). Enschede: Universiteit Twente, 29 pp.

Brouwers, H.J.H., & Eijk, R.J. van.(1997). The influence of radioactive ions on cement hydration. (Confidential report). Enschede: Universiteit Twente, 23 pp.

Tijhuis, W., & (Et Al)(1997). Bouwen in Duitsland - Het gebruik van de VOB. (In samenwerking met Stichting Bouwresearch, Deel-bijdrage aan SBR-rapport, Mei). Rotterdam: Stichting Bouwresearch, 112 pp. ISBN 90-5367-205-2.*

Veeenvliet, K.T.(1997). Evaluatie van het Ontwerpproces van de cursus Systems Engineering ten behoeve van Projectbureau HSL-Zuid ('Een koekje van eigen deeg'). (Extern rapport, in opdracht van Projectbureau HSL-Zuid, Maart). Enschede: Universiteit Twente, 42 pp.*

Brouwers, H.J.H., & Eijk, R.J. van.(1998). Modelling the coating effects on cement hydration. (Confidential report voor de KEMA). Enschede: Universiteit Twente, Civiele Technologie & Management, Oktober 1998, 20 pp.*

Suurenbroek, Y.E., Wessels, J.F.M., Cosijn, A.E., & Et Al(1998). Fysieke aspecten van de veiligheid voor ondergrondse faciliteiten op het gebied van de utiliteitsbouw. (Eindrapport taakgroep project 120 Beveiligingsconcept ondergrondse bouwwerken ingesteld door Centrum Ondergronds Bouwen) COB, 14 pp.*

Schols, C.M.J.(1999). Functionaliteit in bedrijfshuisvesting. (University of Twente, Civil Engineering & Management research report 99R-004/Bt&bp 001). Enschede: University of Twente, 24 pp.

* = External reports registered under the category of professional publications

15d Forthcoming publications (accepted)

Academic publications

Journal articles

Refereed, International

Karim, U.F.A. Large deformation analysis in soil plasticity. International journal of plasticity, ISSN 0749-6419

Tijhuis, W. A Dutch approach in German construction process: experiences of cross-border construction processes. Construction management and economics, ISSN 0144-6193.

Tijhuis, W. Realising hotel projects in Germany: An international case study. Journal of construction procurement, ISSN 1358-9180.

Conference proceedings

Adel, J.F. van den., Al-Jibouri, S.H.S., Karim, U.F.A., & Mawdesley, M. GROUNDSS: Integrated Foundation Design Expert System., [Proceedings of the 8th International Conference on Computing in Civil and Building Engineering, August 14-17, 2000]. Stanford, USA.

Au, S.K., Jafari, M.R., Soga, K., Bolton, M.D., Karim, U.F.A., & Komiya, K. Experimental and numerical investigation of compensation grouting in clay., [GeoEng 2000, Conference on Geological & Geotechnical engineering, 19-24 november 2000]. Melbourne, Australia.

Karim, U.F.A. Large deformation analysis in soil plasticity., [Proceedings of the 8th international symposium on plasticity (Plasticity 2000) 12-17 July 2000]. Whistler Canada.

Mawdesley, M., Al-Jibouri, S.H.S., & Mawdesley, D. A game for teaching project control., [AUBEA 2000 international Conference]. Perth, Australia.

Suurenbroek, Y.E. Observations in the use of multicriteria analysis in safety related issues concerning underground infrastructure., [Public perception of safety and risk in civil engineering. Meeting of CIB working group W32, May 12th 1999]. 6 pp. Prague, Czech Republic.

Professional publications

Dutch

Eijk, R.J. van., & Brouwers, H.J.H.(2000). 3D-computersimulatie van het verhardingsproces. Cement, 52 (nr: 2), (pp. 63-67). ISSN 0008-8811.

Scientific reports

Tijhuis, W. Bouwen in Duitsland - Vergelijking van DIN - NEN voor de woningbouw. In samenwerking met 'De Bondt BV'. (SBR-rapport) De Bondt BV, 80 pp.

1 Integrated modelling of civil engineering systems

3 Programme members

- prof. dr ir H.J. de Vriend, professor, programme leader

- dr ir J.S. Ribberink, associate professor (1996-....)
- dr S.J.M.H. Hulscher, assistant professor (1996-....)
- prof. dr A. van der Veen, professor (part-time) (1997-....)
- dr ir M. Kok, assistant professor (part-time) (1997-...)
- ir M.J. Kolkman, assistant professor
- ir M. Rorink-Heerink, assistant professor (part-time)

4 Key words

Dealing with uncertainty
(Non-)linear behaviour analysis
Model aggregation
Predictive modelling
End user orientation
Sediment transport
Morphology
Rivers/estuaries/coasts/shelf seas
Integrated modelling
Agent-based reasoning
Landuse & landcover

5 Research input of academic staff

fte		1995	1996	1997	1998	1999	total
wp1	aio	0.7	1.8	1.8	2.1	1.7	8.1
	other	0.7	0.5	1.2	1.2	0.8	4.4
wp2	oio	0	0.2	0.9	0.9	1.8	3.8
	other	0	0	0	0	0.4	0.4
wp3	aio	0.2	0	0.1	1.5	2.3	4.1
	other	0	0.8	1.0	1.5	2.1	5.4
total		1.6	3.3	5.0	7.2	9.1	26.2

6 Research output

				1995	1996	1997	1998	1999	total	forth.
Ph.D. theses				0	1*	0	0	1*	2*	
academic publications	journal articles	refereed	international	3	1	2	1	2	9	11
			Dutch	0	0	0	0	1	1	
	non refereed	international	0	0	0	0	0	0	0	1
		Dutch	0	0	0	0	0	0	0	0
	other acad.publications: books, chapters		international	1	3	3	0	0	7	1
			Dutch	0	0	0	0	0	0	0
conference proceedings			3	4	5	19	19	50	13	
professional publications			international	0	0	1	0	0	1	
			Dutch	0	0	0	1	1	2	
scientific reports				1	4	2	5	16	28	3

* = doctorate from other institution partly prepared within the own institution

7 Composition of research input academic staff 1999

<i>fte</i>	wp1	wp2	wp3	total
professor	0.1	0	0	0.1
associate professor (uhd)	0.4	0	0	0.4
other senior staff (ud)	0.3	0	0	0.3
postdoctoral fellows	0	0.4	2.1	2.5
junior staff (aio,oio)	1.7	1.8	2.3	5.8
other junior staff	0	0	0	0
total	2.5	2.2	4.4	9.1

8 Programme design in brief

8.1 Mission

The MICS-programme aims at developing a generic model-based integration methodology that is relevant to the other parts of Civil Engineering & Management. Wherever possible, it makes use of existing knowledge-components, provided by other programmes, or acquired from the literature, collaborations, etc. The development of new disciplinary knowledge and models is undertaken only if this is necessary to make progress in integration and the knowledge cannot be found elsewhere. Since integration can only be achieved on the basis of a certain elementary level of knowledge of the disciplines to be integrated, some research capacity is devoted to sustaining this level.

MICS has the ambition to play a prominent role, national and international, in the research areas it addresses. This is to be achieved through a continuous flow of research by tenure staff, combined with and supported by a number of post-docs and Ph.D.-students and guest-researchers who come over on sabbatical leave or otherwise. The tenure staff must warrant continuity and the absorption and consolidation of knowledge generated by the temporary staff.

8.2 Research programme

General

The key element of the programme is model integration, i.e. bringing knowledge components (often existing models) together and making them communicate and interact. The objective is to be so much in control of the modelling process and the compound model itself, that acceptable levels of model validity, efficiency and predictive capability can be achieved.

Interdisciplinary model integration requires the development of new modelling and analysis techniques, some of which are also being used in mono-disciplinary environments. In the purely physical domain of sediment transport and morphology in alluvial water systems (rivers, estuaries, coasts, shallow seas), for instance, knowledge from a number of sub-disciplines (hydrodynamics, sediment transport) is coupled via a dynamically interacting system of mathematical models. Knowledge, techniques, ability and experience built up in this domain can be of direct use to interdisciplinary model systems.

Apart from this methodological aspect, sediment transport and morphology play such a key role in many problems in integrated water resources management, that CT&M must have in-house expertise in this field.

The MICS-programme can roughly be distributed into two sub-programmes, viz. *Sediment Transport and Morphology* and *Integrated Modelling*, although this subdivision is not perfect and ignores a number of interesting cross-connections.

Theme a: Sediment Transport and Morphology

This theme addresses a number of aspects that can be generic to larger parts of CE&M. They are described briefly below.

Scale interactions and compound model dynamics

The systems we are dealing with are usually non-linear, which implies that their behaviour cannot be split into parts (e.g. spatial and/or temporal scale ranges) that can be considered independently and then be superimposed. Scale-interactions are inherent to these systems. Our research aims at understanding and modelling these non-linear scale interactions. Various projects are carried out in collaboration with researchers from the Faculty of Applied Mathematics.

Coupling models of dynamical processes leads to an essentially richer behaviour of the combined system than that of the individual components. Every new combination of models must therefore be analysed for the behaviour of its solution. The techniques we mainly use here are linear and non-linear perturbation analyses, backed up by numerical modelling. MICS has the ambition to serve as a link between Applied Mathematics and CE&M, by applying these analysis techniques to our type of problems and by feeding the mathematicians with research questions that arise in that process.

Scale flexibility and model aggregation

Knowledge and models from different disciplines usually don't match. This mismatch may concern the model variables, but also the aggregation level, i.e. the spatial and temporal resolution at which the information is provided. The ability to move between aggregation levels ("scale flexibility") is therefore vital to interdisciplinary integration.

MICS aims at contributing to the development of knowledge and techniques in this field. Since most of our knowledge concerns small-scale processes, we first focus on going up the scale-ladder (upscaling), i.e. modelling at spatial and temporal scales that are much larger than those of the constituent small-scale processes. In a later stage, as large-scale models become available, we will also address the issue of going down the ladder (downscaling).

The basis of this development is sought in morphology and socio-economy (Theme b), since most of our in-house expertise lies there. Through collaborations, we try to extend this to ecology, demography, etc.

Dealing with uncertainty

The systems of which we want to predict the behaviour involve many sources of uncertainty, in the forcing (e.g. the weather), as well as in the system properties and in the validity of the models with which we try to describe these systems. Uncertainty is therefore inherent to prediction, to the extent that prediction only makes sense if information is provided about the nature and the magnitude of this uncertainty.

Dealing with uncertainty is therefore one of the focal areas of the MICS programme, which we aim to further develop, making use of knowledge, tools and experience from other disciplines wherever possible.

Sediment transport processes

Sediment transport and morphology are closely linked: reliable morphological predictions require an adequate description of the sediment transport. In general, the sediment transport sub-model is a major source of uncertainty in morphological predictions. In collaboration with other universities, such as Delft University of Technology and Utrecht University, MICS participates in research to reduce this uncertainty.

Theme b: Integrated Modelling and Management

Pattern formation and scale interactions in socio-economy

Non-linear dynamics, scale-interactions and self-organisation are not exclusive to the bed topography of morphologically active shallow surface water systems. Not only are they important in many other natural sciences, they are also issues in social sciences, economy, etc. One way to approach them is direct simulation, in the socio-economic case via *agent-based modelling* (ABM), which simulates the behaviour of *swarms* of individuals, each driven by external factors, interests/ambitions, their own history and interactions with other individuals. The interdisciplinary exchange of views and techniques with ‘Theme a’ turns out to be extremely useful.

Link with end users

End-users, i.e. policy makers, managers, designers, etc., usually need a different kind of information than models produce. A policy maker, for instance, wants to know the manoeuvring space he has and the risks he is running, i.e. he wants to oversee the entire field of possible developments of the system and solutions to the problem he is dealing with. A model study usually gives predictions for a few isolated points in that field. This means that a translation has to be made between the model results and the information to be supplied to the end-user. This problem is encountered in all parts of civil engineering, and rigorous qualitative modelling may have a role to play here. Hence it is addressed in the MICS-programme.

8.3 Significance for education

Many results of the research programme are embedded, directly or indirectly, in the regular education programme (the modelling line: the 2nd and 3rd year courses IMOD-A, IMOD-B, and the 3rd and 4th year packages on Hydraulics and Modelling, M1, M2 and M3). MICS-staff is actively involved in the supervision of internships and practice periods, often in line with ongoing research. Moreover, most MSc-thesis projects in MICS are somehow embedded in

ongoing research. Ph.D.-students and post-docs actively participate in the supervision of those projects.

9 Overview of scientific results

Theme a: Sediment Transport and Morphology

Scale interactions and compound model dynamics

In this research area, MICS has found a niche in seabed dynamics. In the reporting period, we have been involved in a series of international research projects on tidal sandbanks and sand waves. This has resulted in various publications in peer-reviewed scientific journals and a considerable number of conference papers, often on invitation or as a keynote address. The techniques developed can also be used in other parts of CE&M.

Scale flexibility and model aggregation

Via a number of strategic publications and addresses to conferences, MICS has contributed to putting scale flexibility and model aggregation on the list of important research issues. The concept of modelling in accordance with the natural hierarchy of scales was put forward. It was developed for morphological systems, but it has been shown to be transferable to socio-economic systems.

The limited access to numerical model systems has hampered the development of these ideas. Through collaborations we will attempt to improve this situation.

Dealing with uncertainty

In the scientific world, dealing with uncertainty is widely recognised as a research issue, but it is much less so in large parts of engineering practice. This is reflected in a limited possibility to find appropriate research funds. Consequently, this theme is still poorly developed. Collaboration with Delft University of Technology will be sought in order to achieve a critical mass here.

Sediment transport processes

MICS operates in two areas of sediment transport: sheetflow (the intermittent fluidized-bed state due to highly energetic waves) and graded sediment (non-uniform grain size and/or density). MICS-staff members are involved in a variety of international projects. This has resulted in a number of publications in peer-reviewed journals and a considerable number of conference papers.

Theme b: Integrated Modelling and Management

Pattern formation and scale interactions in socio-economy

Qualitative land use / land cover models have been developed and tested against data, e.g. from a number of more or less isolated delta areas in the Mediterranean (Ebro, Rhone, Po). Quantitative simulation models based on ABM are now being developed and lead to promising results regarding pattern formation in land use/land cover.

Link with end users

This issue is presently addressed in an externally funded Ph.D.-project, which is linked to a number of international projects. One of them is an EU demonstration project on integrated coastal zone management of part of the Abruzzo coast, Italy. MICS was invited to provide the basic methodology to this project. The Ph.D.-student was added to the team in order to try out formal techniques for communication with end users.

10 Programme development

Theme a: Sediment Transport and Morphology

Scale interaction and compound model dynamics

We will try to keep the momentum gained by this part of the programme during the past five years. Several new proposals are in preparation or have been submitted, to national programmes, as well as to the EU. This theme fits well into the newly established part-time chair “Morphology and Sediment Transport”. The links with the other parts of CE&M will be developed further.

Scale flexibility and model aggregation

This issue has proven to act as a linking pin between the physically and socio-economically oriented parts of MICS. In the future, it should be developed jointly by the new chairs “Morphology and Sediment Transport” and the other chairs operating in this field. The acquisition of new Ph.D.-projects and a better access to the relevant numerical model systems are at the top of the priority list.

Dealing with uncertainty

This part needs to be developed further. By and by, it is recognised as an issue in the world of practitioners and managers, but this remains to be translated into the availability of research funds. MICS will keep on pursuing this development. In the meantime, one Ph.D.-project is in progress on internal funds. In the next five years, research in this area is expected to take off via a number of Ph.D.-projects, in morphology as well as socio-economy. Collaboration with

other parts of CE&M where adjacent research is done is a prerequisite, collaboration with Delft University of Technology is warranted by personnel overlaps.

Sediment transport and morphology

This part of the programme is expected to be able to maintain its present position. Although most ongoing projects still have one or more years to go, a few new proposals will shortly be submitted, in order to warrant continuity. The theme fits well under the new chair “Morphology and Sediment Transport”.

The conformity of this research with the CE&M-programme is being challenged, but there are various good reasons to continue this work, among which:

- (1) the vital role of sediment transport and morphology in the sustainable development of water systems with a mobile bed (rivers, estuaries, coasts, shelf seas), which justifies having in-house expertise in these fields,
- (2) having an active experimental research group, which stays abreast with new laboratory techniques and is able to show students what water motion and sediment motion are like.

Theme b: Integrated Modelling and Management

General

Since prof. de Vriend resigned from the MICS-chair, there is great uncertainty about how the vacancy shall be filled in. Hence, the future of the Integrated Modelling group of MICS is uncertain. The best we can do at this moment is to look forward as if things remain unchanged.

Pattern formation and scale interactions in socio-economy

The Ph.D.-student working on pattern formation will graduate this year. The results so far and the availability of the ABM-model call for a sequel of this project. We may have to call upon internal funding to materialise this.

Link with end user

Research on this issue is considered to be in an experimental phase. If formal techniques turn out to have a role to play in the communication with the end users, this is a good reason to maintain this as a research issue in the modelling programme.

11 Societal/technological relevance

The societal relevance of predictive modelling of the effects of engineering and management measures on the systems we are considering is obvious. Traffic and transportation, as well as the sustainable use of surface water systems, are major societal issues.

MICS is a typical exponent of a quantitative approach to these issues, arguing that decisions, also at the political level, ought to be based to a reasonable extent on quantitative information and should not just be the outcome of a power contest. Recent discussions about major infrastructural works (Betuwelijn, Maasvlakte-2, Second National Airport) and other human interferences (gas mining in the Wadden Sea) seem to substantiate this point of view.

The various themes are also technologically relevant, in that they contribute to the elimination of important caveats (non-linear dynamics, compound modelling, prediction under uncertainty, multi-body interaction) in the body of knowledge and tools that is presently available to practitioners in the field of civil engineering and management. That these caveats are not always experienced as such should not be a reason to abstain from research to identify them, to point out the potential risk they constitute and to fill them up wherever necessary and possible.

In order to make sure that new knowledge penetrates into practice, research should not end with a set of publications in highly ranked scientific journals. The knowledge has to be transformed into products that are accessible and of use to the end-user (practitioner, manager, politician, the general public). An open two-way interaction between researchers and end-users is of vital importance to the success of this research policy.

The practical relevance of MICS-research is reflected by external collaborations with non-university institutions and companies, among which various Departments of Rijkswaterstaat, WL|Delft Hydraulics, the Dutch Navy Hydrographic Survey, the Netherlands Institute of Applied Geosciences, the European Union (DG XI, DG XII), the US Navy (ONR), the UK Ministry of Agriculture Fisheries and Food, the oil companies NAM and STATOIL, and the specialised advisory institutes Alkyon and Argoss. MICS actively participates in the Netherlands Centre for Coastal Research, the Netherlands Centre for River Studies and the Delft Cluster research programme.

12 Other indications of quality and reputation

Prof. dr ir H.J. de Vriend

guest professorship:	1998-pres.: EPFL, Lausanne, Switzerland
member of editorial boards:	Elsevier's Coastal Engineering Journal of Hydraulic Research Scientia Marina
guest editorships:	Special issue Journal of Coastal Research
international projects:	Co-ordinator G8-M (EU-MAST-2) Co-ordinator PACE (EU-MAST-3) Principal Investigator NICOP "Nearshore Dynamics" (US-Office of Naval Research)
conference organiser:	EUROMECH 395 Colloquium, June 1999, Universty of Twente, Enschede, NL.

Prof. dr A. van der Veen

international projects:

Participant *RICAMA*, EU-LIFE project
Participant *MEDDELDT*, EU Climatology
and Natural Hazards
Participant Hungary Flood Control
Development and Rehabilitation project,
Worldbank, PHRD Grant TF 027107
Invited participant *Euroconference on
Coastal Zone Management*, San Feliu de
Guixols, Spain.

conference organiser:

Workshop “Agents, regions and land use
change”, Wageningen, 9 april 1999.

Dr ir J.S. Ribberink

international projects:

Member steering committee and task leader
SEDMOC (EU-MAST3)
Principal Investigator *NICOP* “Sediment
transport” (US- Office of Naval Research)
Co-ordinator *SISTEX* (EU-TMR,
experiments Grosse Wellenkanal,
Hannover)

Dr S.J.M.H. Hulscher

international projects:

Task leader *Rhythmic Seabed Features*,
EU-MAST3 project *PACE*
Invited participant, UK-MAFF-project
Offshore Tidal Sand Banks

13 Key publications

Hulscher, S.J.M.H.(1996). Tidal-induced large-scale regular bed form patterns in a three-dimensional shallow water model. *Journal of geophysical research*, 101 (nr: C9), (pp. 20,727-20,744). ISSN 0148-0227.

Jager, F.G. de, Jorissen R.E. and Kok M., (1999). System approach for flood protection in the Netherlands. *Int. Conf. Integrated Management Water Resources 21st Century*, Cairo, Egypt, p. 142-163.

Ribberink, J.S., (1998). Bed-load transport for steady flows and unsteady oscillatory flows. *Coastal Engineering*, **34**: 59-82.

Veen, A. van der (1999). Paradise regained: over milieu- en ruimtelijke kwaliteit. *Tijdschrift voor politieke economie*, 21 (nr: 3), (pp. 24-49). ISSN 0165-442X.

Vriend, H.J. de.(1999, May 29). Long-term morphodynamics of alluvial rivers and coasts., [Environmental applications of mechanics and computer science. Proceedings of CISM 30th anniversary conference. CISM Course and lectures no. 409. Bianchi, G. (ed.)].(pp. 1-19). Udine, Italy. ISBN 3-211-83152-5.

14 Dissertations

Hulscher, Dr. S.J.M.H. (1996, November 20). Formation and migration of large-scale, rhythmic sea-bed patterns: a stability approach. Universiteit Utrecht, 143 pp. Promotor(en): Prof. dr W.P.M. de Ruijter, Prof. dr ir H.J. de Vriend. Co-promotor: Dr H.E. de Swart. ISBN 90-393-1447-0.**

Dohmen -Janssen, Ir. C.M. (1999, September 20). Grain size influence on sediment transport in oscillatory sheet flow; phase lags and mobile-bed effects. Technische Universiteit Delft, 247 pp. Promotor(en): Prof. ir J.A. Battjes. Prof. ir K. D'Angremond. ISBN 90-9012929-4.**

** = doctorate from other institution partly prepared within the Department of Civil Engineering

15A Academic publications

Journal articles

Refereed, International

Bakker, W.T., & Vriend, H.J. de.(1995). Resonance and morphological stability of tidal basins. *Marine geology*, (nr: 126), (pp. 5-18). ISSN 0025-3227.

Stive, M.J.F., & Vriend, H.J. de.(1995). Modelling shoreface profile evolution. *Marine geology*, (nr: 126), (pp. 235-248). ISSN 0025-3227.

Wang, Z.B., Louters, T., & Vriend, H.J. de.(1995). Morphodynamic modelling for a tidal inlet in the Wadden Sea. *Marine geology*, (nr: 126), (pp. 289-300). ISSN 0025-3227.

Hulscher, S.J.M.H.(1996). Tidal-induced large-scale regular bed form patterns in a three-dimensional shallow water model. *Journal of geophysical research*, 101 (nr: C9), (pp. 20,727-20,744). ISSN 0148-0227.

Davies, A.G., Ribberink, J.S., Temperville, A., & Zyserman, J.(1997). Comparisons between sediment transport models and observations made in wave and current flows above plane beds. *Coastal engineering*, 31 (pp. 163-198). ISSN 0378-3839.

Vriend, H.J. de.(1997). Evolution of marine morphodynamic modelling: Time for 3-D? In: *Proceedings of 'New challenges for North sea research, Hamburg 1996. Deutsche hydrographische Zeitschrift*, 49 (nr: 2/3), (pp. 331-341). ISSN 0012-0308.

Ribberink, J.S.(1998). Bed-load transport for steady flows and unsteady oscillatory flows. *Coastal engineering*, 1998 (nr: 34), (pp. 59-82). ISSN 0378-3839.

Capobianco, M., Vriend, H.J. de., Nicholls, R.J., & Stive, M.J.F.(1999). Coastal area impact and vulnerability assessment: The point of view of a morphodynamic modeller. *Journal of coastal research*, 15 (nr: 3), (pp. 701-716). ISSN 0749-0208.

Plant, N.G., Holman, R.A., Freilich, M.H., & Birkemeier, W.A.(1999). A simple model for interannual sand bar behavior. *Journal of geophysical research*, 104 (nr: C7), (pp. 755-775). ISSN 0148-0227.

Refereed, Dutch

Veen, A. van der.(1999). Paradise regained: over milieu- en ruimtelijke kwaliteit. *Tijdschrift voor politieke economie*, 21 (nr: 3), (pp. 24-49). ISSN 0165-442X.

Books and bookchapters

International

Swart, H.E. de., & Hulscher, S.J.M.H.(1995). Dynamics of large-scale bed forms in coastal seas. *Nonlinear dynamics and pattern formation in the natural environment*. Doelman, A. & A. van Harten, (eds.) (pp. 315-331). Harlow, Essex, UK: Longman. ISBN 0-582-27371-4.

Green, C., Veen, A. van der., Wierstra, E., Otter, H.S., Reitano, B., Rivilla Lopez, M., & Ketteridge, A.M.(1996). The use of economic instruments in catchment management. In: *Improving Flood Hazard Management Across Europe*. E. Penning-Rowsell (ed.) (pp. 9.1-9.22). Middlesex, UK: Middlesex University. ISBN 1-85924-086-0.

Vriend, H.J. de.(1996). Mathematical modelling of meso-tidal barrier island coasts. Part I: Empirical and semi-empirical models. In: P.L.F. Liu (ed.), *Advances in Coastal and Ocean Engineering*, Vol. 2 (pp. 115-149). Singapore: World Scientific Publ. Cy. ISBN 981-02-2410-9.

Vriend, H.J. de., & Ribberink, J.S.(1996). Mathematical modelling of meso-tidal barrier island coasts. Part II: Process-based simulation models. In: P.L.F. Liu (ed.): *Advances in Coastal and Ocean Engineering*, Vol. 2 (pp. 151-197). Singapore: World Scientific Publ. Cy. ISBN 981-02-2410-9.

Hulscher, S.J.M.H., & Swart, H. de.(1997). 3D sandbank stability. In: *CSTAB Handbook and Final Report, Volume 1*, Editor: Brian A. O'Connor, Report No. CE/05/96, September (pp. 116-129). Liverpool (UK): The University of Liverpool.

Hulscher, S.J.M.H., & Swart, H. de.(1997). Linear stability analysis - tidal sandbanks. In: *CSTAB Handbook and Final Report, Volume 2*, B.A. O'Connor (Ed.), Report No. CE/05/96, September (pp. 436-446). Liverpool (UK): The University of Liverpool.

Hulscher, S.J.M.H., & Swart, H. de.(1997). Morphodynamic modelling. In: *CSTAB Handbook and Final Report, Volume 2*, B.A. O'Connor (Ed.), Report No. CE/05/96, September (pp. 330-335). Liverpool (UK): The University of Liverpool.

Conference proceedings

Jagers, H.R.A., Knosche, T.R., & Peters, M.J.(1995, October 28). Information criteria can help to determine the number of sources from EEG and MEG., [Proc. of the 6th International Congress of ISBET].(pp. 10-10). Tokushima, Japan.

Vriend, H.J. de.(1995). Future paths for maritime hydraulics., [Hydra 2000, Vol. 3 (XXVIth IAHR-Congress), Grass, A.J. (ed.). Thomas Telford].(pp. 1-14). London, UK. ISBN 0-7277-2058-9.

Vriend, H.J. de.(1995, September 11). G6/G8-Coastal Morphodynamics., [Second MAST-days and EUROMAR-market].(pp. 631-650). Wallingford, U.K. ISBN 92-827-5011-6.

Capobianco, M., & Otter, H.S.(1996). Modelling land-use and land-cover changes in deltaic areas., [ICZM in the Mediterranean & Black Sea: Immediate Needs For Research, Education - Training, & Implementation, Ozhan, E. (ed.), 2-5 November].(pp. 201-215). Sarigerme, Turkey.

Otter, H.S., Veen, A. van der., & Vriend, H.J. de.(1996). A methodology for the analysis of the effects of a sea level rise on the socio-economy of the MED-DELTAS., [Impact of Climatic Change on Northwestern Mediterranean Deltas. MEDDELTA Final Book of Papers, Volume II - The Present and the Future, 2-6 October].(pp. 3.1-3.17). Venice, Italy.

Otter, H.S., Veen, A. van der., & Vriend, H.J. de.(1996). Analysis of the effects of a sea level rise on the socio-economy of the Ebro delta, Spain., [Impact of Climatic Change on Northwestern Mediterranean Deltas, MEDDELTA Final Book of Papers, Volume II - The Present and the Future, 2-6 October].(pp. 3.35-3.51). Venice, Italy.

Stive, M.J.F., Vriend, H.J. de., Cowell, P.J., & Niedoroda, A.W.(1996). Behaviour-oriented models of shoreface evolution., [Coastal Dynamics '95. Dally & W.R., R.B. Zeidler (eds.)].(pp. 998-1005). Gdansk, Poland. ISBN 0-7844-0154-3.

Capobianco, M., & Otter, H.S.(1997, November 11). Dealing with model uncertainty in integrated coastal zone management., [Proceedings of the Third International Conference on the Mediterranean Coastal Environment; MEDCOAST 97, November 11-14, 1997 (Ed. E. Özhan)].(pp. 432-447). Qawra, Malta.

Rorink -Heerink, H.M.J., Groesen, E.W.C. van., & Vriend, H.J. de.(1997, August 10). On stable alluvial channels: a variational approach., [Environmental and Coastal Hydraulics: Protecting the Aquatic Habitat. Proceedings of the XXVII-th IAHR congress. Forrest M. Holly Jr. & Adnan Alsaffar (series eds.) Sam S.Y. Wang & Torkild Carstens (theme eds.). ASCE, New York.].(pp. 1008-1014). San Francisco, California. ISBN 0-7844-0272-8.

Hulscher, S.J.M.H.(1997). On validation of a sand waves and sand banks model., [Coastal Engineering 1996: Proceedings of the twenty-fifth international conference, September 2-6, 1996. Edge, Billy L. (ed.)].(pp. 3574-3587). Orlando, Florida, USA. ISBN 0-7844-0242-6.

Dohmen -Janssen, C.M., & Ribberink, J.S.(1997). Grain-size influence on sand transport in oscillatory sheet flow., [Coastal Engineering 1996: proceedings of the twenty-fifth International Conference on Coastal Engineering, September 2-6 1996. Edge, Billy L. (ed.)].(pp. 4779-4792). Orlando, Florida, USA. ISBN 0-7844-0242-6.

Vriend, H.J. de.(1997, June 23). Prediction of aggregated scale coastal evolution (PACE)., [Book of Extended Abstracts of the International Conference on Coastal Research through Large Scale Experiments 23-27 June].(pp. 40-41). Plymouth, UK. ISBN 0-905227-86-7.

Bakker, W., Biezen, S. van der., Heemink (Tud), A.W., & Knaapen, M.A.F.(1998, January 01). Breaker bar dynamics predicted by Kalman filtering., [Coastal dynamics '97. Edward. B. Thornton ed. (23-06-1997)].(pp. 664-673). Plymouth (UK). ISBN 0-7844-0321-X.

Bijker, R., Wilkens, J., & Hulscher, S.J.M.H.(1998, May 24). Sandwaves: where and why., [Proceedings of the 8th International Offshore and Polar Engineering Conference (ISOPE), Montreal, may 24-29, 1998. Volume 2].(pp. 153-158). Montreal. ISBN 1-880653-36-2.

Hulscher, S.J.M.H., & Roelvink, J.A.(1998, August 31). Comparison between predicted and observed large-scale sea bed features., [Advances in Hydro-Science and -Engineering, Proceedings of abstracts (and papers on CD-Rom, isbn 937099-09-0) of the 3rd International Conference on Hydro-Science and -Engineering (ICHE) 31 aug. - 3 sept.), Volume III. Holz,K.P. et al (eds.)].(pp. 197-197). Cottbus/Berlijn, Duitsland. ISBN 0-937099-08-2.

Hulscher, S.J.M.H.(1998, June 22). Dynamics of shoreface bars due to low-frequency waves., [Book of abstracts of the 26th International conference on coastal engineering (22-26 june 1998)].(pp. 396-397). Copenhagen, Denmark.

Hulscher, S.J.M.H.(1998, January 01). Morphodynamic modelling of shoreface bars., [Coastal Dynamics '97. Thornton, Edward B. (ed.) 23- 27 june 1997].(pp. 883-892). Plymouth, UK. ISBN 0-7844-0321-X.

Dohmen -Janssen, C.M., Hassan, W., Wal, R. van der., & Ribberink, J.S.(1998, January 01). Grain-size influence on sand transport mechanisms., [Coastal dynamics '97. Thornton, Edward B. (ed.) 23-27 june 1997].(pp. 58-67). Plymouth, UK. ISBN 0-7844-0321-X.

Knaapen, M.A.F., Hulscher, S.J.M.H., Vriend, H.J. de., & Harten, A. van.(1998, August 31). Behaviour of alternate bar patterns in rivers., [Advances in Hydro-Science and -Engineering, Proceedings of abstracts (and papers on CD-Rom, ISBN: 0-937009-09-0) of the 3rd International Conference on Hydro-Science and -Engineering (ICHE) 31 aug.-3 sept.), Volume III. Paper 20 p. Holz K.P.et al (eds.)].(pp. 32-32). Cottbus/Berlin, Germany. ISBN 0-937099-08-2.

Komarova, N.L., & Hulscher, S.J.M.H.(1998, September 28). Sand wave formation: linear instability mechanisms., [Proceedings Oceans '98 IEEE/OES Conference, 28 september -1 oktober].(pp. 757-761). Nice, France. ISBN 0-7803-5045-6.

Plant, N.G., & Holman, R.A.(1998, June 22). Beach variability: building a better data set., [Book of abstracts of the 26th International conference on coastal engineering (22-26 june 1998)].(pp. 408-409). Copenhagen (Denmark).

Plant, N.G., Holman, R.A., & Freilich, M.H.(1998). Lessons learned from a simple model for sand bar behavior., [EOS, Transactions American Geophysical Union, fall meeting].(pp. 450-450).

Plant, N.G., & Holman, R.(1998, January 01). Strange kinematics of sand bars., [Coastal dynamics '97. Thornton, Edward B. (ed.) 23-06-1997].(pp. 355-364). Plymouth, UK. ISBN 0-7844-0321-X.

Ruggiero, P., Kaminsky, G., & Plant, N.G.(1998, June 22). Coastal morphologic variability of high energy dissipative beaches., [Book of abstracts of the 26th International conference on coastal engineering. 22-26 june 1998].(pp. 454-455). Copenhagen, Denmark.

Salomons, W., Otter, H.S., & Et Al(1998, December 06). Workshop report on system dynamics of the continuum river catchment to the coastal region., [Proceedings of the trans-diciplinary Euroconference on Coastal Management Research].(pp. 51-61). San Feliu de Guixols, Spain.

Taylor, J.A., Vincent, C.E., Thorne, P.D., Hardcastle, P.J., Humphrey, V.F., Zang, J.D., & Dohmen -Janssen, C.M.(1998). Three-dimensional sediment transport measurement by acoustics (TRIDISMA)., [Proceedings of OCEANS '98 IEEE/OES Conference, 28 september-1 oktober 1998].(pp. 1108-1114). Nice, France. ISBN 0-7803-5045-6.

Vriend, H.J. de.(1998, August 31). Morphodynamics at small and large scale in space and time., [Advances in Hydro-Science and -Engineering, Proceedings of abstracts (and papers on CD-Rom) of the 3rd International Conference on Hydro-Science and -Engineering (ICHE) 31 aug. - 3 sept.), Volume III].(pp. 7-7). Cottbus/Berlijn, Duitsland. ISBN 0-937099-08-2.

Vriend, H.J. de.(1998, May 23). On the predictability of coastal morphology., [Proceedings of the Third European Marine Science and Technology Conference, 23-27 May 1998. Barthel,K.G., M. Suranyi,H. Barth et al. (eds.)].(pp. 289-300). Lisbon, Portugal. ISBN 92-828-4726-8.

Vriend, H.J. de.(1998, January 01). Prediction of aggregated-scale coastal evolution., [Coastal dynamics '97. 23-06-1997. Thornton, Edward B. (ed.)].(pp. 644-653). Plymouth, UK. ISBN 0-7844-0321-X.

Vriend, H.J. de.(1998, May 23). Prediction of aggregated-scale coastal evolution (PACE)., [Proceedings of the 3rd European marine science & technology conference, May 23-27, 1998. project synopses. Volume II: Strategic Marine Research].(pp. 487-502). Lisbon, Portugal. ISBN 92-828-3035-7.

Whitehouse, R.J.S., Beech, N.W., Hulscher, S.J.M.H., & Huntley, D.A.(1998, June 08). Understanding the behaviour and engineering significance of offshore and coastal sandbanks., [33rd MAFF Conference of River and Coastal Engineers, Keele University, 1-3 juli 1998].(pp. 2.3.1-2.3.14). Keele, UK.

Blom, A., & Ribberink, J.S.(1999, September 06). Non-uniform sediment in rivers: vertical exchange between bed layers., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 45-54). Genova, Italy.

Brink, G.M. van den., & Hulscher, S.J.M.H.(1999, September 06). Prediction of sand waves and sand banks in the North Sea., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 217-226). Genova, Italy.

Capobianco, M., & Otter, H.S.(1999, August 16). Modelling the mechanisms of land use and land cover change in deltaic areas., [Coastal environment management. Proceedings Coastline '97 op CD-ROM. G. Randazzo ed. EUCC-Italy. 2-6 june 1997]. 16 pp. Naples, Italy.

Chatelus, Y., Katopodi, I., Dohmen -Janssen, C.M., Ribberink, J.S., & Et Al(1999, January 01). Size gradation effects in sediment transport., [Coastal engineering 1998, proceedings 26th conference, volume three, Billy L. Edge ed. 22-26 june 1998].(pp. 2435-2448). Copenhagen, Denmark. ISBN 0-7844-0411-9.

Goldsborough, D.G., & Kolkman, M.J.(1999, April 22). Mimicking real life problem solving by integrating simulation modelling and role-play., [What have they learned? Assessment of student learning in higher engineering education. Proceedings of a seminar of the SEFI-working group on curriculum development. 22-23 april 1999, TUD].(pp. 39-46). Delft, Netherlands. ISBN 2-87352-026-4.

Jager, F.G.J. de., Jorissen, R.E., & Kok, M.(1999, November 21). System approach for flood protection in the Netherlands., [Proceedings of the International conference on integrated management of water resources in the 21st century, Volume I. Jubileum congress NWRC-IAH, 21-25 november 1999].(pp. 142-163). Cairo, Egypt.

Jagers, H.R.A.(1999, September 06). Numerical analysis of cutoff development., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 553-562). Genova, Italy.

Dohmen -Janssen, C.M., Hout, G. van der., & Ribberink, J.S.(1999, January 01). Phase-lag effects in oscillatory sheet flow., [Coastal engineering 1998, proceedings 26th conference, volume three. Edge, Billy L. (ed.)].(pp. 2449-2462). Copenhagen, Denmark. ISBN 0-7844-0411-9.

Dohmen -Janssen, C.M.(1999, September 06). Velocity profiles and sand concentrations in sheet flow under waves and currents., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 467-476). Genova, Italy.

Katopodi, I., Ribberink, J.S., Hamm, L., Kitou, N., Samothrakis, P., Dohmen -Janssen, C.M., & Savioli, J.C.(1999). Comparison of concentration measurements with well-sorted and bi-modal sand., [Proceedings of Coastal Sediments 1999, ASCE, june 1999].(pp. 64-77). Hauppauge, Long Island, New York, USA. ISBN 0-7844-0436-4.

Knaapen, M.A.F., Hulscher, S.J.M.H., & Vriend, H.J. de.(1999, September 06). On the possibility of genetic algorithms and the Ginzburg-Landau equation to model alternate bars: a sensitivity analysis., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 283-292). Genova, Italy.

Plant, N.G., & Holman, R.A.(1999, January 01). Extracting morphological information from field data., [Coastal engineering 1998, conference proceedings volume two, Billy L. Edge ed.].(pp. 2773-2785). Copenhagen, Denmark. ISBN 0-7844-0411-9.

Plant, N.G., Hulscher, S.J.M.H., & Falqués, A.(1999, December 13). Prediction of instabilities in the nearshore beach profile., [American Geophysical Union, Fall Meeting Abstracts. 13-17 december 1999].(pp. os31C-08-os31c09). San Fransisco, USA.

Rose, C.P., Trouw, K., Cloin, B., Arnott, A.D., Sisternans, P.G.J., Graaff, J. van de., Dong, P., Ribberink, J.S., & O'Connor, B.A.(1999). Vertical sediment entrainment characteristics in oscillatory sheet flow conditions., [Proceedings of Coastal Sediments 1999, ASCE, june 1999]. Long Island, New York. ISBN 0-7844-0436-4.

Ruggiero, P., Kaminsky, G., & Plant, N.G.(1999, January 01). Coastal morphologic variability of high energy dissipative beaches., [Coastal engineering 1998, conference proceedings volume two. Edge, Billy L. (ed.)].(pp. 3238-3251). Copenhagen, Denmark. ISBN 0-7844-0411-9.

Steijn, R.C., Roelvink, J.A., Rakhorst, H.D., Ribberink, J.S., & Overeem, J. van.(1999, January 01). North coast of Texel: A comparison between reality and prediction., [Coastal engineering 1998, proceedings 26th conference, 22-27 june 1998, volume two. Edge, Billy L. (ed.)].(pp. 2281-2293). Copenhagen, Denmark. ISBN 0-7844-0411-9

Vriend, H.J. de.(1999, September 06). Long term morphological prediction., [Proceedings of I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999].(pp. 617-618). Genova, Italy.

Vriend, H.J. de.(1999, May 29). Long-term morphodynamics of alluvial rivers and coasts., [Environmental applications of mechanics and computer science. Proceedings of CISM 30th anniversary conference. CISM Course and lectures no. 409. Bianchi, G. (ed.)].(pp. 1-19). Udine, Italy. ISBN 3-211-83152-5.

Vriend, H.J. de.(1999). On the role of laboratory experiments in morphological predictions., [Proceedings of the Hydrolab-Workshop on experimental research and synergy effects with mathematical models, 17-19 february 1999. Evers, K., J. Grüne & A. van Os (eds.)].(pp. 39-48). Hannover, Germany. ISBN 3-000-004942-8.

15B Professional publications

International

Vriend, H.J. de.(1997). State of the art in modelling coastal morphodynamics - Practical implications. [Häfen, Wasserstrassen, Küstenschutz. Proceedings of the 50th HTG congress 1997.].(pp. 53-63). Bremen, Germany.

Dutch

Hulscher, S.J.M.H., Bosch, R., & Ranzijn, I.(1998). Baggerstrategiën in de Eurogeul. *Natuur en techniek*, 66 (nr: 8), (pp. 42-43). ISSN 0028-1093.

Kuypers, A., Flikkema, H., Kok, M., & Lammers, I.B.M.(1999). Extreme neerslag en de afwatering van Fryslân. *Waterschap*, 84 (nr: 2), (pp. 54-59). ISSN 1380-4251.

15C Scientific reports

Ribberink, J.S., & Vriend, H.J. de.(1995). Morphodynamics of a meso-tidal barrier-island coast. (Delft Hydraulics H2129. Deelrapport in : Morfodynamiek van de Nederlandse kust op verschillende tijd en ruimteschalen, een samenvatting in drie rapporten van de kennis verkregen in het project Kustgenese). Delft: Delft Hydraulics,

Hulscher, S.J.M.H.(1996). Formation and migration of large-scale rhythmic sea-bed patterns; a stability approach. (Cinquannual report of the activities and achievements of the NCK). Delft: NCK,

Hulscher, S.J.M.H.(1996). Formation and migration of shoreface bar systems by low-frequency waves: a stability approach. (Civil Engineering & Management / Institute for Marine and Atmospheric Research Utrecht research report R 96-16). Enschede / Utrecht: Universiteit Twente / Universiteit Utrecht, 51 pp.

Ribberink, J.S., & Dohmen -Janssen, C.M.(1996). Dynamics and grain size effects in oscillating sheet flow conditions. (Cinquannual report of the activities and achievements of the NCK, 15 december). Delft: NCK,

Jagers, H.R.A.(1996). Behaviour oriented modelling of braided rivers. Delft: Delft Hydraulics, 45 pp.*

Hulscher, S.J.M.H., & Roelvink, J.A.(1997). Comparison between predicted and observed large-scale sea bed features in the Southern North Sea. (Delft Hydr. Report H2487). Enschede: Universiteit Twente, 23 pp.

Vriend, H.J. de.(1997). PACE overall workshop (ed.). (Extern Rapport, EG, PACE-project. Book of abstract; PACE overall workshop, Barcelona). Enschede: Universiteit Twente, 100 pp.

Dohmen -Janssen, C.M., & Hassan, W.N.M.(1998). Numerical modelling of wave-period influence on oscillatory suspended sediment and flow dynamics. (Delft Hydraulics & UT research report). Delft/Enschede: WL/UT, 31 pp.

Ribberink, J.S., & Buijsrogge, R.H.(1998). Ontwikkeling hydraulisch morfologisch model Oude IJssel en effectenstudie ecologische verbindingzone rond Doetinchem. (Civil Engineering & Management research report: 98R-001/mics-001, febr. '98). Enschede: University of Twente, 12 pp. ISBN 90-365-111-9.

Vriend, H.J. de.(1998). PACE overall workshop (ed.). (Extern Rapport, EG, PACE-project; Book of abstracts; PACE workshop London). Enschede: Universiteit Twente, 250 pp.

Whitehouse, R.J.S., Beech, N.W., Hulscher, S.J.M.H., & Huntley, D.A.(1998). Understanding the behaviour and engineering significance of off shore and coastal sand banks. (HR Wallingford report HRPP 177). Wallingford, UK: HR Wallingford,

Whitehouse, R.J.S., Beech, N.W., Roelvink, J.A., Hulscher, S.J.M.H., & Et.Al.(1998). Understanding the behaviour and engineering significance of offshore and coastal sand banks. (HR Wallingford report: SR 512. Report Offshore sand banks: Basic processes and effects on long term coastal morphodynamics carried out by a consortium Hr Wallingford LTd., Posford Duvivier, Delft Hydraulics and the Institute of Marine Studies (Plym.)). Wallingford, UK: HR Wallingford Ltd., 88 pp.

Blom, A., & Kleinhans, M.(1999). Non-uniform sediment in morphological equilibrium situations. Data report sand flume experiments 97/98. (Civil engineering & management research report 99R-002 / MICS-001, i.s.m. RWS/RIZA, WL/Delft Hydraulics, ook op CD-ROM). Enschede: Universiteit Twente, 26 pp.

Hassan, W.N.M., Kroekenstoel, D.F., Ribberink, J.S., & Rijn, L.C.J. van.(1999). Gradation effects on sand transport under oscillatory sheet-flow conditions. (research report). Delft/Enschede: Delft Hydraulics/ University of Twente, 165 pp.

Dohmen -Janssen, C.M.(1999). Sheet flow under monochromatic waves and wave groups. CCM measurements in the Large Wave Flume, Hannover. (Civil engineering & management research report 2000R-003 / MICS-012. RIKZ (KUST*2000), Human Capital and Mobility , NICOP (ONR)). Enschede: University of Twente, 54 pp.

Dohmen -Janssen, C.M.(1999). Sheet flow under monochromatic waves and wave groups. Set-up of CCM measurements in the Large Wave Flume, Hannover. (Civil engineering & management research report 99R-016 / MICS-006. RIKZ project 22990559 (KUST*2000)). Enschede: University of Twente, 26 pp.

Koningsveld, M. van., Marchand, M., Heslenfeld, P., Rijswijk, L. van., & Salman, A.(1999). Spatial planning in European coastal zones. Review of approaches in spatial planning, coastal policy and coastal defence. (WL / Delft Hydraulics report Z2568). Delft: WL/Delft Hydraulics, 106 pp.

Krooshof, C., & Veen, A. van der.(1999). Interactive decision-making for integrated coastal zone management: a review report to the RICAMA project. (Civil Engineering & Management research report 99R-014/MICS-006). Enschede: University of Twente, 36 pp.

Otter, H.S., & Veen, A. van der.(1999). Public safety in riverine floodplains: The case of the Netherlands compared to other countries in the world. (Civil Engineering & Management research report 99R-017 / MICS-007. Hungary flood control project. Report to the ministry of transport, communications and water management). Enschede: University of Twente, 36 pp.

Vriend, H.J. de.(1999). Getij-analyse Westerschelde. Hoe nu verder?. (CT&M onderzoeksrapport in opdracht). Enschede: Universiteit Twente, 10 pp.

Vriend, H.J. de. (editor)(1999). PACE Final workshop. (Extern rapport, EG, PACE-project Book of abstracts pace workshop Venice). Enschede: Universiteit Twente, 300 pp.

Vriend, H.J. de. (editor) Hulscher, S.J.M.H., et.al.(1999). Prediction of aggregated-scale coastal evolution. Final scientific report PACE. (Part 1: Abstracts-in-Depth. Abstracts of the Pace final workshop 9-12 march 1999, Enschede). Enschede: Universiteit Twente,

Vriend, H.J. de.(1999). Prediction of aggregated-scale coastal evolution. Final scientific report PACE. (Part 2: Institute reports and output list). Enschede: Universiteit Twente,

Vriend, H.J. de. (editor)(1999). Prediction of aggregated-scale coastal evolution. Final scientific report PACE. (Part 3: JCR-papers. Papers to be published in Special issue of Journal of Coastal research). Enschede: Universiteit Twente,

Vriend, H.J. de.(1999). Prediction of aggregated-scale coastal evolution. Final scientific report PACE. (Part 4: Summary of results). Enschede: Universiteit Twente, 25 pp.

Kok, M., & Lammers, I.B.M.(1999). Onderzoek waterschade ten gevolge van neerslag. (Extern rapport. PR 285, oktober 1999). Lelystad: HKV-Lijn in water, 49 pp. *

Kok, M., Vrisou Van Eck, E., & Vrouwenfelder, A.(1999). Standardmethode schade en slachtoffers ten gevolge van overstromingen. (Extern rapport. PR 236, november 1999) HKV Lijn in water, 110 pp.*

Stolker, C.(1999). Beheersdocument SOBEK-model van de Oude IJsel en Aa-strang. (Civil Engineering & Management research report 99R-020 / MICS-008). Enschede: University of Twente, 44 pp.*

* External reports registered under the category of professional publications

15d Forthcoming publications (accepted)**Academic publications****Journal articles***Refereed, International*

Capobianco, M., Vriend, H.J. de., Stive, M.J.F., Southgate, H.N., Jimenez, J., Larson, M., & Hanson, H. Large-scale coastal evolution. Toward a robust model-based methodology. *Journal of coastal research*, ISSN 0749-0208.

Hanson, H., Aarninkhof, S., Capobianco, M., Jimenez, J., Larson, M., Nicholls, R.J., Plant, N.G., Southgate, H.N., Steetzel, H., Stive, M.J.F., & Vriend, H.J. de. Medium-term modelling of coastal evolution. *Journal of coastal research*, ISSN 0749-0208.

Hulscher, S.J.M.H., & Brink, G.M. van den. Comparison between predicted and observed sand waves and sand banks in the North Sea. *Journal of geophysical research*, ISSN 0148-0227.

Knaapen, M.A.F., Hulscher, S.J.M.H., Vriend, H.J. de., & Harten, A. van. Alternate bar patterns in rivers: Modelling vs. laboratory experiments. *Journal of hydraulic research*, ISSN 0022-1686.

Komarova, N.L., & Hulscher, S.J.M.H. Linear instability mechanisms for sand wave formation. *Journal of fluid mechanics*, ISSN 0022-1120.

Larson, M., Capobianco, M., Jansen, H., Rózyński, G., Southgate, H.N., Stive, M.J.F., & Wijnberg, K.M. Analysis and modelling of field data on coastal morphological evolution over yearly and decadal time scales. Part 1 Background and linear techniques. *Journal of coastal research*, ISSN 0749-0208.

Mclean, S.R., Ribberink, J.S., Dohmen -Janssen, C.M., & Hassan, W.N.M. Sediment transport measurements within the sheet flow layer under waves and currents. *Journal of waterway, port, coastal & ocean engineering (ASCE)*.

Otter, H.S., & Capobianco, M. Uncertainty in integrated coastal zone management. *Journal of coastal conservation*, ISSN 1400-0350.

Plant, N.G., Ruessink, B.G., & Wijnberg, K.M.(2010). Morphologic properties derived from a simple cross shore sediment transport model. *Journal of geophysical research*, ISSN 0148-0227.

Plant, N.G., Holman, R.A., & Freilich, M.H.(2010). The role of morphologic feedback in surf zone sand bar response. *Journal of geophysical research*, ISSN 0148-0227.

Southgate, H.N., Wijnberg, K.M., Larson, M., Capobianco, M., & Jansen, H.(2010). Analysis and modelling of field data on coastal morphological evolution over yearly and decadal time scales. Part 2 Non-linear techniques. *Journal of coastal research*, ISSN 0749-0208.

Non refereed, International

Speijker, L.J.P., Noortwijk, J.M. van., Kok, M., & Cooke, R.M.(2000). Optimal maintenance decisions for dikes. *Probability in the engineering and informational sciences*, 14 (pp. 101-121).
ISSN 0269-9648.

Books and bookchapters

International

Vriend, H.J. de.(2010). Mathematical modelling of 3D nearshore morphology. *International handbook of coastal engineering*, Watanabe, Isobe, A.M. & N.C. Kraus (eds.) San Diego, USA: Academic press.

Conference proceedings

Hassan, W.N.M., & Ribberink, J.S. Wave-period influence on sand transport mechanisms and flowdynamics under oscillatory sheet flow conditions., [International Conference on Coastal engineering 2000].

Hulscher, S.J.M.H., & Fluit, C.C.J.M. Modelling gasmined bed depressions and tidal sand banks., [Conference on physics of estuaries and coastal seas]. Norfolk, USA.

Hulscher, S.J.M.H., Knaapen, M.A.F., & Scholl, O.(2000, March 23). Regeneration of dredged sand waves., [Proceedings of Marine sandwave Dynamics. 23-24 march 2000. Trenteseaux, A. & T. Garlan, eds.](pp. 93-95). Lille, France. ISBN 2-11-088263-8.

Jak, M.C.A., & Kok, M. A database of historical flood events in the Netherlands., [Proceedings of the NATO Advanced research workshop on floods: Coping with floods: lessons learned from recent experience, may 16-21]. Malenovice, Czech Republic.

Knaapen, M.A.F., Hulscher, S.J.M.H., & Vriend, H.J. de.(2000, March 23). Data analysis of sand waves in the North Sea., [Proceedings of Marinesand wave dynamics. 23-24 march 2000. Trenteseaux, A.& T. Garlan, eds.](pp. 97-100). Lille, France. ISBN 2-11-088263-8.

Knaapen, M.A.F., & Hulscher, S.J.M.H. Predicting the regeneration of sand waves after dredging: an amplitude evolution model tuned by a genetic algorithm., [Coastal engineering 2000 (ASCE), Billy L. Edge ed.]. Sydney, Australia.

Nemeth, A.A., Hulscher, S.J.M.H., & Vriend, H.J. de.(2000, March 23). Modelling migration of sand waves in shallow shelf seas., [Proceedings of Marine sandwave dynamics. 23-24 march 2000. Trenteseaux, A. & T. Garlan, eds.](pp. 143-151). Lille, France. ISBN 2-11-088263-8.

Nemeth, A.A., Hulscher, S.J.M.H., & Vriend, H.J. de. Modelling sand wave dynamics in shallow shelf seas., [Conference on physics of estuaries and coastal seas]. Norfolk, USA.

Plant, N.G., & Hulscher, S.J.M.H. Non-linear interaction of nearshore morphology., [27th international conference on Coastal engineering 2000, B.L. Edge, ed.]. Sydney, Australia.

Ribberink, J.S., Dohmen -Janssen, C.M., Hanes, D.M., Mclean, S.R., Taylor, J.A., & Vincent, C.E. Near-bed sand transport mechanisms under waves: A large-scale flume experiment (SISTEX)., [27th. international Conference on Coastal engineering 2000]. Sydney, Australia.

Vincent, C.E., Bjorno, L., Dohmen -Janssen, C.M., Guyomar, D., Humphrey, V.F., Perrenes, M., Ribberink, J.S., Schaafsma, A., Taylor, J.A., & Thorne, P.D. Tridisma - 3-D Sediment transport measurement by acoustics., [27th. international Conference on Coastal engineering 2000]. Sydney, Australia.

Vriend, H.J. de., Hulscher, S.J.M.H., & Brink, G.M. van den. Free modes of seabed behaviour., [Seminar on sediment transport modelling, ITB Bandung february 5-6 1999]. 16 pp. Bandung, Indonesia.

Vriend, H.J. de. Large scale morphological prediction. Key-note speech on I.A.H.R. symposium on river, coastal and estuarine morphodynamics, volume I. September 6th-10th 1999, Genova, Italy. G. Seminosa ed. Springer verlag.

Scientific reports

Krooshof, C., & Veen, A. van der.(2000). Managing interactive decision-making in ICZM. (Civil Engineering & Management research report 20R-001 / MICS-010). Enschede: University of Twente, 22 pp.

Scholten, R.W., Veen, A. van der., & Otter, H.S.(2000). Evaluation methodologies in integrated coastal zone management. A review. Porgetto RICAMA. (Civil Engineering & Management research report 2000R-002 / MICS-011). Enschede: University of Twente, 60 pp.

Kok, M.(2000). Mogelijkheden voor het verzekeren van schade. (Extern rapport PR 351). Lelystad: HKV Lijn in water, 54 pp.

1 Transportation Engineering & Management

3 Programme members

- prof. dr ir M.F.A.M. van Maarseveen, professor (programme leader)

- prof. dr ir E.C. van Berkum, professor (part-time) (1998-...)
- ir A. Coffa, assistant professor
- ir H.L. ter Huerne, assistant professor (part-time)
- ir M. Rorink-Heerink, assistant professor
- drs S.I.A. Tutert, assistant professor (1999-...)
- dr M.J.G. Witbreuk, assistant professor (part-time)

4 Key words

Transportation engineering
Dynamic Traffic Management
Traffic simulation
Transportation modelling and analysis
Transportation planning
Transportation policy and organisation
Evaluation and impact studies
Road engineering and maintenance

5 Research input of academic staff

fte		1995	1996	1997	1998	1999	total
wp1	aio	2.4	1.9	2.6	1.9	1.9	10.7
	other	1.6	0.7	0	1.0	2.2	5.5
wp2	oio	0	0	0	0	0	0
	other	0	0	0	0	0	0
wp3	aio	0	0	0	0	0.1	0.1
	other	0	0	0	0	0.3	0.3
total		4.0	2.6	2.6	2.9	4.5	16.6

6 Research output

				1995	1996	1997	1998	1999	total	forth.
Ph.D. theses				0	1	1	0	0	2	
academic publications	journal articles	refereed	international	0	1	0	0	0	1	2
			Dutch	1	0	0	0	0	1	
	non refereed	international	0	0	0	0	0	0		
		Dutch	0	0	0	0	0	0		
	other acad.publications: books, chapters		international	0	1	1	1	4	7	
			Dutch	0	0	0	0	0	0	
conference proceedings				6	5	5	3	6	25	22
professional publications				international	0	0	0	0	0	
				Dutch	0	1	1	0	3	1
scientific reports				0	1	3	3	4	11	

7 Composition of research input academic staff 1999

<i>fte</i>	wp1	wp2	wp3	total
professor	0.4	0	0	0.4
associate professor (uhd)	0	0	0	0
other senior staff (ud)	1.7	0	0	1.7
postdoctoral fellows	0.3	0	0.1	0.4
junior staff (aio,oio,moz)	1.9	0	0.1	2.0
other junior staff	0	0	0	0
total	4.3	0	0.2	4.5

8 Programme design in brief

8.1 Mission

The research activities are focused on the technical and managerial aspects of the functioning of transportation systems, from the transportation perspective or within a broader social, economical or ecological context. By conducting both fundamental and applied research, the programme aims to generate new multidisciplinary knowledge by means of a system analytic approach and the design and development of engineering tools. Characteristic features are quantitative analysis, simulation methods and information processing techniques.

8.2 Research Programme

General

In the last decades, the developed world has learned a good deal from a long period of weak transport planning, limited investment, emphasis on the short term and mistrust in strategic transport modelling and decision making. Old transport problems (e.g. congestion, pollution, accidents, financial deficits) do not fade away under the pressure of mild attempts to reduce them through better traffic management; old problems reappear with even greater vigour, pervading wider areas, and in their new forms they seem more complex and difficult to handle.

A new contemporary dimension is the fact that most developing countries are suffering serious transport problems as well. These are no longer just the lack of roads to connect distant rural areas with markets. Indeed, the new transport problems bear some similarities with those prevalent in the industrialised world; however, they have a number of very distinctive features deserving a specific treatment (e.g. fast urbanisation and change, poor accessibility and mobility for population groups, high demand for public transport, scarcity of resources).

It is widely believed that there is a need for a different way of addressing the problems in the transport sector. One of the most promising ways forward is to adopt an integral approach to land-use and transportation planning and to internalise the concept of sustainable development in planning and decision making.

More recently, advanced information technologies have received greater attention in the transportation sector. Worldwide transport applications have entered a new era with the activation of several strategic initiatives affecting both road infrastructure and vehicle technologies. Central to such initiatives are the development of advanced transport telematics systems and the implementation of a new generation of technological options in

transport environment with a relevant impact in terms of improved traffic management, increased efficiency and safety.

Applications and experiences are spreading not only for key off-line tasks (e.g. traffic network design, pavement management and rehabilitation, traffic signal design, public transport planning), but also in on-line ‘core tasks’ related to road traffic control and management, where domain requirements are certainly more demanding but the potential benefits are likely to be the highest. The number and variety of such applications have now reached a level which clearly demonstrates the need for a systematic presentation and analysis of this rapidly evolving research and application area.

The research programme in Transportation Engineering & Management can roughly be subdivided into three themes, viz. *Sustainable Development and Planning*, *Road Traffic Information and Control* and *Road Engineering and Maintenance*, although this arrangement ignores a number of interesting cross-connections.

Theme a: Sustainable Development and Planning

This theme concentrates on travel demand analysis and forecasting, the design, development and application of planning models, the design and evaluation of policy scenarios and management schemes, assessment and internalisation of socio-economic and environmental impacts of transportation systems, and policy and organisational issues, all with an emphasis on sustainable development.

Theme b: Road Traffic Information and Control

This theme concentrates on technical and organisational aspects of using telecommunications and information technology for strategic and operational dynamic traffic management purposes. It includes the analysis of information demands, technological assessment studies, the design, development, application and evaluation of monitoring systems and management schemes, the design, development and validation of simulation tools, and (multi-actor) policy and organisational issues.

Theme c: Road Engineering and Maintenance

This theme concentrates on the design, development and application of engineering tools for managerial aspects of road construction and maintenance processes of asphalt pavements. The focus is on both operational and strategic issues of pavement rehabilitation processes in practice. From an operational point of view both the impacts of circumstantial factors (e.g. weather conditions, logistics, human factors) and different engineering schemes (e.g. roller processes) on asphalt pavement qualities are being investigated. The

strategic issue deals with the optimal integration of road construction with traffic management schemes.

8.3 Significance for education

Results of the research programme are predominantly embedded in the final two years of the regular education programme:

- the packages Infrastructure Planning and Policy (V2) and Travel Demand Analysis and Modelling (V5),
- the packages Dynamic Traffic Management (V1) and Strategic Traffic Management (V7), and
- Road and Railroad Engineering.

Moreover, the staff is actively involved in the supervision of internships and practice periods. A continually increasing part of the M.Sc. projects is embedded in or connected with ongoing research. Ph.D. students actively participate in the supervision of those projects.

9 Substantive overview of results

Theme a: Sustainable Development and Planning

Modelling for strategic planning

Most transportation planning models are inappropriate for strategic planning purposes because of scale inflexibility and the level of detail. These models do not have the ability to incorporate new information or integral approaches. For example, new insights in household activity patterns or land-use transportation interactions can hardly be dealt with. In a study exploring the existence of potential limits in car mobility growth a new strategic planning model on a national scale has been developed. The model is based on a microscopic utility approach for activity patterns and is able to deal with individual time and money constraints. The model is calibrated with data from national surveys and has been applied within a scenario framework.

Internalising sustainable development

In transportation planning and policy the concept of sustainable development is continually receiving greater attention, especially in the transport sector. However, the majority of theoretical research is descriptive and qualitative, and focused on defining the concept and assessing various impacts. On the other hand, planning practice strives for sustainable development by a fairly sectoral approach and implementing ad hoc modal shift measures and infrastructure actions.

To bridge this gap a conceptual framework has been developed to internalise the concept of sustainable development within traditional transportation planning. The framework is based on a review of the various definitions of the concepts “sustainability” and “development” and the rare initiatives to adopt certain notions in a planning context. The conceptual framework will be used to develop an integral land use-transportation model.

Effectiveness of co-operation

Usually, irrespective of scale, many actors are involved in transportation planning and policy. Therefore, an integral transportation policy requires horizontal and vertical co-operation between several actors. However, co-operation tends to be not very effective. Using the theory of fiscal federalism a conceptual model has been developed that relates key factors in co-operation to indicators of effectiveness. These relations have been empirically tested in a number of case studies, and translated into design rules for co-operation. Moreover, the approach has been adopted for the design and implementation of a regional parking policy.

Presently, free competition and financing regimes play an important role in public transport planning. In a research project the (potential) impacts of these aspects have been evaluated for the performance of public transport systems.

Theme b: Road Traffic Information and Control

Traffic flow prediction

For a continuous and near optimal traffic flow throughput it is essential to detect upcoming saturation levels in order that adequate measures can be taken to prevent congestion phenomena. Because huge amounts of data are constantly processed, this is not an easy task. The performance of a number of mathematical data processing techniques for short-term prediction of traffic flow is being investigated for different qualities of data sets and varying complexities of road networks. Analysis of data from the Netherlands and the USA reveals that neural networks appear to be a promising option.

Guidance and control

In more branched road networks with route alternatives traffic management can be applied to direct traffic flow. For ex ante evaluation studies it is essential to be able to simulate the impacts of route choice behaviour on traffic flow in time. A research project has been started to assess the potentials of dynamic traffic assignment techniques for traffic simulation and transportation planning models.

Moreover, the transferability in time and place of the effects of a large range of dynamic traffic management tools is empirically tested.

Monitoring and management

The technological feasibility of a satellite communication system for monitoring and management of urban public transport systems is studied within a pilot project. The first results show that the technical performance of the GPS-system is reliable as those from existing VETAG/VECOM systems.

Driver support tools

A new generation fuel-efficient support tool has been developed to support drivers in achieving a fuel-efficient driving behaviour. The system is able to detect the context the vehicle is in, to compare actual driving behaviour within that context with the optimal behaviour and to give feedback to the driver on how to change this behaviour. In the design, which has been patented, both technological, psychological and ergonomical aspects are considered. Extensive tests in a driving simulator experiment have revealed that substantial reductions in fuel consumption can be reached. Moreover, an ex ante simulation study has shown that the adapted driving behaviour created by the support tool has no adverse impacts on traffic flow performance and traffic safety.

Theme c: Road Engineering and Maintenance

Pavement rehabilitation is becoming of major importance compared with construction of roads. Heavy flows on road networks, however, put tight time and spatial constraints on maintenance works. These constraints imply that maintenance works regularly have to be performed under less favourable circumstances (e.g. weather, darkness, time of day). An aggregate evaluation study based on existing data sets has shown that strong indications exist that under these circumstances the quality of (new) asphalt pavements is at stake.

Using a Finite Element Method a model has been designed to simulate the compaction process of asphalt pavements under scenarios regarding roller schemes and weather conditions. In addition, for calibration purposes, a new device has been developed, tested and implemented to measure material properties of asphalt mixtures in the course of the compaction process.

10 Programme development

Organisation

The first professor in Transportation Engineering & Management was appointed in April 1995. From January 1, 1997 he also acts as research director for Civil Engineering & Management. In January 1998 a second (part-time) chair was established in Strategic and Operational Traffic Management.

Theme a: Sustainable Development and Planning

Research with respect to the assimilation of the concept of sustainable development in the traditional planning tools will be intensified. Research challenges are the integration with land-use models, expansion of the demand oriented approaches with supply-side factors, and the adaptation from open-end to closed-loop formulations. A number of research proposals are in preparation, partly in collaboration with IHE-Delft. With respect to this research theme a start has been made to set up a research network of universities within Europe, Africa and Asia for exchanging staff, Ph.D. and M.Sc. students working in this field. The research scope is also broadened to traffic safety issues within planning, for which co-operation with the SWOV is being established.

In order to improve the quality of transportation planning models, new initiatives are currently taken to set up a research project for an ex-post evaluation of transportation policy measures. For this project the collaboration with local authorities, and Dutch research institutes and consultancy firms will be continued.

Theme b: Road Traffic Information and Control

The need for areawide traffic management schemes is evident. The effectiveness of local traffic control actions is limited, and to increase traffic network efficiency a more integral approach is needed.

Important issues are: evaluation of network performance, the potentials of floating car data, sophistication of data processing techniques, the development of more adequate characterisations of traffic flow, assessment of information demands for information and monitoring systems, and the design of system architectures and organisation of local traffic centres.

The research on this theme will heavily depend on 2nd and 3rd money stream. In collaboration with other European universities and telecommunications and information technology companies some EU proposals are already in a processing stage. The co-operation with national and local authorities will be continued. Some of these local authorities already have shown serious interest in acting as a pilot for areawide traffic management schemes, for a local traffic centre or for automated guided vehicle systems.

Within the FEST-project the fuel-efficient support tool is being extensively tested and evaluated in a number of field trials. In this research project TNO Human Factors and an automobile industry are partner. The FEST-project itself is part of a new research platform on Intelligent Transport Systems involving universities in Sweden, The United Kingdom, France and The United States.

Theme c: Road Engineering and Maintenance

The current Ph.D.-project will end this year with the validation and application of the compaction process model. In order to achieve a critical mass the collaboration with Delft University of Technology will be continued. The scope of the research will be broadened in three ways: extension with other quality parameters and materials of asphalt pavements, the impacts of other circumstantial factors, and investigating the relation between initial qualities and lifespan of the construction. Depending on completion of the chair collaboration will also be sought with the chair of Construction Engineering.

11 Societal/technological relevance

Actually the research programme in Transportation Engineering & Management has been established since 1996. Due to the phase lag between input, production and actual output (publication date), the demonstrable societal/technological impact is still weak.

However, the practical relevance of the research is reflected by external collaborations with non-university institutions and companies, among which the various Departments of Rijkswaterstaat, the Ministry of Transport and Public Works, several local authorities, TNO-institutes, CROW, SWOV, public transport companies and consultancy firms.

Part of the staff is part-time employed in consultancy firms.

12 Other indications of quality and reputation

Prof. dr ir M.F.A.M. van Maarseveen

international projects:

Co-ordinator FEST-project
Member ITS platform on Intelligent
Transport Systems
Member International Association
of Transport Behaviour Research
invited speaker South African
Transport Conference, Pretoria, July
1999

conference organiser:

Biennial National Meeting in
Transportation Science

Prof. dr ir E.C. van Berkum

international projects:

Member Transportation Research Board

Member International Association of
Transport Behaviour Research

national projects:

Member Platform on Assignment &
Simulation Models

13 Key publications

Kraan, Dr.ir. M.E. (1996, October 11). Time to travel. University of Twente, Enschede, The Netherlands (200 pp.). Promotor: Prof. dr ir M.F.A.M. van Maarseveen. ISBN 90-3650854-1.

Voort, M.C. van der., Dougherty Ma, M., & Watson, S. (1996). Combining Kohonen Maps with Arima Time Series Models to Forecast Traffic Flow. *Transportation Research Part C*, 4 (nr: 5), (pp. 307-318). ISSN 0968-090X.

Berkum, E.C. van., & Mede, P.H.J. van der.(1998). The impact of dynamic traffic information: Modelling approach and empirical results. *Travel behavior research: updating the state of play*. De Dioz Ortuzar, J.,D. Henschler & S. Jara-Diaz (eds.) (pp. 401-421). Oxford, UK: Elsevier, Oxford. ISBN 0-08-043360-X.

Witbreuk, M.J.G., & Guihéry, L.(1999). Fiscal federalism and regionalisation of transport policy in Europe. In: *Proceedings of the 8th world conference on transport research*. Volume IV: transport policy. Meersman, H. et al (eds.) (pp. 445-458). Elsevier. ISBN 0-08-043590-4.

Voort, M.C. van der., & Maarseveen, M.F.A.M. van.(1999). Design and evaluation of a new generation fuel efficiency support tool., [ITS: Smarter, smoother, safer, sooner. *Proceedings on CD-rom of the 6th world congress on intelligent transport systems*, 8-12 november 1999]. Toronto, Canada.

14A Dissertations

Kraan, Dr.ir. M.E. (1996, October 11). Time to travel. Universiteit Twente, 200 pp. Promotor(en): Prof. dr ir M.F.A.M. van Maarseveen. ISBN 90 365 0854 1.

Witbreuk, Dr. M.J.G. (1997, October 30). Het Regionale Verkeersnetwerk als Common Pool Resource. Universiteit Twente, 231 pp. Promotor(en): Prof. dr ir M.F.A.M. van Maarseveen. Assistent promotor(en): Prof. dr A. van der Veen. ISBN 90 365 101`98.

15A Academic publications

Journal articles

Refereed, International

Voort, M.C. van der., Dougherty, M.S., & Watson, S.(1996). Combining Kohonen maps with Arima time series models to forecast traffic flow. *Transportation research Part C*, 4 (nr: 5), (pp. 307-318). ISSN 0968-090X.

Refereed, Dutch

Kraan, M.E.(1995). Op zoek naar grenzen aan de mobiliteitsgroei. *Tijdschrift voor vervoerswetenschap*, 31 (nr: 1), (pp. 103-118). ISSN 0040-7623.

Books and bookchapters

International

Kraan, M.E.(1996). Modelling activity patterns with respect to limited time and money budgets. *Proceedings 7th WCTR - Volume 1: Travel Behaviour*. 16-20 july. Hensher, D., J. King & T. Oum (eds.). Pergamon, Elsevier (pp. 151-164). Sydney, Australia: ISBN 008-0427782.

Kraan, M.E.(1997). In search for limits to mobility growth with a model for the allocation of time and money. *Activity-Based Approaches to Travel Analysis*. Ettema & Timmermans (eds.) (pp. 89-116). Pergamon. ISBN 0-08-042584-4.

Berkum, E.C. van., & Mede, P.H.J. van der.(1998). The impact of dynamic traffic information: Modelling approach and empirical results. *Travel behavior research: updating the state of play*. De Dioz Ortuzar, J.,D. Henscher & S. Jara-Diaz (eds.) (pp. 401-421). Oxford, UK: Elsevier, Oxford. ISBN 0-08-043360-X.

Berkum, E.C. van., & Mede, P.H.J. van der.(1999). Driver information and the (de)formation of habit in route choice. *Behavioral and network impacts of driver information systems*, Emmerink, R. & P. Nijkamp eds. (pp. 155-180). Aldershot, UK: Ashgate publ. ISBN 1-84014-506-4.

Berkum, E.C. van., Speulman, M., Vlist, M.S. van der., & Schouten, W.(1999). The impact of different information strategies on variable message signs. Travel behavior research, H. Mahmassani ed. Elsevier science ltd.

Sambali, G., Zuidgeest, M.H.P., & Langen, M. de.(1999). Determinants of cycling in medium large cities in Sub-Saharan Africa. In: Proceedings of the 8th world conference on transport research. Volume IV: transport policy. Meersman, H. et al (eds.) (pp. 419-430). Elsevier. ISBN 0-08-043590-4.

Witbreuk, M.J.G., & Guihéry, L.(1999). Fiscal federalism and regionalisation of transport policy in Europe. In: Proceedings of the 8th world conference on transport research. Volume IV: transport policy. Meersman, H. et al (eds.) (pp. 445-458). Elsevier. ISBN 0-08-043590-4.

Conference proceedings

Jong, L. de.(1995, November 01). Metaplan-methods in engineering., [Active and Productive Learning in Higher Engineering Education (SEFI-Seminar, 1-3 november)].(pp. 421-425). Enschede. ISBN 90-365-0779-0.

Kraan, M.E.(1995). A time allocation model analysed and discussed., [Colloquium Vervoersplanologisch Speurwerk. Deel 3. Meurs, H.J. & E.J. Verroen (eds.)].(pp. 765-786). Delft, CVS.

Maarseveen, M.F.A.M. van.(1995). Parkeeronderzoek en -beleid in regionaal perspectief. De Case Twente., [Verkeerskundige werkdagen 1995 (Uitgever C.R.O.W.)].(pp. 207-214). Ede. ISBN 90-6628-192-8.

Witbreuk, M.J.G.(1995). Collectieve actie en regionaal verkeers- en vervoersbeleid., [Colloquium Vervoersplanologisch Speurwerk 1995, In: Meurs H.J. & E.J. Verroen (eds.), 23-24 november].(pp. 301-322). Delft.

Witbreuk, M.J.G.(1995). Collective action and regional transport policy., [5th Common Property Conference Reinventing the Commons, 24-28 May].(pp. 1-21). Bodo, Norway.

Witbreuk, M.J.G., Maarseveen, M.F.A.M. van., & Veen, A. van der.(1995, May 25). Das Staettedreieck und die Verkehrsinfrastruktur., [In: ECOMOVE Congress 'Land Use, Lifestyle and Transport'. M. Jerichow (ed.)].(pp. 348-357). Kassel, Germany. ISBN 3-88122-809-8.

Huerne, H.L. ter., & Maarseveen, M.F.A.M. van.(1996). Het spanningsveld tussen uitvoeringsomstandigheden en kwaliteit., [Wegbouwkundige Werkdagen 1996].(pp. 1299-1312). ISBN 90-6628-221-5.

Kraan, M.E., & Maarseveen, M.F.A.M. van.(1996). Grenzen aan de mobiliteitsgroei: de beperkende invloed van tijd., [Colloquium Vervoersplanologisch Speurwerk - Beheersbare mobiliteit: een utopie?, C.V.S., deel 2, Mouwen, A.M.T., N. Kalfs & B. Govers (eds.)].(pp. 695-716). Delft.

Voort, M.C. van der., Dougherty, M.S., & Watson, S.(1996). The KARIMA method - Combining Kohonen maps with arima time series model to forecast traffic flow., [Neural Network Applications in Highway and Vehicle Engineering, 10-11 April].(pp. 165-174). Ashburn, Virginia, USA.

Witbreuk, M.J.G.(1996). De regio: bekering of vervoering?., [Colloquium Vervoersplanologisch Speurwerk - Beheersbare mobiliteit: een utopie?, C.V.S., deel 3, Mouwen, A.M.T., N. Kalfs & B. Govers (eds.)].(pp. 1157-1176). Delft.

Witbreuk, M.J.G.(1996). Regional cooperation in the management of transport-systems., [Sixth Common Property Conference, 5-9 June].(pp. 1-16). Berkeley, California, USA.

Kok, J.L. de., Wind, H.G., Coffa, A., Densen, W.L.T. van., & Pet-Soede, L.(1997, August 19). Fuzzy logic as a method for the application of qualitative concepts in a quantitative system framework., [Systems Approach to Learning and Education into the 21st Century: Proceedings of the 15th International System Dynamics Conference. 19-22 augustus. Volume I. Barlas, Y., V.G. Diker & S. Polat (eds.)].(pp. 161-165). Istanbul Turkey. ISBN 975-518-099-0/100-8.

Kraan, M.E., & Maarseveen, M.F.A.M. van.(1997). An individual based model for the allocation of time and money., [In: Preprints 8th Meeting of the International Association for Travel Behaviour Research]. 19 pp. Austin, Texas, september 21-25.

Voort, M.C. van der., & Hogema, J.H.(1997). Een beoordeling van de effecten van mistsignaleringsystemen., [Verkeerskundige Werkdagen 1997, Deel II (uitgever C.R.O.W.), 3 en 4 juni].(pp. 445-460). Ede. ISBN 90-6628-248-7.

Witbreuk, M.J.G., & Maarseveen, M.F.A.M. van.(1997). Ontwerpcriteria voor samenwerking. [Verkeerskundige Werkdagen 1997, Deel I (Uitgever C.R.O.W.)].(pp. 123-132). Ede. ISBN 90-6628-248-7.

Witbreuk, M.J.G., Maarseveen, M.F.A.M. van., & Veen, A. van der.(1997, November 27). Zijn regionale verkeersnetwerktragedies te voorkomen?., [Colloquium Vervoersplanologisch Speurwerk 1997. Sprong in het Duister? Lange termijn ontwikkelingen in het vervoersplanologisch onderzoek, deel 2. B. Egter & N. Kalfs (eds.) 27-28 november 1997].(pp. 967-984). Amsterdam.

Huerne, H.L. ter., & Maarseveen, M.F.A.M. van.(1998, May 01). De invloed van walsparameters op het verdichtingsresultaat van asfalt., [Wegbouwkundige werkdagen 1998 (deel II)].(pp. 105-117). Ede. ISBN 90-6628-276-2.

Huisken, G., & Maarseveen, M.F.A.M. van.(1998, November 12). Congestievoorspelling gebaseerd op neurale netwerken: een krachtig hulpmiddel voor sturing van verkeersstromen., [Colloquium vervoersplanologisch speurwerk (CVS) 1998: "Sturen met structuren" 12 en 13 november, Deel 4].(pp. 1793-1812). Delft.

Witbreuk, M.J.G., & Halsema, J.G.M.(1998, November 12). Parkeren goed reguleren?! - een onderzoek naar de tevredenheid van belanghebbenden., [Colloquium vervoersplanologisch speurwerk (CVS) 1998: "Sturen met structuren" 12 en 13 november, Deel 1].(pp. 349-366). Delft.

Dougherty, M.S., & Voort, M.C. van der.(1999, August 02). An automata theory for autos., [Proceedings of the 11th Mini-Euro Conference on Artificial Intelligence in Transportation Systems and Science, and the 7th Euro-Working Group Meeting on Transportation. August 2-6 Helsinki University of Technology].(pp. 39-1-39-6). Espoo, Finland. ISBN 951-22-4589-2, ISSN 0781-5816.

Maarseveen, M.F.A.M. van.(1999, July 19). A comparative analysis of railway safety between Great Britain and the Netherlands., [Proceedings of South African transport conference 2c: Freight traffic. 2. 19-22 juli, CSIR]. 10 pp. Pretoria, South Africa. ISBN 0-620-24466-6.

Maarseveen, M.F.A.M. van., & Voort, M.C. van der.(1999, July 19). An intelligent in-vehicle support tool for car fuel efficiency., [Proceedings of the South African transport conference 3b: Traffic management and safety. 4. 19-22 juli, CSIR]. 10 pp. Pretoria, South Africa. ISBN 0-620-24468-2.

Voort, M.C. van der., & Maarseveen, M.F.A.M. van.(1999). Design and evaluation of a new generation fuel efficiency support tool., [ITS: Smarter, smoother, safer, sooner. Proceedings on CD-rom of the 6th world congress on intelligent transport systems, 8-12 november 1999]. Toronto, Canada.

Voort, M.C. van der., & Dougherty, M.S.(1999, September 28). Reducing fuel consumption by using a new fuel-efficiency support tool., [1999 IEEE Africon. 5th AFRICON conference in Afrika, Volume 1. 28-9/1-10, Cape Technikon].(pp. 27-32). Cape Town, South Africa. ISBN 0-7803-5546-6.

Witbreuk, M.J.G., & Maarseveen, M.F.A.M. van.(1999, November 18). Bekostiging van het openbaar vervoer: een onderzoek naar de financiële en verkeerskundige effecten in kwalitatieve zin van een aantal maatregelen., [Colloquium vervoersplanologisch spuurwerk (CVS), Colloquium vervoersplanologisch spuurwerk 1999: Nederland is af! 18 en 19 november. Deel 3].(pp. 1335-1352). Delft.

15B Professional publications

Dutch

Craen, A.A.W.G. de.(1996). Aanpassingsinrichting: op efficiënte wijze een gebied netjes achterlaten. Compensatiemaatregelen bij grote infrastructurele projecten. *Wegen*, 1969 (nr: 8), (pp. 18-25). ISSN 0043-2067.

Huerne, H.L. ter.(1997). Asfalteren bij duisternis en regen leidt tot minder goed wegdek. *Wegen*, (nr: 4), (pp. 16-19). ISSN 0043-2067.

Leeuw, A.M. de., Tutert, S.I.A., & Willems, G.(1999). Rekenen aan rotondes. *Verkeerskunde*, (pp. 20-22). ISSN 0377-8495.

Witbreuk, M.J.G.(1999). Belanghebbendenparkeren goed gereguleerd?! Een onderzoek naar de tevredenheid van belanghebbenden in Enschede. *Vexpansie*, 13 (nr: 1), (pp. 5-10). ISSN 0921-5476.

Maarseveen, M.F.A.M. van.(1999). Zonder Twentestad maken Enschede en Hengelo geen kwaliteitssprong. *Twentestad - Elf meningen die ertoe doen* (pp. 34-37). Enschede: Gemeente Enschede. ISBN 90-805-174-1-0.

15C Scientific reports

Voort, M.C. van der.(1996). Toepassingen van neurale netwerken in de verkeer- en vervoersector. (Civil Engineering & Management research report). Enschede: University of Twente, 192 pp.

Scheper, W.E.(1997). De gevolgen van de openstelling van station Drienerlo. (Extern Rapport met bijlagen). Enschede: Universiteit Twente, 36 pp.*

Scheper, W.E.(1997). Reizen via Drienerlo. Vooronderzoek naar het mogelijk gebruik van station Drienerlo (Extern Rapport met bijlagen). Enschede: Universiteit Twente, 21 pp.*

Voort, M.C. van der.(1997). A new generation fuel efficiency support tool: motivation, state-of-the-art and salient features. (CTS Working paper, 1997:9). Borlange, Sweden: CTS, 79 pp.

Heuvel, N. van den., & Dragt, A.J.(1998). Visa versa - Een voorstel voor een attractie verkeer en vervoer in maquettevorm in Hengelo: Haalbaarheidsonderzoek. (Rapport in opdracht van de dienst stadsontwikkeling en beheer en de dienst sociale zaken van de gemeente Hengelo. V&V i.s.m. DHV oost Nederland.). Hengelo: UT/DHV-oost nederland, 29 pp.*

Maarseveen, M.F.A.M. van., & Witbreuk, M.J.G.(1998). Twente in 2030: een visie voor het verkeers- en vervoersbeleid. (University of Twente. research report 98R-009/V&V-002. Rapport in opdracht van de Regio Twente). Enschede: Universiteit Twente, 66 pp. ISBN 90-365-1265-5.*

Witbreuk, M.J.G., & Halsema, J.G.M.(1998). Parkeerreguleringen geëvalueerd: Opinie van belanghebbenden over parkeerregelingen binnen de gemeente Enschede. (University of Twente. Civil Engineering & Management research report 98R-007/V&V-001). Enschede: Universiteit Twente, 63 pp.*

Berkum, E.C. van., & Hamerslag, R.(1999). Floating car data. Gebruik, penetratie en map matching. (Rapport voor Rijkswaterstaat, Adviesdienst voor Verkeer en Vervoer, Rotterdam)*

Sinnema, H.H., Witbreuk, M.J.G., & Berkum, E.C. van.(1999). Sabimos zet het licht op groen: groen licht voor Sabimos. Evaluatie Sabimos. (Civil Engineering & Management research report 99R-019 / V&V-010). Enschede: University of Twente, 45 pp.*

Witbreuk, M.J.G., & Maarseveen, M.F.A.M. van.(1999). Bekostiging van het openbaar vervoer. Een onderzoek naar de financiële en verkeerskundige effecten in kwalitatieve zin van een aantal maatregelen. (Civil Engineering & Management Research report 99R-009/V&V-006). Enschede: University of Twente, 63 pp. ISBN 90-365-1332-4.*

Voort, M.C. van der., & Hogema, J.H.(1999). Analysis of the impact of fuel efficient driver behaviour on driving characteristics. (TNO-rapport TM-99-C013). Soesterberg: TNO Human Factors Research Institute, 41 pp.

* External reports registered under the category of professional publications

15d Forthcoming publications (accepted)

Academic publications

Journal articles

Refereed, International

Akinyemi, E., & Zuidgeest, M.H.P.(2000). Sustainable development & transportation: past experiences and future challenges. *World transport policy and practice*, 6 (nr: 1), (pp. 31-39). ISSN 1352-7614.

Voort, M.C. van der., Dougherty, M.S., & Maarseveen, M.F.A.M. van. A new generation fuel-efficiency support tool. *Transportation research Part C*, ISSN 0968-090X.

Conference proceedings

Berkum, E.C. van., & Wismans, L. Network impact of locally optimized DTM measures., [Proceedings of the IFAC Conference on Technology Transfer in Developing Countries - Automation in Infrastructure Creation, 5-7 July 2000]. Pretoria, South Africa.

Berkum, E.C. van., & Wismans, L. Towards network optimization using traffic management measures., [Improving knowledge and tools for transportation and logistics development. Proceedings 8th EWGT Meeting Rome Jubilee 2000 conference, 11-14 September 2000]. Rome, Italy.

Hamideh, A.R., Sinha, K.C., Howe, J.D., & Zuidgeest, M.H.P.(2000). Transportation planning under uncertainty: The case of Metropolitan Jerusalem. [Urban Transportation and Environment. Proceedings of CODATU IX, Mexico, Oscar Díaz, González Palomas & Christian Jamet (eds.)] (pp. 109-114). Rotterdam: Balkema. ISBN 90-5809-128-7.

Hop, G., Koster, J.H., & Jong, L. de.(2000). A busway on Jogoo road, Nairobi., [Urban Transportation and Environment. Proceedings of CODATU IX, World congress of Urban Transportation, April 11-14, Oscar Díaz, González Palomas & Christian Jamet, eds.].(pp. 315-322). Mexico city, Mexico. ISBN 90 5809 128 7.

Huisken, G., & Coffa, A. Neural networks and fuzzy logic to improve trip generation modelling., [Proceedings of the 9th International Association for Travel Behaviour Research Conference, 2-7 July 2000]. Gold Coast, Australia.

Huerne, H.L. ter., Maarseveen, M.F.A.M. van., & Molenaar, A.A.A.(2000). Design and evaluation of a simulation tool for the compaction process of asphalt pavements., [Transportation Research Board, 79th Annual Meeting, 9-13 January 2000, On CD-rom]. Washington DC, USA.

Huerne, H.L. ter., & Maarseveen, M.F.A.M. van. Simulatie van de verdichting van asfalt op basis van de Critical State Theory., [Proceedings Wegbouwkundige Werkdagen 2000, CROW, 8-9 June 2000]. Ede.

Huisken, G., & Maarseveen, M.F.A.M. van. Congestion prediction on motorways: A comparative analysis., [Proceedings of the 7th World Congress on Intelligent Transportation Systems, 6-9 November 2000]. Torino, Italy.

Huisken, G., & Berkum, E.C. van. DAB in the Netherlands., [Improving knowledge and tools for transportation and logistics development. Proceedings 8th EWGT Meeting Rome Jubilee 2000 Conference, 11-14 September 2000]. Rome, Italy.

Huisken, G., & Coffa, A.(2000). Short term congestion prediction: comparing time series with neural networks., [Proceedings of the 10th International Conference on Road Transport Information and Control, IEE conference publication 472, 4-6 April 2000].(pp. 60-63). London, UK. ISBN 0-85296-725-X, ISSN 0537-9989.

Huisken, G. Short-term congestion forecasting: time series versus fuzzy sets., [Proceedings of the South African Transportation Conference, 17-20 July 2000]. Pretoria, South Africa.

Huisken, G., & Voogd, G.(2000, February 10). DAB binnen DVM: mogelijkheden en knelpunten. [Proceedings Verkeerskundige Werkdagen 2000, CROW Deel 2].(pp. 33-42). Ede. ISBN 90-662-8311-4.

Jong, L. de. Intermediate technology bridge design by means of automationized computer calculations., [Proceedings of the IFAC Conference on Technology Transfer in Developing Countries - Automation in Infrastructure Creation 5-7 July 2000]. Pretoria, South Africa.

Koster, J.H., & Hop, G.(2000). Formal and informal public transport performance assessment. Niarobi case study., [Urban transportation and Environment. Proceedings of CODATU IX, World Congress of Urban Transportation, april 11-14, Oscar Díaz, González Palomas & Christian Jamet, eds.](pp. 307-314). Mexico city, Mexico. ISBN 90 5809 128 7.

Maarseveen, M.F.A.M. van., & Zuidgeest, M.H.P. A transportation modelling approach to sustainable development., [Improving knowledge and tools for transportation and logistics development. Proceedings 8th EWGT Meeting Rome Jubilee 2000 conference, 11-14 September 2000]. Rome, Italy.

Voort, M.C. van der., Tillema, F. & Maarseveen, M.F.A.M. van. Design and assessment of the impact of an in-car fuel efficiency support tool., [Proceedings of the IFAC Conference on Technology Transfer in Developing Countries - Automation in Infrastructure Creation 5-7 July 2000]. Pretoria, South Africa.

Wismans, L.(2000, February 10). Optimaliseren verkeersafwikkeling op netwerkniveau. [Proceedings Verkeerskundige Werkdagen 2000, CROW Deel 2].(pp. 75-86). Ede. ISBN 90-662-8311-4.

Witbreuk, M.J.G.(2000, February 09). SABIMOS: een betere doorstroming binnen handbereik?. [Proceedings Verkeerskundige Werkdagen 2000, CROW Deel I].(pp. 247-256). Ede. ISBN 90-6628-311-4.

Witbreuk, M.J.G.(2000, January 09). The management of regional transport networks: The effectiveness of regional cooperation., [Transportation Research Board, 79th Annual Meeting, 9-13 January 2000. On CD-rom]. 25 pp. Washington DC, USA.

Zuidgeest, M.H.P., & Akinyemi, E.(2000, February 09). Duurzame ontwikkeling & transport: aanzet tot een hernieuwde discussie. [Proceedings Verkeerskundige Werkdagen 2000, CROW deel I].(pp. 169-176). Ede. ISBN 90-6628-311-4.

Zuidgeest, M.H.P., & Maarseveen, M.F.A.M. van. Transportation planning for sustainable development., [Proceedings of the South African Transportation Conference, 17-20 July 2000]. Pretoria, South Africa.

Zuidgeest, M.H.P., Witbreuk, M.J.G., & Maarseveen, M.F.A.M. van. Sustainable transport: a review from a pragmatic perspective., [Proceedings of the South African Transportation Conference 2000, 17-20 July 2000]. Pretoria, South Africa.

Professional publications

Witbreuk, M.G.J. (2000), Kwaliteit van straatparkeren. Vexpansie, 14 (1). Maart 2000, pp. 13-14. ISSN:0921-5476

1 Water Resources Management

3 Programme members

- prof. dr ir H.G. Wind, professor (programme leader)

- dr ir D.C.M. Augustijn assistant professor
- ir. G.D. Geldof assistant professor (part-time) (1999-....)
- dr J.L. de Kok, assistant professor
- dr ir M. Kok, assistant professor (part-time) (....-1997)
- prof. dr ir C.B. Vreugdenhil, professor (1996-...)

4 Key words

Decision Support Systems
Integrated Water Management
Interdisciplinary interaction
Spatial and temporal resolution
Error propagation
Flooding and flood damage
River ecology
Complexity, chaos and attractors

5 Research input of academic staff

fte		1995	1996	1997	1998	1999	total
wp1	aio	2.0	2.0	0.6	1.2	1.2	7.0
	other	0.2	0.6	1.6	1.9	2.1	6.4
wp2	oio	0	0	0	0	0	0
	other	1.0	1.0	1.0	0.5	0	3.5
wp3	aio	2.1	1.4	1.5	0.9	1.4	7.3
	other	0	0	0	0	0	0
total		5.3	5.0	4.7	4.5	4.7	24.2

6 Research output

				1995	1996	1997	1998	1999	total	forth.
Ph.D. theses				1	0	2	0	0	3	
academic publications	journal articles	refereed	international	1	4	1	2	2	10	2
			Dutch	0	0	0	0	0	0	
		non refereed	international	0	0	0	0	0	0	
			Dutch	0	0	0	0	0	0	
	other acad. publications: books, chapters		international	2	2	4	2	1	11	
			Dutch	0	0	0	0	0	0	
conference proceedings			0	3	3	5	8	19	4	
professional publications		international	0	1	0	0	0	1		
		Dutch	0	1	1	1	3	6	1	
scientific reports			5	1	3	6	3	18		

7 Composition of research input academic staff 1999

<i>fte</i>	wp1	wp2	wp3	total
professor	0.8	0	0	0.8
associate professor (uhd)	0	0	0	0
other senior staff (ud)	1.3	0	0	1.3
postdoctoral fellows	0	0	0	0
junior staff (aio,oio,moz)	1.2	0	1.4	2.6
other junior staff	0	0	0	0
total	3.3	0	1.4	4.7

8 Programme design in brief

8.1 Mission

The mission of the Water Resources Group is to improve the allocation and use of water taking into account interests from the points of view of social needs, economy, ecology, natural values, and institutional settings, in short: integrated water resources management. This is pursued by studying natural phenomena, and management approaches with the aim of supporting decision-making. The scope of research ranges from the problem formulation in water resources management to identification of management options and the evaluation of impacts of a selected set of measures. Strong emphasis is placed on the multi-disciplinary aspects.

8.2 Research programme

The problem domain

The last decades show a growing interest of both policy makers and researchers in the interaction between socio-economic, ecological, and geophysical processes in water resources. The Water Resources group therefore studies these aspects with emphasis on their interrelations. Most of the work is in the domain of strategic planning on a large scale (e.g. an entire river catchment area on a time scale of decades). The main application field is river management but related topics for wetlands or coastal zones are also studied. Points of interest range from environmental planning and the regional effects of climate change to analyzing options for river managers in reconciling possible conflicting objectives. The decision-maker often is interested in the overall effects and the corresponding uncertainties (see Figure 1). A significant part of the research is aimed at developing integrated models for decision support.

Objectives

The overall objectives of the research are:

1. to improve methods for *integrated* water management
2. to improve the dissemination of this knowledge to the water management community
3. to improve the scientific education in the field of integrated water management
4. to support and strengthen new conceptual developments in the field.

The resulting knowledge, working methods, control strategies and (prototype) computer tools are, whenever possible, evaluated for practical applications. The overall outcome

should be improved methods for the analysis of impacts in integrated water systems, based on new techniques, computer support tools and working practice.

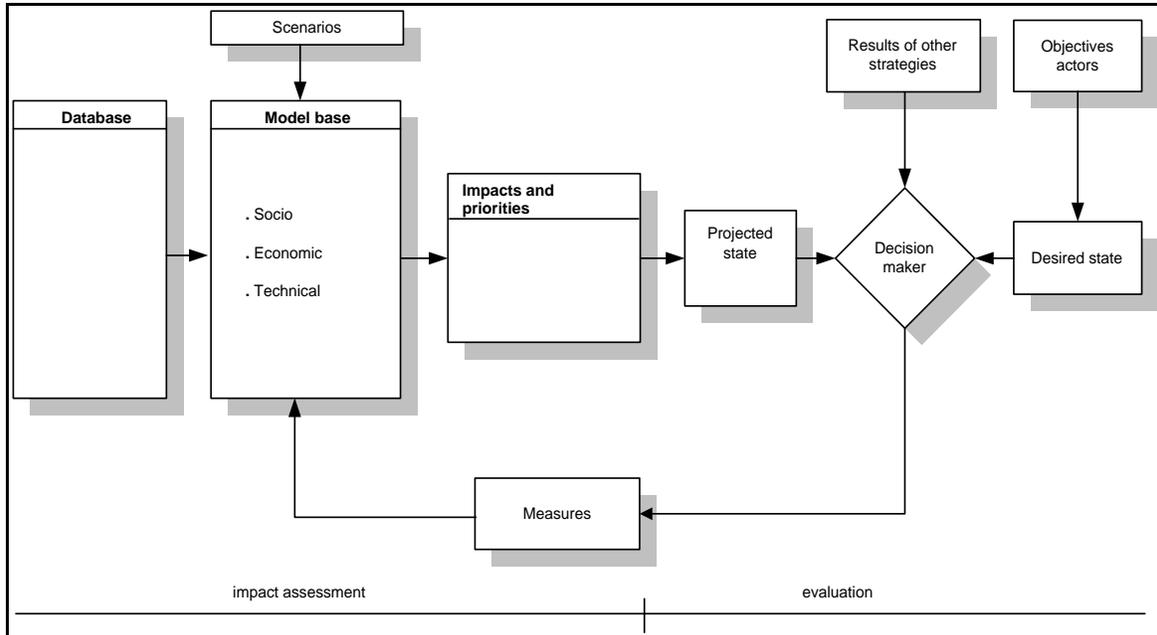


Figure 1: schematic representation of a water management system model

Approach

The unique property of *integrated* water management is that processes and tools are described in some aggregated way. Consequently, a thorough analysis is needed to arrive at *consistent* and *appropriate* problem definitions, (i) in which there is a balance in detail and reliability of various subsystems and (ii) which are at the right level of detail for answering the questions at hand. This means that the following aspects are of importance:

- How good are models of physical, ecological, economic (etc.) processes at various levels of detail? The answer depends on the aspect considered. Example: how much accuracy is gained in describing flooding by advancing from a 1D to a 2D or 3D model of flood waves in rivers?
- What is the importance of each process in an integrated system (again depending on the aspect considered)? Example: How important are the development with time and the duration of an inundation in case of river flooding to estimate total flood damage?
- How do uncertainties propagate? Example: how accurately can total damage of a flood be estimated if there is a basic uncertainty in damage to individual houses?

- What is the level of accuracy needed to distinguish between various management options? Example: How accurately should total damage be known to distinguish between building levees or relocating inhabitants away from threatened regions?

The research programme

The research deals with physical processes and modelling and generation of methodologies for water resources management, represented in computer tools. Some important topics derived from the approach described above are:

- process of consistent problem formulation for integrated models of river basins or wetlands areas
- system design consistent with the type of questions to be solved by the decision maker
- selection of the appropriate time and space scales, e.g. in hydrologic modelling, flood damage evaluation
- disciplinary integration of subsystems into balanced integrated models
- development of simulation methods
- communication of results to the decision maker

8.3 The significance for education

Significant parts of the courses related to physical processes, water management and decision making contain both a theoretical part and practical applications, based on the research results. Research contributions have been included in the following courses:

- water resources planning (hydrology, water supply, water use and water distribution) (W1)
- water management (water infrastructure, decision making, conceptual design of system models) (W3)
- environmental management (environmental problems and management options in water systems) (W4)
- decision making under uncertainty (risk analysis, simulation, decision making) (W6)

Part of the material is also included Post Academic courses.

9 Overview of academic results

Process of problem formulation

The process of problem formulation identifies the difference between the present state and the required state and a formulation of means to get there. This classical approach of

problem formulation is the basis of an approach for designing information systems. In the Ph.D. thesis of Nieuwkamer this concept has been elaborated theoretically for single or multiple actors in river management. Verbeek showed that some of the means and objectives in water management tend to change with time in the design phase. This is related to the acceptance level of means and objectives (support) and on the other hand the clarity of impacts (consistency). This yields a classification system for projects for which information systems can be developed successfully and projects for which this will not be the case. Jasperse analysed the causes of time delays in the design and execution of 50 river restoration projects. The most important delay was in acquiring the necessary strips of land. Information systems are of little help for this type of problems. Van Hijum studies the way public water management is financed within its institutional context. The main research question is how institutional design (fiscal decentralization) affects the legitimacy of charging for water management and water services.

System design and selection of the appropriate time and space scales

An information system for water management should produce the required output with a certain accuracy related to the decision or control space. Furthermore it is required that the system is internally consistent, meaning that the contribution to the output uncertainty of each of the sub-models, the measures and the data is similar. This requirement provides a norm for the selection of data, sub-models and scenarios.

De Blois analysed an existing transport model for contaminants in the Rhine and found that internal consistency is not obvious. He designed an internally consistent model for flood damage in the Meuse River. Attention in this ongoing project is focussed on the selection of appropriate time- and space scales, given accurate GIS data and less accurate water level and flood damage prediction.

In all river management problems, uncertainty in inflow of water is essential. Booij works on an analysis of the accuracy and time- and space scales needed to represent impacts of climate change in discharges of the Meuse River, starting from GCM (general circulation model) results which have only a limited reliability.

In a recently started study of the Red River Delta, Vietnam, Phan studies the level of detail of models for tidal flow, salinity and nutrient transport and sedimentation in one of the Red River estuaries, with a view on long-term effects such as precipitation changes, sea level rise, dam construction, irrigation practice.

Disciplinary integration

Dynamic interaction between processes is one of the particular features of integrated water management. A system in which a number of disciplines (concepts) are integrated, should represent the observed overall behavior as well as characterize the evolution of each of the

disciplinary subsystems. A project by a number of universities for integrated coastal zone management in Sulawesi was constructed in which the role of WRM was to formulate the integration between the disciplinary concepts. This resulted in a demonstration decision support system and a number of papers combining fisheries, corals, economy and cultural anthropology, using techniques like fuzzy logic, fuzzy cognitive maps and a scenario approach. The study of the dynamic interaction between disciplines is also one of the topics in a project on the Wadden Sea region in The Netherlands, carried out in co-operation with the University of Maastricht, the University of Utrecht and the Department of the Environment.

Communication of results to the end-user

In Decision Support Systems, attention is paid to three aspects of communication of the results to the end-user:

- A: consistent approach of measures, objectives and scenarios.
- B: representation of the structure of the system
- C: presentation of spatial and temporal data

In both the Sulawesi and Wadden Sea models, these aspects have been demonstrated.

10 Programme development

As the programme is far from completed, it will be continued in the near future. A number of actions are already under way, directed towards integrated water management. Our choice is not to concentrate primarily on technical actions for alleviation of water problems, but to study the management aspect of water resources, i.e. the process leading to decisions involved in handling water problems. In a sense this is methodological research, but it is conducted on the basis of actual water resources problems, such that the special type of problems occurring in this field is taken into account. This includes technical, physical, ecological and economic interactions with the objective to clarify management options to decision makers in water resources. The following topics are included.

Process of problem formulation

The problem formulation in a water resources project often has to deal with various uncertainties. To formulate these uncertainties, the following questions arise:

- What is the information demand in the design phase of a water resources project? How can the management objectives be characterized (e.g. by expected utility) and how large

is the decision space in which managers can operate?

- How does the information demand change in time? How can a decision support system take these changes into account?
- How does the perception of the complex system in which water resources management takes place influence the formulation of objectives?

Actions already taken:

- A project to analyse decision space for a water resources project has been submitted to the Delft Cluster.
- Analysis of information demand will be incorporated in new projects on the Elbe River, financed externally by the German Government.
- In a research project together with TAUW Consultants, the process of problem formulation in water management is being studied in terms of adaptive complex systems.
- A research project is being prepared on establishing the relative importance of criteria such as hydraulic conditions (flooding frequency), ecologic requirements (suitability for certain types of nature development) and environmental (pollution) aspects for management of river flood plains.

Systems design and the selection of appropriate time and space scales

The problem formulation usually gives rise to the development of a model, simulation or decision support system. For heterogenic systems (i.e. systems involving technical, economic, social, institutional aspects), the level of detail for various components should be determined. The components are generally connected in a feedback system and therefore cannot be considered separately. A consistent way of model development is needed in which the components are:

- sufficiently detailed to represent essential links and feedbacks in the system
- no more detailed or accurate than is warranted by uncertainties in data and objectives

Actions already taken:

- A project on the selection of the appropriate time and space scales, given the uncertainty in data and processes. A subject of application is flood damage.
- A project on the relation between the choice of system limits and management objectives, e.g. for the Wadden Sea region.
- Uncertainty in the observations related to the uncertainty in management variables will be studied in a project “sustainable development of natural resources”.
- The spatial resolution for the analysis of the impacts of changes in land use on agricultural production and water quality is one of the topics in a Ph.D. project on river basin management in Sumatra.

- The modelling requirements for supporting management of the Meuse river will be studied considering flood prevention, nature preservation and navigation as the major (conflicting) objectives.

Disciplinary integration

The integration between disciplines is an essential part of most projects mentioned above. It is studied in that context and not as a separate item.

Communication of the results to the end-user

In the information systems developed by WRM in co-operation with other universities, attention is paid to the user friendliness: impacts of measures is represented spatially as well as in graphs and tables. It is not our purpose to develop new graphical presentation techniques, but to find ways to present information to decision makers using available tools. Two lines that will be followed somewhat further are “making the end-user more aware of the increasing uncertainty of the results with increasing time horizon” and “the use of information systems in gaming”.

Operational management

Apart from strategic water management on large scale in space and time, the field of application will be extended to operational management as this often is an important aspect of the overall performance of water systems. The type of questions is:

- Which (existing) optimization techniques are most suitable for multi-objective systems with stochastic input?
- How can uncertainties be taken into account?
- How can the planning horizon be extended by using advanced prediction techniques for precipitation and flood propagation?

Actions already taken:

- A cooperation project with the University of Yichang (China) on multipurpose storage reservoirs in rivers will be started soon with financial support from KNAW.
- A project on reservoir management in the Yellow River (China) is being discussed with the river manager.
- Several student projects have already been done on sizing and operational management of flood retention basins, which may be continued.

11.1 Societal/technological relevance

The emphasis on better methods for allocation and use of water implies a direct societal relevance. The technological relevance is that the design of the systems used for predictive modelling in water management needs to be brought to a more scientific level.

11.2 Local, national and international co-operation

To bridge the gap between science and decision making in water resources management, co-operation is initiated and stimulated with the Departments of Public Administration and Business Administration. This has resulted in joint Ph.D. theses and the exchange of students.

At a national level, the water management group from the Province of Overijssel and WRM have investigated the main problems in using scientific information in water resources management. The Province provided the funds for two Ph.D. theses and has suggested to extend the co-operation with another Ph.D. student. Rijkswaterstaat, directorate Limburg has formulated and financed a research programme for the Management of the river Meuse in which presently two Ph.D. students are working. Furthermore WRM has participated in the Netherlands School for Advanced Studies in Hydraulic and Geotechnical Engineering and the Land Water Impulse Programme. Also, we participate (together with the Integrated Modelling Department) in the Netherlands Centre for River Studies, which involves all major Dutch institutes in this field and which aims at enhancing common research.

International co-operation has been effectuated in various WOTRO programmes: sustainable development of the coastal zone of Sulawesi (Hassanudin University in Ujung Pandang, Indonesia) and Impacts of long-term changes on the Red River Delta (Vietnam National University, Hanoi).

A feasibility study for development of a knowledge system for management of the Elbe basin is performed with the Bundesanstalt für Gewässerkunde (Koblenz), based on the results of an extensive German Research Programme carried out by 28 German Universities and Institutions. Initiated by Chinese interest in the research results of WRM, the options of research collaboration for the Yellow River and the Yang Tse River are being explored.

12 Other indications of quality and reputation

Prof. dr ir H.G. Wind

referee:	ASCE Journal of Water Resources Planning and Management WOTRO
international projects:	EUROflood WOTRO Sulawesi
national projects:	DSS Waddensea; Land Water Impuls programme and Rijkswaterstaat Directie Noord DSS for River management; Delft Hydraulics Integrated Water management between uncontrolled interruption and uninterrupted control; Province of Overijssel Precious water; consortium of waterboards, provinces and Rijkswaterstaat Interests of Water boards; consortium of Frisian farmers Integrated management of the river Meuse; Rijkswaterstaat Directie Limburg.

Prof. dr ir C.B. Vreugdenhil

referee:	Journal of Hydraulic Research Journal of Hydraulic Engineering
projects:	WOTRO Red River Delta KNAW Operational management of Chinese Rivers
national co-operation:	Member of Supervisory Board of Netherlands Centre for River Studies (NCR)

13 Key Publications

Geldof, G.D. (1999, August 30). Complexity: the end of determinism? (Proceedings of the 8th International conference on Urban Storm Drainage. Proceedings, Volume II. Ian B. Joliffe & James E. Ball eds. 30-8/

Nieuwkamer, Dr.ir. R.L.J. (1995, February 24). Decision support for river management. Universiteit Twente, 232 pp. Promotor(en): Prof. dr ir H.G. Wind. ISBN 90-9008008-2.

Verbeek, Dr.ing. M. (1997, November 13). Integraal Waterbeheer tussen ongestoorde sturing & ongestuurde storing. Universiteit Twente, 231 pp. Promotor(en): Prof. dr ir H.G. Wind. ISBN 90-365-1039-2

Wind, H.G., Kok, J-L de (1997). Rapid assessment model for coastal-zone management. Bordomer 97. Aménagement et protection de l'environnement littoral. Tome 2. Actes du colloque. IFREMER. 28-29 Octobre Bordeaux, France (pp 410-415).

Wind, H.G., Nierop, T.M., Blois, C.J. de & Kok, J.L. de (1999). Analysis of flood damages from the 1993 and 1995 Meuse floods. Water Resources Research, 35 (nr 11), (pp. 3459-3465). ISSN 0043-1397.

14 Dissertations

Nieuwkamer, Dr.ir. R.L.J. (1995, February 24). Decision support for river management. Universiteit Twente, 232 pp. Promotor(en): Prof. dr ir H.G. Wind. ISBN 90-9008008-2.

Jasperse, Dr. P. (1997, October 24). Beekherstel in Nederland: voortmodderen met grondverwerving. Universiteit Twente, 205 pp. Promotor(en): Prof. dr ir H.G. Wind. Assistent promotor(en): Prof. mr dr H.M. de Jong. ISBN 90-651018X.

Verbeek, Dr.ing. M. (1997, November 13). Integraal Waterbeheer tussen ongestoorde sturing & ongestuurde storing. Universiteit Twente, 231 pp. Promotor(en): Prof. dr ir H.G. Wind. ISBN 90-365-1039-2.

15A Academic publications

Journal articles

Refereed, International

Wind, H.G., Pouwels, I.H.M., & Witter, J.V.(1995). Multiobjective decision-making in integrated water management. Physics and chemistry of the earth, 20 (nr: 3-4), (pp. 221-227). ISSN 0079-1946.

Blois, C.J. de., & Wind, H.G.(1996). Assessment of flood damages and benefits of remedial actions: "What are the weak links?"; with application to the Loire. *Physics and chemistry of the earth*, 20 (nr: 5-6), (pp. 491-495). ISSN 0079-1946.

Kok, J.L. de.(1996). South Sulawesi site of methodology development. *Coastal management in tropical Asia*, (nr: 6), (pp. 32-33). ISSN 1391-0019.

Verbeek, M., Post, H., Pouwels, I.H.M., & Wind, H.G.(1996). Policy Analysis for strategic choices in integrated water management. *Water science and technology*, 34 (nr: 12), (pp. 17-24). ISSN 0273-1223.

Wind, H.G., & Kok, J.L. de.(1996). Towards design of a methodology for sustainable coastal zone management in tropical countries. *Coastal management in tropical Asia*, 3 (nr: 6), (pp. 32-33). ISSN 1391-0019.

Kok, J.L. de., Arifin, T., Noor, A., Wind, H.G., & Augustinus, P.G.E.F.(1997). Systems analysis as a methodology for sustainable coastal-zone management in tropical countries. (Special Issue; also presented on International Seminar on the Sea and its Environment, 19-20 September 1995, Ujung Pandang Indonesia). *Torani. Marine science and technology bulletin*, 8 (pp. 31-41). ISSN 0853-4489.

Booij, M.J., Leijnse, A., Haldorsen, S., Heim, M., & Rueslatten, H.(1998). Sunpermafrost groundwater modelling in Ny-Alesund, Svalbard. *Nordic hydrology*, 29 (nr: 4/5), (pp. 385-396). ISSN 0029-1277.

Gijzen, M.B. van., Vreugdenhil, C.B., & Oksuzoglu, H.(1998). The finite element discretization for stream-function problems on multiply connected domains. *Journal of computational physics*, 1998 (nr: 140), (pp. 30-46). ISSN 0021-9991.

Jasperse, P., & Wind, H.G.(1999). Problem areas in stream rehabilitation projects. *European water management*, 2 (nr: 6), (pp. 40-44). ISSN 1461-6971.

Wind, H.G., Nierop, T.M., Blois, C.J. de., & Kok, J.L. de.(1999). Analysis of flood damages from the 1993 and 1995 Meuse floods. *Water resources research*, 35 (nr: 11), (pp. 3459-3465). ISSN 0043-1397.

Books and bookchapters

International

Wind, H.G., Rowsell-Penning, P., Fordham, M., Nunes Correia, F., Green, C., Hubert, G., Ketteridge, A.M., Klaus, J., Parker, D., Peerbolte, E.B., Pflugner, W., Reitano, B., Rocha,

J., Sanchez-Arcilla, A., Graca Saraiva, M. da., Schmidtke, R., Torterotot, J.P., Veen, A. van der., & Wierstra, E.(1995). Floods across Europe; Hazard assessment, modelling and management. Results from the EUROFLOOD project. London (U.K.): Middlesex University Press 214 pp. ISBN 1-898253-01-3.

Augustijn, D.C.M., & Rao, P.S.C.(1995). Enhanced removal of organic contaminants by solvent flushing. *Emerging Technologies in Hazardous Waste Management V*. Tedder, D. William & Frederick G. Pohland (eds.) (pp. 224-236). Washington, USA: American Chemical Society. ISBN 0-8412-3322-5.

Blois, C.J. de., & Wind, H.G.(1996). Technical Annex 17: Identification of uncertainty sources in flood damage assessment. In: *EUROflood II* (pp. 1-210). Enschede: Universiteit Twente. ISBN 1-85924-086-0.

Wind, H.G., Blois, C.J. de., Kok, M., & Green, C.(1996). Model integration: an analysis of best practices in Europe. *Improving Flood Hazard Management Across Europe* (pp. 4.1-4.16). Middlesex, UK: E. Penning-Rowsell, Middlesex University. ISBN 1-85924-086-0.

Augustijn, D.C.M., Lee, L.S., Jessup, R.E., Rao, P.S.C., Annable, M.D., & Wood, A.L.(1997). Remediation of soils and aquifers contaminated with hydrophobic organic chemicals: theoretical basis for the use of cosolvents. *Subsurface Restoration*, Ward, C.H., J.A. Cherry & M.R. Scalf, (eds.) (pp. 231-250). Chelsea, Michigan, USA: Ann Arbor Press, Inc. ISBN 1-57504-060-3.

Jorissen, R.E., & Kok, M.(1997). Review problem owner and engineering perspective. In: *Engineering Probabilistic Design and Maintenance for Flood Protection*. Cooke, R, M. Mendel & H. Vrijling (eds.) (pp. 109-131). Dordrecht / Boston / London: Kluwer Academic Publishers.

Noortwijk, J.M. van., Kok, M., & Cooke, R.M.(1997). Optimal decisions that reduce flood damage along the Meuse: an uncertainty analysis. *The practice of Bayesian Analysis*. French, S. & J.Q. Smith (eds.) (pp. 151-172). Dordrecht, London, Sidney, Auckland, New York, Toronto: Arnold & John Wiley & Sons, Inc.

Noortwijk, J.M. van., Kok, M., & Cooke, R.M.(1997). Optimal maintenance decisions for the Sea-Bed Protection of the Eastern-Schelde Barrier. *Engineering Probabilistic Design and Maintenance for Flood Protection*. Cooke, R., M. Mendel & H. Vrijling (eds.) (pp. 25-56). Dordrecht, Boston, London: Kluwer Academic Publishers.

Jasperse, P.(1998). Policy networks and the success of lowland stream rehabilitation projects. In: Rehabilitation of rivers; principles and implementation. L. de Waal, A.R.G. Large & P.M. Wade (eds.) (pp. 13-29). John Wiley & Sons. ISBN 0-471-95753-4.

Lee, L.S., Priddy, N.D., & Augustijn, D.C.M.(1998). Estimating mass transfer of polyaromatic hydrocarbons from coal tar-contaminated soil. In: Soil and aquifer pollution: Non-aqueous phase liquids - contamination and reclamation. N.a.v. International workshop Soil and Aquifer pollution, 13-15 mei 1996, Haifa, Israel. Rubin,H., N. Narkis & J. Carberry (eds.) (pp. 91-108). Berlin, Germany: Springer verlag. ISBN 3-540-62586-0.

Wind, H.G.(1999). Evaluating the socio-economic impacts of flooding in the Netherlands. In: Le coût du risque.. L'évaluation des impacts socio-économiques des inondations. Hubert, G & B. Ledoux (eds.) (pp. 191-199). Paris, France: Presses de l'école national des ponts et chaussées. ISBN 2-85978-321-0.

Conference proceedings

Blois, C.J. de., & Wind, H.G.(1996). Uncertainty in flood damage assessment: The use of expert opinion., [Proceedings of the 31st MAFF Conference of River and Coastal Engineers, 3-5 July].(pp. 5.3.1-5.3.14). London, UK.

Jonge, J.J. de., Kok, M., & Hogeweg, M.(1996). Modelling floods and damage assessment using GIS., [Hydro - GIS, July]. Vienna, Austria.

Kok, J.L. de., & Wind, H.G.(1996). System dynamics as a methodology for sustainable coastal-zone management., [Proceedings System Dynamics '96. Richardson, George P. & John D. Sterman (eds.), Volume 1: A-L, 21-25 July].(pp. 113-116). Cambridge, Massachusetts, USA.

Kok, J.L. de., Wind, H.G., Coffa, A., Densen, W.L.T. van., & Pet-Soede, L.(1997, August 19). Fuzzy logic as a method for the application of qualitative concepts in a quantitative system framework., [Systems Approach to Learning and Education into the 21st Century: Proceedings of the 15th International System Dynamics Conference. 19-22 augustus. Volume I. Barlas, Y., V.G. Diker & S. Polat (eds.)].(pp. 161-165). Istanbul Turkey. ISBN 975-518-099-0/100-8.

Wind, H.G., & Kok, J.L. de.(1997, October 28). Rapid assessment model for coastal-zone management., [Bordomer 97. Amenagement et protection de l'environnement littoral. Tome 2. Actes du colloque. IFREMER (28-29 Octobre)].(pp. 410-415). Bordeaux, France.

Wind, H.G., Blois, C.J. de., Kok, M., Peerbolte, E.B., & Green, C.(1997, February 13). Uncertainty in flood damage assessment: When does it matter? A European perspective., [Proceeding of the first International RIBAMOD workshop, 13-15 febr. 1997, Delft].(pp. 251-266). Delft. ISBN 92-828-2002-5, ISSN 1018-5593.

Brouwers, H.J.H., & Augustijn, D.C.M.(1998, October 14). An analytical model for complete removal of pure contaminant under nonequilibrium conditions., [Deicing and dustbinding - risk to aquifers. Proceedings of an international symposium, 14-16 october Nordic Hydrological Programme. NHP report no. 43. T. Nystén & T. Suokko eds.].(pp. 187-192). Helsinki, Finland. ISBN 952-11-0348-5, ISSN 0900-0267.

Hijum, Y.J. van.(1998, June 21). Financing public water management: dealing with economic costs of water use., [Water quality international '98. Selected proceedings of the 19th Biennial Conference of the international association on water quality. 21-26 juni 1998. Grabow, W.O.K, Dohman, M., C. Haas, E.R. Hall, A. Lesouef, D. Orhon, A. van der Vlies et al (eds.)]. 8 pp. Vancouver, Canada. ISBN 0-08-43397-9.

Kok, J.L. de., Wind, H.G., & Titus, M.(1998, August 24). Applicability of fuzzy logic to incorporate social science concepts in a decision support system for coastal zone management., [Hydroinformatics '98. Proceedings of the third international conference on hydroinformatics. Volume I, Vladan Babovic & Lars Christian Larsen, Eds. 24-28 augustus 1998].(pp. 387-393). Copenhagen, Denmark. ISBN 90-5410-984-X.

Wind, H.G., Verbeek, M., Nieuwkamer, R.L.J., Blois, C.J. de., & Kok, J.L. de.(1998, August 31). An approach to consistent and efficient system building for decision support in water management., [Advances in Hydro-Science and -Engineering, Proceedings of abstracts and papers (on CD-Rom) of the 3rd International Conference on Hydro-Science and -Engineering (ICHE) 31 aug. - 3 sept. Volume III].(pp. 294-294). Cottbus/Berlin, Germany. ISBN 0-937099-08-2.

Wind, H.G., & Blois, C.J. de.(1998, June 08). Analysis of uncertainties in the flood damages of the Meuse floods in 1993 and 1995., [33rd MAFF Conference of River and Coastal Engineers, Keele University. 1-3 juli 1998].(pp. 6.2.1-6.2.14). Keele, UK.

Booij, M.J., & Vreugdenhil, C.B.(1999, January 01). Impacts of trends and uncertainties in river flooding due to climate change., [RIBAMOD. River basin modelling, management and flood mitigation. Concerted action. Proceedings of the 2nd RIBAMOD Workshop, 26-27 februari 1998. P. Balabanis, A. Bronstert, R. Casale & P. Samuels, eds.].(pp. 297-308). Wallingford, UK. ISBN 92-828-7110-X.

Geldof, G.D.(1999, August 30). Complexity: the end of determinism?., [Proceedings of the 8th International conference on Urban Storm Drainage. Proceedings, Volume II. Joliffe, Ian B. & James E. Ball (eds.) 30-8/3-9].(pp. 817-824). Sydney, Australia. ISBN 0-858225-718-1.

Geldof, G.D.(1999, August 30). Qwerties in integrated water management., [Proceedings of the 8th International conference on Urban Storm Drainage. Proceedings, Volume II. Joliffe Ian B. & James E. Ball (eds.) 30-8/3-9].(pp. 809-816). Sydney, Australia. ISBN 0-858225-718-1.

Hijum, Y.J. van.(1999, May 01). Legitimiteit, dat kun je niet maken., [Conferentie maatschappijgeschiedenis: Maakbaar Nederland. SISWO instituut voor maatschappijwetenschappen. 28 mei 1999].(pp. 72-77). Amsterdam.

Vreugdenhil, C.B.(1999, August 08). Numerical river models, reliability and uncertainty., [Water resources into the new millenium: Past accomplishments and new challenges. Proceedings of 1999 ASCE international water resources engineering conference, 8-11 augustus 1999. On CD-rom]. 10 pp. Seattle, USA.

Vreugdenhil, C.B.(1999). Numerische modelle von flussläufen., [Mathematische modelle in der gewässerkunde. Stand und perspective. Rapport nr. 19. Beitrage zum kolloquium am 15-09-1998].(pp. 61-69). Koblenz, Berlin, Dld. ISSN 1431-2409.

Wind, H.G., Reijngoud, T.T., Engelen, G., & Keizers, N.(1999). Decision support systems for river management based on experience with WadBOSs., [River basin management - Challenge to research. Proceedings of the international conference on 8-9-june 1999. In UFZ bericht nr. 31/1999. Walter Geller ed.].(pp. 104-108). Magdeburg, Deutschland. ISSN 0948-9452.

Wind, H.G., & Lieshout, G.M.G.M. van.(1999, June 02). Wadbos: a case study for the design of interdisciplinary water systems., [The learning society and the water-environment. International symposium European thematic network of education and training ETNET/Unesco International Hydrological Programme].(pp. 298-305). Paris, France. Also in Symposium proceedings , A. van der Beken, M Ihailescu, P. Hubert & J. Bogardi, eds., (pp. 64-72), ISBN: 92-828-8308-6

15B Professional publications*International*

Kok, J.L. de., & Wind, H.G.(1996). South Sulawesi site of methodology development. Intercoast network, (pp. 15-16).

Dutch

Berger, H.E.J., Schwartz, M.J.C., & Verbeek, M.(1996). Bestrijding verdroging: een resultaatgericht proces. Waterschap, 81 (nr: 9), (pp. 298-303). ISSN 1380-4251.

Hijum, Y.J. van., & Verbeek, M.(1997). Regioprovincie Twente vergeet het waterbeheer. Waterschap, 81 (nr: 21), (pp. 699-701). ISSN 1380-4251.

Hijum, Y.J. van.(1998). Financiële verantwoordelijkheid in het waterbeheer. Waterschap, 83 (nr: 13), (pp. 517-520). ISSN 1380-4251.

Jasperse, P., & Wind, H.G.(1999). Integraal waterbeheer en grondverwerving. Waterschap, 84 (nr: 1), (pp. 6-11). ISSN 1380-4251.

Wolf, I. de., & Augustijn, D.C.M.(1999). Infiltratie hemelwater: een model en voor de praktijk relevante uitkomsten. H2O: tijdschrift voor watervoorziening en afvalwaterbehandeling, 32 (nr: 20), (pp. 31-33). ISSN 0166-8439.

Wolf, I. de.(1999). Kwaliteitsaspecten bij infiltratie van afstromend hemelwater: de wetgeving. H2O: tijdschrift voor watervoorziening en afvalwaterbehandeling, 32 (nr: 20), (pp. 29-31). ISSN 0166-8439.

15C Scientific reports

Kok, M.(1995). Decision support for assessing flood damage reduction strategies in the Netherlands. (Delft Hydraulics report 495). Emmeloord: Delft Hydraulics, 14 pp.

Kok, M., Noortwijk, J.M. van., & Cooke, R.M.(1995). Optimal decisions that reduce flood damage along the Meuse: an uncertainty analysis. (Delft Hydraulics report 491). Emmeloord: Delft Hydraulics, 24 pp.

Kok, J.L. de.(1995). Methodology for sustainable coastal-zone management with application to the coastal zone area of South-West Sulawesi. (Progress report one: Formulation of the problem and selection of relevant interactions). Enschede: University of Twente, Civil Engineering & Management research report,

Wind, H.G., Rowsell-Penning, P., Fordham, M., Nunes Correia, F., Green, C., Hubert, G., Ketteridge, A.M., Klaus, J., Parker, D., Peerbolte, E.B., Pflugner, W., Reitano, B., Rocha, J., Sanchez-Arcilla, A., Graca Saraiva, M. da., Schmidtke, R., Torterotot, J.P., Veen, A. van der., & Wierstra, E.(1995). Flood hazard assessment, modelling and management: Results from the EUROFLOOD project. London, U.K.: Flood Hazard Research Center, 38 pp.

Verbeek, M.(1995). Ontwikkeling Gebiedsgericht Waterbeleid: deelrapport III: Analyse projecten. (Extern rapport; in opdracht van provincie Overijssel/provincie Gelderland/Rijkswaterstaat, directie Oost-Nederland). Enschede: Universiteit Twente, 123 pp.

Blois, C.J. de.(1996). EMBRiO. Evaluation of methods for the assessment of flood damage and flood risk in floodplains. Phase 1 report: Final Version 3.0. Theoretical framework and evaluation of six methods. (Extern rapport, Rijkswaterstaat, Dienst Weg- en Waterbouwkunde). Enschede: Universiteit Twente, 96 pp.

Blois, C.J. de., & Veen, A. van der.(1997). EMBRiO. Evaluation of methods for the assessment of flood damage and flood risk in floodplains. (Phase 2 report: Non-monetary damage, discounting, and economic growth.). Enschede: University of Twente, 25 pp.

Blois, C.J. de.(1997). EMBRiO. Evaluation of methods for the assessment of flood damage and flood risk in floodplains. (Phase 3 report: Uncertainty analysis and analysis of flood data (in Dutch)). Enschede: University of Twente, 101 pp.

Kok, J.L. de.(1997). On the integration of economic input-output and dynamic process modelling. (Land-Ocean interactions in the coastal zone (LOICZ); Report of the Coastal zone science in Southeast Asia (no. 28), 24-28 November 1997. (pp. 28-33)). Den Burg, Texel: LOICZ International project office Netherlands Institute for Sea Research (NIOZ), 6 pp.

Hijum, Y.J. van.(1998). Jild as wetter: een onderzoek naar de kostentoedeling in de Friese kwantiteitswaterschappen. (Civil Engineering & Management Research Report 98R-004 / WH&M-002). Enschede: Universiteit Twente, 33 pp.

Kok, J.L. de.(1998). On the integration of economic input-output and dynamic process modelling. (Linking coastal zone change regimes to input/output modelling in South East Asia, Land ocean interactions in the coastal zone (LOICZ) report no. 32. Report of the LOICZ meeting on 7-12 december in Surat Thani, Thailand. Bijdrage de Kok p. 34-39). Den Burg, texel: LOICZ, 51 pp.

Turner, R.K., Adger, N., & Kok, J.L. de.(1998). Towards integrated modelling and analysis in coastal zones: Principles and practices. (Land-Ocean Interactions in the Coastal Zone (LOICZ) Reports and studies, nr. 11 (Bijdrage De Kok: p. 45-49)). Texel: LOICZ International Project Office Netherlands Institute for Sea Research,

Visser, M.(1998). A suspended sediment transport model for the coastal zone of Southwest Sulawesi, Indonesia. (Institute for Marine and Atmospheric Research University of Utrecht / Civil Engineering & Management, University of Twente report R-98-11). Utrecht / Enschede: Rijksuniversiteit Utrecht / Universiteit Twente, 28 pp.

Hijum, Y.J. van.(1998). Inventarisatie visies en beleidsplannen. Een inventarisatie van visies en beleidsplannen op het gebied van het watersysteem- en ketenbeheer van de bij het Waterpact Twente betrokken instanties. (rapport in opdracht van projectgroep Waterpact van Twente, Civil Engineering & Management Research report 98R-008/WH&M-005, Augustus 1998). Enschede: Universiteit Twente, 31 pp.*

Pothof, I., Keizers, N., Wind, H.G., & Engelen, G.(1998). WadBOS: Integrale modelstructuur. (Civil Engineering & Management Research Report 98R-005 / WH&M-003). Enschede: University of Twente, 35 pp.*

Hijum, Y.J. van.(1999). Kostelijk water: probleemstelling, onderzoeksopzet en probleemanalyse. (Civil Engineering & Management Research Report 99R-001 / WH&M-006). Enschede: Universiteit Twente, 65 pp.

Kok, J.L. de., & Wind, H.G.(1999). Methodology for sustainable coastal zone management in the tropics. (Final report prepared for the Netherlands organization for the advancement of tropical research under grant WK. 79.35). Enschede: University of Twente, 272 pp.

Wessel, J., Wind, H.G., & Mostert, E.(1999). Paradigms in water management. (RBA series on river basin administration. Research report 11. Proceedings of a workshop held on 5 march 1999 within the framework of ETNET). Delft: RBA Centre for Research on River Basin Administration, Delft University, 95 pp.*

* External reports registered under the category of professional publications

15d Forthcoming publications (accepted)**Academic publications****Journal articles***Refereed, International*

Augustijn, D.C.M., Baas, A., & Laane, R.W.P.M.(2010). Uncertainties in the chemical yardstick for judging the quality of Dutch water systems. *European water management*, 8 pp. ISSN 1461-6971.

Kok, J.L. de., Wind, H.G., & Titus, M.(2010). Application of fuzzy sets and cognitive maps to incorporate social science scenarios in integrated assessment models: A case study of urbanization in Ujung Padang, Indonesia. *Integrated assessment*, ISSN 1389-5176.

Conference proceedings

Booij, M.J. Model appropriateness for simulation climate change and river flooding., [Proceedings of the XIIIth international conference on computational methods in water resources, June 25-29 2000]. 8 pp. Calgary, Canada.

Hijum, Y.J. van. An institutional approach to taxing and spending., [Conference delivering and managing justice in the 21st century. European group of public administration. 1-4 september 1999].

Wind, H.G., & Kok, J.L. de. Interdisciplinary co-operation: The key to river basin management., [Proceedings statusseminar Elbe-ökologie, 2-5 nov 1999]. Berlin, Germany.

Wind, H.G., & Kok, J.L. de. Interdisciplinary co-operation: The key to river basin management., [Proceedings convention day OSW, 22 december 1999]. Delft.

Professional publications

Smink, L.M.G.(2010). *Huizenboek*. Huizenboek Rijkwaterstaat.

